DERIVATIVES MARKETS AND REAL ECONOMIC ACTIVITY

This thesis is presented in fulfillment of the requirements of the degree of Doctor of Philosophy

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DECLARATION

The candidate hereby declares that the information reported in this thesis has not been submitted to any other university or institute for the award of a degree.

Ruchi Gupta

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ABSTRACT

Arguably, the single largest innovation in global financial markets in response to financial deregulation and financial innovation over the past two decades has been the emergence and spectacular growth of derivatives markets. The dramatic emergence of derivatives has caught many Central Bankers unaware and only recently has the Bank of International Settlements (BIS) started investigating seriously the impact of derivatives on policy issues. However, what is needed is further insight into and analysis of the impact of derivative growth on macroeconomic policy and the macroeconomy. Such insights should enable policy makers to use derivatives to their best advantage. Therefore, the purpose of the study is to examine how monetary policy transmission changes in the presence of derivative markets.

There has been a striking growth in the invention and the use of new financial instruments such as swaps, financial futures and options. These instruments have increased the ability of the users to cope with fluctuations in exchange rates, interest rates and security prices. Futures and options have increased the opportunity for hedging and arbitrage between cash and derivative markets; and thus made these markets interdependent nationally and internationally. Also it means that market participants are now better equipped to insulate themselves from changes in interest rates thus reducing the impact of monetary policy as a tool for regulating or stimulating aggregate demand.

Theoretically, the presence of derivatives markets speeds up the transmission mechanism of monetary policy to the real economy by reducing market imperfections. Research shows that information is more rapidly incorporated into the prices of underlying securities in the presence of derivatives because of the link between the derivatives markets and the

underlying markets. If this is the case then it is likely that derivatives trading will reduce the impact of monetary policy on real output.

Using a Vector Autoregressive and Structural Autoregressive methodology an empirical study for the United States has been conducted to assess the impact of derivatives trading on the real macreconomy. The empirical section assesses the impulse responses due to monetary policy shocks for interest rates, output and inflation in the presence of derivatives markets trading in order to investigate the relationship between derivatives trading and the real economy.

For the macroeconomy, theory suggests that large scale derivatives trading does impact on monetary policy transmission by speeding up the transmission process across asset types, this has been confirmed by the empirical results of this study, but their impact on the real economy is still not strongly definitive. Nevertheless, the results from this study tend to support the proposition that the impact of any interest rate shock on the overall economy starts earlier than would otherwise occur in the absence of derivatives markets.

CHAPTER 1

INTRODUCTION TO DERIVATIVES MARKETS AND REAL ECONOMIC ACTIVITY

1.1 Introduction

There has long been interest in macroeconomic research on the extent to which the monetary sector influences the real sector of the economy. Moreover, there has been vigorous debate dating back to Keynes on whether the transmission mechanism from the monetary sector to the real sector is direct or indirect, and the extent to which money matters in macroeconomic management and performance. However, there have been huge changes in world financial markets over the last two decades and the financial markets of today bear little resemblance to the financial markets of yesterday. Arguably, the single largest innovation in global financial markets over the past two decades has been the emergence and spectacular growth of derivatives markets. Derivatives, sudden presence has caught most Central Bankers unaware and only recently the Bank of International Settlements (BIS) has seriously started investigating the impact of derivatives on policy issues. A lack of definitive conclusions over the impact of derivative growth on policy may pose a significant problem. The purpose of this thesis is to examine how monetary policy transmission, changes in the presence of derivative markets.

Many factors have contributed to the changed monetary economy including the abolition of exchange controls, and the breaking down of entry barriers to national markets, including those preventing foreign or institutional ownership of security dealers. Deregulation of commission rates in the United States, the United Kingdom and other markets have removed major legal and institutional obstacles to cross-border capital flows. Again there has been a virtual revolution in information and computer technology that has accelerated the international flow of information to markets. Improved technology has also driven down the cost of operations, thereby permitting the use of various hedging strategies. Throughout this period a wide range of financial products emerged and the funds managers developed varied strategies regarding risk and return analysis.

Diversification alone, as a means to manage risk, is not adequate in today's world of change, characterised by rapidly advancing technology, deregulation, financial product proliferation, and volatile financial markets. In these free conditions large institutional investors are seeking avenues to diversify their portfolios. Multinationals are searching for the best terms on which to finance their operations. The amount of funds investors have to invest and the multinationals need to finance has been growing rapidly. New strategies like hedging and new tools of hedging are now required, and derivative instruments meet this requirement.

The increased use of derivatives for interest rate risk exposure is said to have changed the interest rate elasticity of investment, creating further changes to the transmission mechanism of monetary policy and thus to the real sector. This study aims to analyse these changes and develop relevant policy implications.

In consequence, there has been an expansion in cross border investment in bond markets, equity markets, and the derivatives markets and in international equity issues. There has been a striking growth in the invention and the use of new financial instruments such as swaps, financial futures and options. These instruments have increased the ability of the users to cope with fluctuations in exchange rates, interest rates and security prices. Futures and options have increased the opportunity for hedging and arbitrage between cash and derivative markets; and thus made these markets interdependent nationally and internationally. Swaps have enabled lenders and borrowers with different preferences for currencies or for fixed and floating rate interest payments or receipts, to find the terms which they consider the most suitable for them, by exchanging obligations with counterparties with complementary preferences. In doing so the financial markets are integrated internationally.

Today, financial markets are playing an increasingly important role in the transmission of monetary policy. The effects of monetary policy are transmitted mainly through financial markets as they adjust much faster than product markets.

A significant amount of recent academic research is focussing attention on the idea that financial factors reinforce real fluctuations. The common presumption behind this reasoning is the fact that monetary shocks lower the value of an asset that is used to secure a firm's borrowing. Moreover, the frequent volatility in interest rates makes external financing more difficult and expensive. In turn, this lowers the aggregate investment and prospects for output even further. Given the uncertainties surrounding movements in interest rates and currencies, financial and non-financial institutions are increasingly using derivatives to hedge or protect against future unwelcome shifts. These economic uncertainties can have huge financial repercussions and can rob the institutions of profits, in the same way that a bad season can deprive a farmer of his income. One way to protect against these uncertainties is to engage in hedging activities.

As a result, an increased role for dynamic hedging activity has emerged since the beginning of the 1990s. However, such hedging may be another source of increased sensitivity of asset prices to monetary policy actions through a strengthening of the relationship between short term and long-term interest rates. Past research by (Vrolijk, 1997) has found that the greater use of derivatives can have two important ramifications for financial markets. First, they have speeded up the transmission of monetary policy from short-term interest rates, which are more sensitive to monetary policy developments to the price of the assets in other markets. This has been achieved by raising asset price substitutability across financial markets. For instance, an interest option contract based on government securities can be used to protect against a change in interest rates on a corporate security. This practise increases the link between the government and corporate securities markets. Second, the greater use of derivatives may help the financial market reaction to monetary policy be less abrupt because they are designed to help insulate firms, at least temporarily from unexpected changes in revenue and debt servicing costs. According to the survey of the global markets conducted by the Bank of International Settlements (BIS, press release ending May 2001), interest rates and currency derivatives dominated the market, accounting for about $29 trillion and $18 trillion, respectively or about 98% of the total. As a result of structural changes in financial markets, financial adjustments to shocks may have become larger and less predictable. They are transmitted faster and wider, posing threats for macroeconomic stability and this in turn could mean fresh challenges to the market participants and regulators. As Myron S. Scholes rightly states:

> "...the future will be a continuation of the present. Financial innovation will continue at the same, or at even an accelerating, pace because of the insatiable demand for lower cost, more efficient solutions to client problems. Information and financial technology will continue to expand and so will the circle of understanding of how to use this technology... Although some would like to see derivatives wither in importance, they will not for they have become essential mechanisms in the tool kit of financial innovation." (Scholes 1996, p.271-86)

1.2 Contribution to Knowledge

Monetary policy is an important policy tool; so important in fact that in most economies monetary policy is under the control of independent expert panels. In the US, this is done by the Federal Reserve Board of Governors. There has been a debate in academic circles as to whether "money matters". That is, do changes in monetary policy affect the real sector of the economy or does monetary policy accommodate real sector activity? What is agreed is that changes in monetary policy have long-lived effects upon the economy and are associated with long time lags. However, the traditional academic debate may now be a non-sequitor to some extent because of the emergence of the new types of financial assets known as derivatives. The emergence of derivatives and their related markets raises interesting new questions about their potential impact upon the monetary and real sectors, and on the transmission mechanism between the monetary and the real sectors. One obvious question is to what extent has the emergence of derivatives weakened the role of monetary policy? Therefore, an important contribution of the research contained in this thesis is to enable:

- An analysis of the relationship between the derivatives markets and real economic activity through their impact on the monetary policy transmission mechanism; and
- Empirical Testing of the long-term economic impact of the increased turnover in the derivatives markets on the macro economy.

1.3 Statement of Significance

The thesis provides a deeper understanding of the nexus between the derivatives markets, the monetary policy transmission mechanism and its effects on real economic activity. The rationale for studying the relationship between financial and real economic activity arises from both theoretical models and empirical evidence, that indicate movements in financial asset prices are potentially important for understanding how the economy behaves. The phenomenal growth in the turnover of derivative instruments has made them an important financial sector. This market is relatively new and is growing fast. The literature in financial economics is relatively quiescent with regard to derivative market activity. Past studies have particularly examined the association of the stock markets to Monetary Policy and Real Economic Activity. But similar kinds of studies are limited in regard to derivatives markets. This study attempts to fill this gap in knowledge. Figure 1.1 explains the traditional relationship and causation between the real sector and the monetary sector. This study will focus on the U.S derivatives markets and the economy of the U.S. The U.S is the financial centre of the world and has the most sophisticated derivatives markets; lessons learnt in this case will have universal impact especially for developed economies because of the dominant role played by the U.S financial markets in the world.

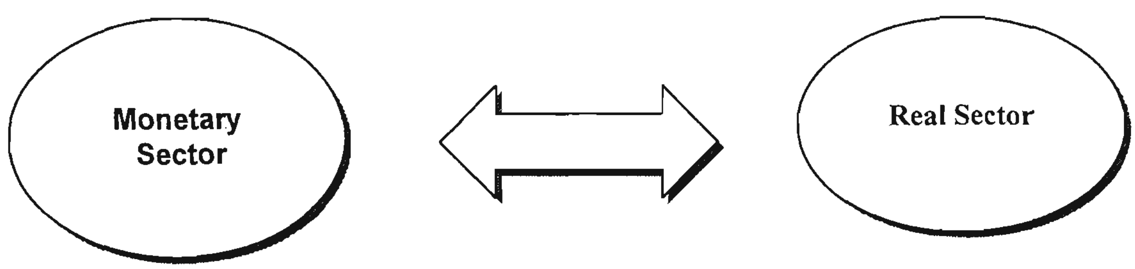


Figure 1.1: Traditional Transmission Mechanism of Monetary Policy

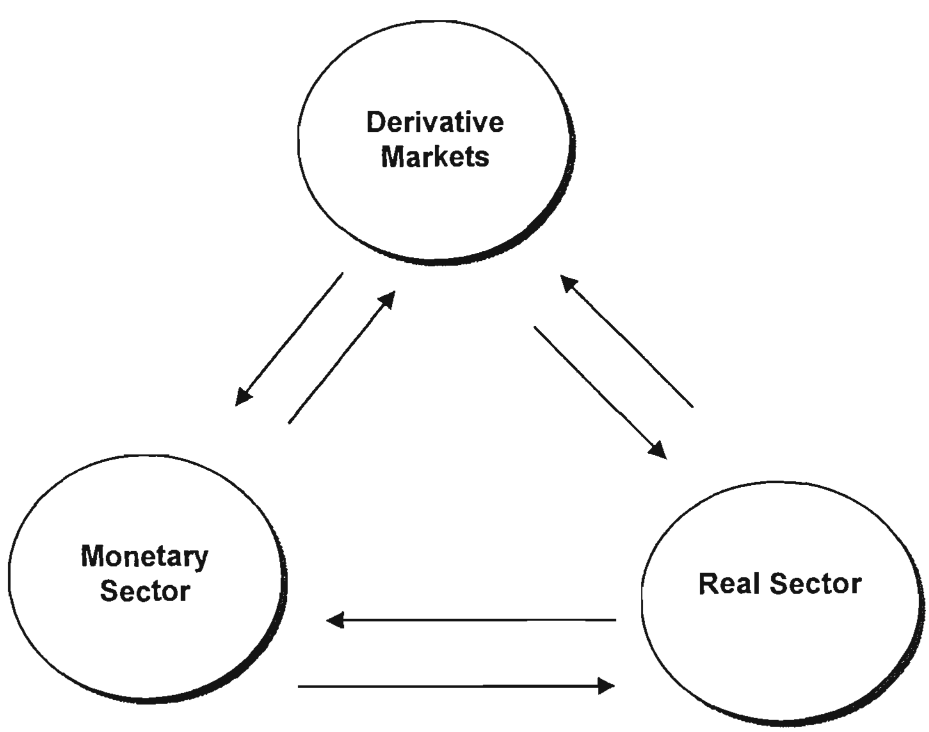


Figure 1.2: New Transmission Mechanism of Monetary Policy

Figure 1.2 portrays the relationship between the real and monetary sectors in the presence of derivatives markets. The thesis tests a set of hypotheses concerning the extent to which the existence of derivatives markets impact upon the transmission mechanism of monetary policy for the U.S economy.

1.4 Structure of the Thesis

This thesis is organised as follows. Chapter 2 is an overview of the growth of the derivatives markets and its historical development. This chapter also outlines the different channels of the monetary policy transmission mechanism, their relative importance and the likely impact of derivatives trading on the effectiveness of each of these channels. The relative importance of this section stems from the current scale of derivative markets as reported by the Bank of International Settlements (BIS, 1995), which when combined with the risk and price hedging opportunities offered by derivatives is likely to offer a possible change in both the transmission and the effect of monetary policy.

Chapter 3 examines the role of the derivatives markets for hedging risk and the ramifications it has for the global financial markets. The emphasis is more on whether the use of derivatives has actually speeded up monetary policy transmission, or has inturn made the reaction by players in the financial markets less dramatic, by creating a position where business firms are in a better position to insulate themselves from risk. Thus, this chapter examines the impact of financial innovation in particular derivatives on the overall functioning of the financial system.

In Chapter 4, the major theoretical contributions to the nexus between financial markets and real economic activity are outlined. This begins from the classical view of the neutrality theory of money, where it affects the nominal and not the real variables (output, employment and interest rates). Money is neutral when changes in money stock lead only to changes in the price level, with no real variables (output, employment, and interest rates) changing. The Monetarists (Friedman and Fisher) make an important distinction between the long and the short run effects of changes in money. They argue that in the long run money is more or less neutral, but it does have important real effects in the short run. An extreme contrast to the above view comes from (Keynes, 1936), that money does play a role of its own. The literature review is carried further to more recent works. Past research examined whether growth in financial variables led to an increase in real activity and the impulse responses quantifying the absolute and relative sizes of these effects. These tests address the fundamental and still controversial issue of whether financial development merely proceeds along with, or follows from economic growth emanating from real-sector forces, or whether growth is finance led. The research extends the idea above, but with special emphasis on derivatives markets. It will also look into the changes derivatives markets have brought in the monetary policy transmission mechanism. The literature survey will also undertake a comprehensive review of the various modelling methodologies used to date.

Chapter 5 introduces the econometric methodology used to test a range of hypotheses relevant to the central research questions. The chapter deals with a range of issues including variable selection and model development. Following the recent trend in studying the relationship between monetary policy and real output, this chapter outlines the VAR methodology. A range of statistical analyses are conducted to test the specification issues involved with time series properties (i.e., unit root, ordering) for each variable.

Chapter 6 first develops the vector Autoregression (VAR) process originally proposed by (Sims, 1980) and the results are verified using the Structural Vector Autoregression approach (SVAR). The chapter aims at aggregating the impact of derivatives on monetary policy transmission to the real economy through empirical analysis for the U.S economy, as it is difficult to weigh the importance of individual channels of monetary policy. If the impulse response functions are less lagged in the sample period then it will indicate that derivatives do affect monetary transmission and hence real economic activity. SVAR is a useful tool to analyse the macroeconomic response of the economy. This methodology has an additional advantage over VAR, as it requires a minimum set of identifying restrictions in order to separate the movements of the model's variables into parts, due to underlying shocks. The models estimated in this chapter will directly incorporate the derivatives market size variable as measured by the amount of turnover on the Chicago Board of Trade. Most SVAR studies try to ascertain the impact of a particular event or structural change to compare the impulse responses in the sample before and after the change. In this chapter the model is estimated by directly incorporating the derivatives markets in the sample period itself. This method is preferred as it means that differences in policy transmission with and without derivatives will be attributable to both the growth in derivatives markets and any structural change that was co-integrated with the growth of derivatives markets, in the U.S economy.

Finally Chapter 7 presents a brief overview of the success of the empirical model and the policy implications that can be derived from the econometric analysis.

1.5 Summary

This thesis investigates questions concerning the dramatic rise in the size and importance of derivative markets and how the emergence of derivatives markets impacts upon the transmission mechanism of monetary policy. Figure 1.3 presents a summary stylised flow diagram of the essential relationship between derivatives markets and the critical question concerning the relationship between the monetary sector and the real sector of the economy. Figure 1.3 further illustrates the fact that market imperfections lead to the growth of derivatives markets which in turn lead to changes in the monetary sector through reduced demand for money. The reduced impact of monetary aggregates, reducing market imperfections ultimately makes the real sector less sensitive to monetary sector changes. As argued in Chapter 3 derivatives are a step closer towards complete markets. They lower the transaction costs, and thus it is possible to say that their prices provide more accurate information about the nature of monetary shocks. This information should help agents to differentiate between real and nominal disturbances thereby reducing any potential real effects of monetary policy. A reduction of the real effects of monetary policy is likely to reduce the powers of the Central Bank, as there will be a limited role for it to influence real output. Hence we come to the key question: Is the real sector of the economy less sensitive to monetary sector influences?

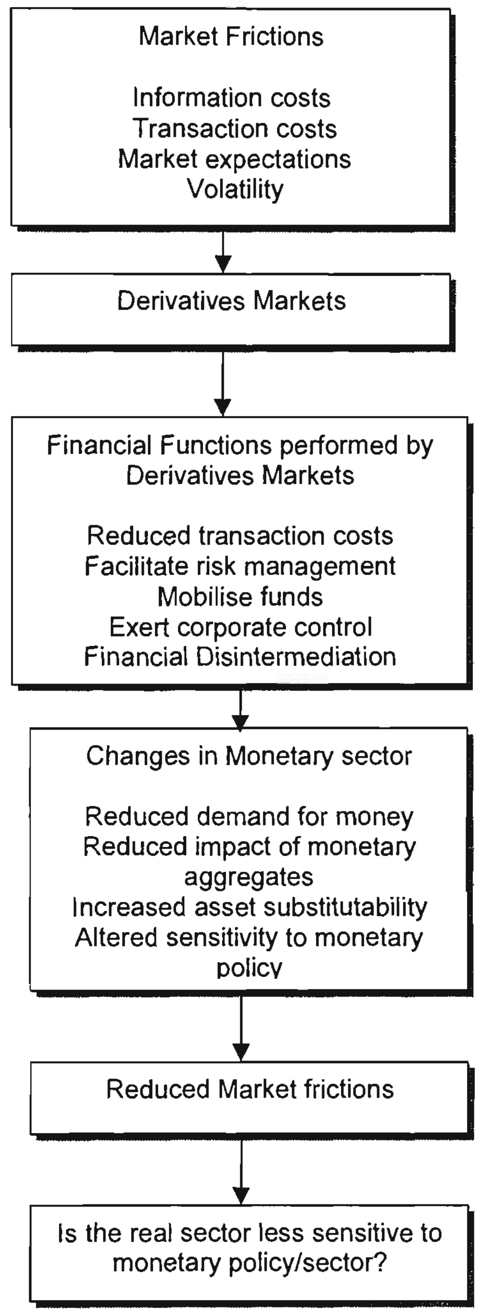


Figure1.3: Theoretical Approach

CHAPTER 2

THE DERIVATIVES MARKETS AND MONETARY POLICY TRANSMISSION MECHANISM

2.1 Introduction

This chapter is effectively split into two parts. The first part introduces the concept of derivatives and describes their growth over the past two decades. The second part describes the transmission mechanism of monetary policy. The aim of this chapter is straightforward: to highlight the importance of the growth of derivatives markets, and to examine how monetary policy transmission changes in an economy with sizeable derivatives markets. In the second part of the chapter the impact of derivatives on monetary policy is closely examined, with special emphasis to the individual channels of monetary policy transmission.

Arguably, the single largest innovation in global financial markets over the past two decades has been the spectacular growth of derivatives markets. Derivatives markets have developed because they give market participants the ability to gain control over the entire range of risks associated with doing business, whether that involves delivering services worldwide or managing a global investment portfolio. Derivatives are the main financial tool for managing financial risk, and the range of characteristics that make them desirable as assets are as follows:

- Their value is linked to the value of an underlying asset without the holder of the derivative having a fully paid up position in the real asset.
- A further attraction to users of derivatives is improved liquidity and lowered transaction costs, for example searching for a counterpart with matching needs.

- Banks may customise derivatives to meet the particular portfolio needs of corporate customers. The risk characteristics of assets and liabilities may also be more readily changed by the use of derivatives. This allows corporations to hedge their interest rate and exchange rate obligations against market volatility with ease.
- Derivatives contribute to efficient markets by providing more numerous options for investors, thus making the market complete. Arrow (1954) suggests that markets become more complete as contingent claim securities are added to the economy. In a complete market, the number of securities would equal the number of possible states of the world. Individuals would be more willing to assume risk if they had the means of insuring against all possible future states. In other words, in a more complete market, investors would have the choice of reducing uncertainty and obtaining a more desirable outcome, regardless of the state of the world. Thus, in a world of more complete markets, financial market participants would create more derivatives related to the different risk factors like inflation rates, exchange rates and interest rates that influence the future state of the world, and would be more willing to take risk. The proliferation of derivative instruments in the last two decades has no doubt produced more complete markets.
- There are also regulatory advantages to the use of derivatives. Swaps for instance, require little or no principal; thus little bank capital is needed to be set-aside as reserves to meet bank regulations.
- Derivatives are often used as risk management instruments and are available in the form of swaps, options, traded futures (exchange) contracts and forwards.

2.2 Definition and Early Growth of Derivatives

Derivative instruments have a very long history and can be traced back to the 6^{th} century BC in Greece, where forward contracts were traded in olive presses. In Europe negotiable instruments were traded in the Middle Ages, and in 17^{th} century Japan, rice futures were actively traded (Securities Institute, 1997). The use of derivatives rapidly expanded during the early 1970s due to extreme uncertainty in the business environment. The rise in uncertainty of exchange rates, interest rates, and commodity prices can be traced back as far as the mid 1900s. However, volatility was continuous and marked from 1973 when the Bretton Woods System of exchange rate fixing was abandoned. The high levels of volatility that followed changed the business environment forever. Changes in prices created stiff competition where none previously existed. This environment led to considerable demand for risk management instruments and financial economists in research and practise responded; accordingly, the presence of risk is an inducement to innovation in order to shift the burden of risk. Other forces motivating changes in the market place are increased competition in the financial market, the desire and the need to circumvent regulatory constraints, the shifting patterns of net flows of international savings and investment, the need to create a massive pool of funds to finance huge projects, and the shifting preferences of borrowers and lenders.

Derivatives are powerful, useful and conservative tools that shield companies from margin erosion and commodity price changes. Risk management methods come in a variety of forms such as capital structure management, short-term cash management; self and purchased insurance and derivatives instruments provide formidable speed by which positions can be altered. Derivatives allow hedged positions to be rebalanced rapidly and simplify active exposure management. There are a variety of instruments available to practitioners and the combinations of instruments are almost unlimited. Derivative markets have developed because they give market participants the ability to gain control over the entire range of risks associated with doing business, whether that involves delivering services worldwide or managing a global investment portfolio. The combination of new and efficient technologies and analytical tools provide the means to fundamentally affect the risk characteristics of any business or investment portfolio by creating products designed to reallocate exposure and risks.

A derivative can be defined as a contract whose value depends on (is derived from) the value of an underlying asset, benchmark rate or index. The "underlying" asset can be a stock, bond, currency, an interest rate index, a share price index or a commodity. For example, the value of an interest rate swap is related to the yield on the reference of a treasury bond and the premium of a share price index option depends on the value of the selected index of shares. The Bank of International Settlements (BIS) defines a financial derivative as:

> "a contract whose value depends on the prices of underlying assets, but which does not require any investment of principal in those assets. As a contract between two counterparts to exchange payments based on underlying prices or yields, any transfer of ownership of the underlying asset and cash flows becomes unnecessary." (BIS, 1995)

The Macquarie Dictionary's definition of the word 'derivative' is: "derived...not original or primitive; secondary." The definition of the word 'derive' is: 'to receive or obtain from a source of origin'. The bottom line is that a derivative does not stand-alone but is in some way related to something else. A financial derivative is related to one or another of the financial markets such as the stock market, interest rate market, foreign exchange and so forth. The market to which the derivative instrument is related is called the underlying market.

2.2.1 Market Characteristics

Derivative instruments can be classified according to the type of market in which they are traded. There are two fundamental types of market:

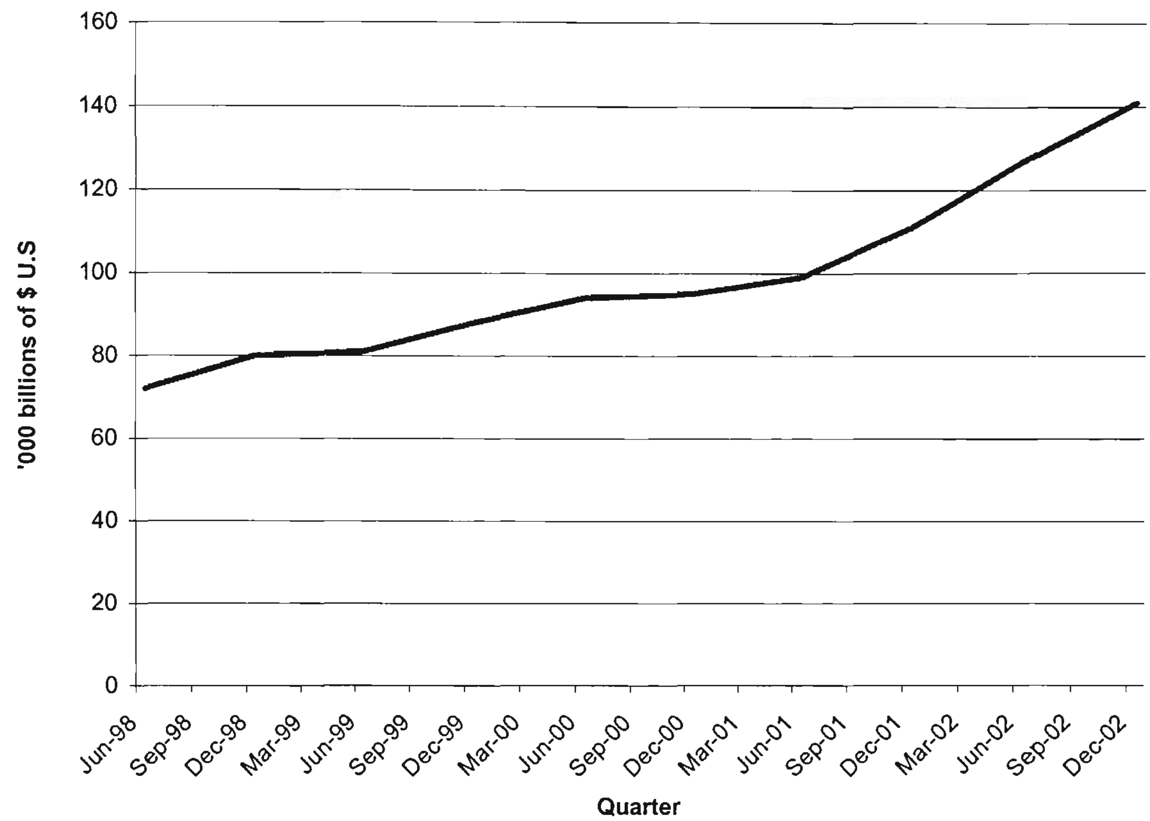
- Exchange traded based on formalised exchange.
- Over-the-counter markets which are outside a formalised exchange.

Derivatives may be traded over-the-counter (OTC) or openly on organised exchanges. OTC contracts are negotiated privately between the counter-parties, typically between dealers and end users. They are customised rather than standardised. For example, a corporation with an ongoing borrowing program approaches a bank derivative dealer with a view of swapping floating for fixed rate funds. The terms of this interest rate swap such as amount, maturity and interest rates would be negotiated between the bank and the corporation.

Exchange-traded derivatives are standardised regarding amount, maturity and delivery mode. The clearing bears the credit risk. Futures are always traded on organised exchanges; options are traded on exchanges and OTC. OTC derivatives have an advantage over listed derivatives in that they provide complete flexibility and can be tailored to fit an investment strategy. In fact, one of the keys to the success of OTC derivatives is the flexibility of the structures. A fundamental difference between listed and OTC derivatives are that listed options and futures are guaranteed by the exchange; while in the OTC market the derivative is guaranteed by the issuer. Thus, the investor is subject to counterparty credit risk. The derivative instruments include forward contracts, futures, options and swaps, combinations of futures and options, caps, floors, collars, and exotic derivatives such as swap options. The market underlying derivatives pertains to foreign currencies, interest rates and bills, equities and commodities.

2.2.2 Overview of Global Derivative Markets

In July 1997, the Bank for International Settlements (BIS) began releasing a semiannual report on market statistics for OTC derivatives. The data covers four main categories of derivatives: 1) foreign exchange, 2) interest rate, 3) equity, and 4) commodities. Figure 2.1 graphs the phenomenal increase in the growth of financial derivatives since 1998 to 2002. In the initial stages the growth was moderate but since 2000 onwards the growth in derivatives has been sharp and steady.



Source: BIS

Figure 2.1: Growth of Financial Derivatives: Notional Amount Outstanding of Total Contracts for Over the Counter Derivatives

Data released by the BIS on positions in the global over-the counter (OTC) derivatives market show continued market growth in the first half of 2000. The total estimated notional amount of outstanding OTC contracts stood at $94 trillion at the end-June 2000, a 7% increase over end-December 1999 and a 30% increase since end-June 1998, when the BIS survey was initiated.

At the same time, the ratio of gross market values to notional amounts outstanding continued their downward trend. Growth in the first half of 2000 was led by activity in forward-type contracts, particularly interest rate swaps, outright forwards and foreign exchange swaps. In terms of broad market risk categories, interest rate, foreign exchange and commodity contracts expanded at about the same pace, while equity contracts declined. The overall buoyancy of activity in OTC derivates markets contracts on the derivatives exchange (Figure 2.1) is a trend evident for much of the 1900s. The notional amount measures the face value of a contract to which the exchange rate, the interest rate or the index are applied to compute the cash flow of the derivative. As a general rule, the notional amount is often not actually owned and cannot be claimed; therefore it does not indicate the riskiness of the derivatives position. A more appropriate measure is given by the gross market value of derivatives. The term gross market value of derivatives represents the cost of replacing the contracts at market prices prevailing at that time. For this reason, the term replacement value of derivatives is also used. For example, the gross market value of an option equals its premium. It measures the cost or the gain that would occur if the option had to be replaced for one reason or another, such as option-writing bank defaulting. It is a more meaningful measure of the economic relevance of contracts than their notional amounts. The term gross indicates that no netting of offsetting contracts within banks has occurred. There are a number of developments across the different risk categories. For example, there is a continued rise in the share of euro-denominated transactions, particularly in interest rate swaps, where the euro has extended its lead as the largest currency segment. At the same time, the rate of expansion of yen-denominated contracts slowed down relative to the previous review period. In addition, business with non-financial customers expanded fastest in all risk categories.

The interest rate segment expanded by 7%, to $64.1 trillion over the previous reporting period of end June 1999. With the stock of forward rate agreements (FRAs) and options stagnating, growth was concentrated in swaps by 9%, to $48 trillion in the same period. Swaps have increased at a more robust pace than other interest rate instruments in recent years. This can be attributed to the following factors. Firstly, the growing variety of structures on offer has enabled the swaps market to respond in a more flexible way to the risk management requirements of market participants than exchange-traded markets. Secondly, the introduction of the euro has led to a rapid expansion of European capital market issuance, with some of the resulting exposure likely to have been hedged in the interest rate swap market. Thirdly, net repayments of securities by central governments in some of the major reporting countries have affected the liquidity of government bonds markets and the effectiveness of traditional hedging vehicles, such as government bond futures. This has encouraged market participants to switch to more effective hedging instruments such as interest rate swaps.

In the area of currency instruments, the values of contracts outstanding increased by 8%, to $15.5 trillion, following a slight decline in the previous reporting period at the end of December 1999. All types of instruments shared in the expansion, with outright forward and forex swap contracts rising more rapidly (by 9%), followed by currency swaps (7%) and options (3%) from the previous reporting period to the end of December 1999. Some of the increase in the outright forwards and forex swaps can be easily attributed to the increase in the activity in the international interbank market since the second half of 1994. There was also a sharp increase in the currency contracts involving the euro (26%). Contracts involving the US dollar and Sterling grew by 9% and 11% respectively in the period ending December 1999.

Activity in the equity-linked sector declined by 85%, to $1.7 trillion from the end of December 1999. Much of the drop was accounted for by contracts on US equities held by non-financial market participants. The equity-linked sector is still considerably smaller than the foreign exchange or interest rate market segments. Commodity derivatives markets expanded by 75%, to $0.6 trillion in December 1999. The rate of expansion of gold contracts, the largest single group in that market segment, slowed considerably relative to the previous review period (to 8% from 29%). Estimated gross market value declined by $232 billion, to $2.6 trillion. The ratio of gross market values to notional amounts outstanding fell to 2.7% at the end-June 2000 from 3.2% at end-December 1999, maintaining the downward trend since the BIS began collecting over the counter (OTC) market data. Lower ratios were recorded in all market risk categories, with the exception of the commodity-linked segment, which saw an increase. The most pronounced decline took place in foreign exchange instruments (to 3.7% from 4.6%). Much of the reduction was accounted for by contracts involving the yen, which was consistent with lower volatility of the underlying market during the review period. The decline was less substantial for interest rate instruments (to 1.9% from 2.2%) but was nevertheless noticeable in the euro segment (to 2% from 2.4%) and the yen sector (to 1.6% from 1.9%), probably also reflecting the lower volatility of the underlying markets. The gross market values exaggerate actual credit exposure since they exclude netting and other risk reducing arrangements. Allowing for netting, the derivatives related credit exposure of reporting institutions was considerably smaller ($937 billion, or about 1% of notional amounts outstanding).

Data released by the BIS on positions in the global OTC derivatives market show a marked slowdown of the market growth in the second half of 2000. The total estimated notional amount of outstanding contracts stood at $95.2 trillion at the end of December 2000 a 1% increase over end June 2000 and an 8% increase since end December 1999. At the same time the gross market value[1] rose by 24%. The interest rate segment expanded by only 1% in the second half of 2000, to $64.7 trillion.

Commodity derivatives markets expanded rapidly, to $0.7 trillion. The stock of gold contracts went down substantially (by 16%) as the gold market showed marked reduction in the price swings as compared to the previous year. The stock of "other" commodities contracts expanded at a record pace (by 38%), the upsurge in oil prices could well explain the active business in commodity contracts.

Activity in the equity-linked sector grew strongly, to $1.9 trillion, with the entire expansion-taking place in the equity option segment. Year 2000 saw uncertainty in the global stock markets with a downward pressure on the prices of technology stocks. Data from the BIS survey on positions in the global OTC derivatives market at the end of December 2001 point to an increase in activity. The total estimated notional amount of outstanding OTC contracts

[1] Gross market value is defined as the sum of the positive market values of all reporters' contracts and the negative market value of their contracts with non-reporters.

stood at $111 trillion at end-December 2001, an increase of 11% over end-June 2001. Gross market value grew by 24% to $ 3.8 trillion. Interest rate instruments, the largest of the broad market risk categories, drove growth, with outstanding contracts rising by 15%. Notional principal outstanding amounts for interest rate swaps and options and currency swaps were $69.2 trillion at the end of 2001 compared with $57.3 trillion at mid-year and $63.0 trillion at the end of 2000.

These numbers represented a 20% increase since the Mid-Year Survey and a 10% increase on the year. Among the top dealers, volume increased 20% from $34.7 trillion at the end of 2000 to $43.0 trillion at the end of 2001; virtually all of the increase occurred during the second half. For the period ending June 2002 there was a further acceleration in the OTC market activity. The total estimated notional amount of outstanding OTC contracts stood at $128 trillion, a 15% increase over end-December 2001. This is testimony to the value that these products bring to market participants in managing risk in times of volatility and uncertainty. There was an unusually robust growth in euro denominated interest rate swap contracts in the second half of 2002. As a result, the total estimated notional amount of outstanding OTC contracts stood at $141.7 trillion at the end of December 2002, an 11% increase from the end of June 2002. At the same time, gross market values grew sharply, rising by 43% to $6.4 trillion, compared with an 18% increase in the first half of 2002. The following trends are notable (BIS, 2003):

- Substantial rise in gross market values,
- Strong double digit growth in notional amount outstanding,
- Euro-denominated swap instruments dominate,
- Subdued market for currency derivatives,
- OTC business accelerates relative to that on the exchanges.

This discussion combined with the evidence in Figure 2.1 highlights the tremendous growth in the use of derivatives over the past fifteen years or so. It is now important to consider the reasons that have been identified to explain the higher growth.

2.2.3 Reasons for Growth

Some of the reasons explaining the sudden surge in financial innovations can be attributed to the following (McClintock, 1996):

- The increased volatility of financial markets since deregulation and globalisation engendered hedging needs and attracted speculation.
- Derivative products are cheaper.
- Derivatives allow investors to take a large leveraged position. In the case of exchange traded derivatives, only a fraction of the contract value has to be paid up front in the form of a deposit. A low margin requirement and low premiums provide high leverage. Leverage appeals to speculators.
- The easing of legal and regulatory barriers provided the industry with the freedom to expand and introduce new products. The Basle Capital Adequacy Requirement treats exchange-traded derivatives quite favourably by recognising their relatively low credit risk.
- The move to floating exchange rates: impetus towards financial innovation was provided by the collapse of the Bretton Woods regime of fixed exchange rates. Wide fluctuations in exchange rates followed, soon adding uncertainty to all international financial transactions. A response to this increased uncertainty was the development of the exchange traded foreign exchange futures contracts by the Chicago Mercantile Exchange, or the CME.
- Financial Regulation: Different regulatory structures stimulated the process of financial innovation. The most striking example is that of the swap in which a corporation

exchanges its fixed rate-borrowing obligation for another's floating rate obligation in an infinite way.

- Computers and information technology: The immense volume of transactions undertaken these days can be attributed to the data processing capacities of the computer.
- Substitutability of assets: Derivatives make arbitrage between two different assets or two similar assets denominated in different currencies much easier. The extra trading caused by arbitrage transactions increases liquidity and improves market efficiency.
- Allows smoothing of income due to fluctuations in interest, currency, and asset prices.
- Allows domestic agents to concentrate on their strengths since non-core risks such as interest rate and currency risk are priced away.
- Increased capital inflows since foreign agents can price away currency risks.

In summary, the factors contributing to the growth of the derivatives markets can be summed up as demand and supply side factors.

On the demand side, increased risk, increased market volatility, greater corporate need to hedge interest rate risk and the diversification of institutional investors into international equities all contributed to growth in derivatives trading. At the macroeconomic level, the shift from a fixed exchange rate to a floating exchange rate regime in 1973 resulted in greater exchange rate volatility. Similarly, the Federal Reserve's switch from targeting interest rates to monetary aggregates in 1979 generated interest rate volatility. More temporary but sudden bouts of volatility were triggered by the stock market crash of 1987 and the currency crisis of 1992 that also increased demand for derivatives as ways of reducing market risk.

On the supply side of the derivatives markets, the market making activities of large brokers and bank intermediaries, made rapid growth possible, as well as low regulatory barriers. Along with low capital requirements and the off balance sheet treatment of swaps, product and process innovation have further contributed to an increased supply of derivatives. The outcome has been a significant improvement in the ability of derivatives dealers to customize instruments to meet the particular needs of clients' portfolio strategies.

Therefore, extensive derivative usage produces efficiency in capital markets. The increase in liquidity through leverage, dynamic hedging and larger capital flows leads to more accurate price discovery. In addition, the substutability of assets results in diminished price discrepancies between different assets, which leads to more accurate prices in otherwise illiquid markets.

Low transaction costs increase market efficiency. Large capital inflows raise the level of capital supply, again reducing the price of capital. Finally, certain types of derivatives such as swaps, allow two or more agents to enjoy gains from trade through comparative advantage in obtaining either fixed of floating rates of interest on capital.

In terms of the impact on the real economy, the more preferable risk distribution through hedging, combined with the lower cost of capital, allows agents to better concentrate on their specific strengths leading to larger sustainable growth rates.

2.2.4 Large Global Size and Potential Impact

It is likely that derivatives may have a significant impact on monetary policy transmission and its effectiveness on the real economy. The growth in derivatives markets was accompanied with a host of other structural changes in the world of financial markets and therefore it is difficult to empirically isolate the impact on monetary policy due to derivatives trading alone. To analyse the impact of derivatives on the real economy it is important to individually look at the different channels of the monetary policy transmission mechanism, and this is carried out in the following section.

A lot of factors have contributed to changes in the financial markets. The abolition of exchange controls, the breaking down of entry barriers to national markets, including those preventing foreign or institutional ownership of security dealers. Deregulation of commission rates in the U.S, the U.K and other markets have removed major legal and institutional obstacles to cross-border capital flows. A virtual revolution in information and computer technology has accelerated the international flow of information to markets. Improved technology has also driven down the cost of operations, thereby permitting the use of various hedging strategies. These changes occurred simultaneously with the growth of the derivatives markets and each change is closely intertwined with the other. For example, globalisation of markets is among other things, a result of increased derivative use. A net effect of the increased capital flows is an increase in liquidity and the availability of capital at a global level.

Diversification alone as a means to manage risk is not adequate in today's world of change characterised by rapidly advancing technology, deregulation, financial product proliferation, and volatile financial markets. New tools are required, and derivative instruments meet this requirement.

The increased use of derivatives for interest rate risk exposure is said to have changed the interest rate elasticity of investment, which means further changes to the transmission mechanism of monetary policy and its impact on the real sector.

2.2.5 Policy Effectiveness on Overnight Rates

Since the most important tool of monetary policy is the overnight rate, it is important to analyse the possible impact of derivatives on the management of overnight liquidity. One area where derivatives have not had a substantial impact is in overnight cash rates or the management of overnight liquidity. Substitute synthetic derivatives are not accepted by Central Banks in the settlements system and banks require net cash positions at the day's end. Thus, from an operational perspective, there is no change in policy effectiveness via overnight rates. However, it is true that derivatives contribute by rapid short-term rate changes to other asset prices. Derivatives do affect liquidity at the day's end and so may affect the demand for overnight liquidity as a whole (Smith and Hentschel, 1997).

2.3 Derivatives and Monetary Policy Transmission Channels

Monetary Policy is a powerful macroeconomic stabilization tool. But to be successful in conducting monetary policy the monetary authorities must have an accurate assessment of the timing and the effect of their policies on the economy. For this to happen, it is important that there is an understanding of the mechanism of the transmission of monetary policy in the economy. The term "monetary transmission mechanism" has evoked different opinions from different researchers in the past. The symposium on "The Monetary Policy Mechanism" as published in the Journal of Economic Perspectives (1995) featured the different views of the writers. For instance Bernanke and Gertler (1995) emphasise the credit channel; Meltzer (1995) promotes the monetarist view of recognizing multiple assets. Different observers weigh differently the various specific channels through which monetary policy works. An understanding of the transmission process is essential to the appropriate design and implementation of monetary policy. Changes in the structure of the economy including changes in balance sheet positions, the financial markets and instruments or in expectations concerning future policy - tend to alter the economic effects of monetary policy. In this study the concept of a transmission process is similar to the one given by Taylor (1995), "the process through which monetary policy decisions are transmitted into changes in real GDP and inflation".

For emerging markets, the impact of derivatives on the money channel of monetary transmission is ambiguous, because of the following factors:

- Derivatives may increase the speed and the extent of the transmission of monetary policy, as yields would adjust faster to changes in the money market rate,
- Derivatives may make financial flows more independent of central bank decisions reflected in the money market rate.

In the past the banking system and the money market were the first link in the transmission mechanism. But to a large extent they were just a mechanism – that is a system that passed on the impulse response function to the rest of the economy without producing any unpredictable reactions of its own. This is no longer the case. In recent years the financial markets have become an active force. They have acquired an active role working for macroeconomic stability or against it. The growth of financial markets may enhance the effectiveness of monetary policy. Announcements of specific policy objectives may enhance market expectations in a positive direction and if this is the case, then the derivatives markets will be adding power to the process.

The Federal Reserve can influence liquidity in the payments clearing system, by shifting the interest rate at the short end of the yield curve, which is the cash rate. The cash rate is the operating instrument to influence activity and prices. The transmission process can operate as follows:

Real output depends on real interest rates. Higher interest rates create an output gap – a deviation of potential output from the actual output through direct effects and indirect effects on wages. Changes in interest rates also affect exchange rates, which feed indirectly into prices thereby influencing economic activity. Price expectations depend on past price increases and on the anti-inflationary credibility of the central bank. Credibility can be defined as a measure of confidence by the public in the policy commitments of the central bank. A more precise definition of credibility addresses the problem of time consistency (Kydland and Prescott, 1977). A policy is credible if, given objectives, the policy maker maximises by choosing the expected policy action when the time comes to act. Credible policy depends on the objectives of the policy maker, on the expectations of the public, on the public's knowledge of the rule. Schematically it can be represented as follows (see Figure 2.2) (Taylor, 1995):

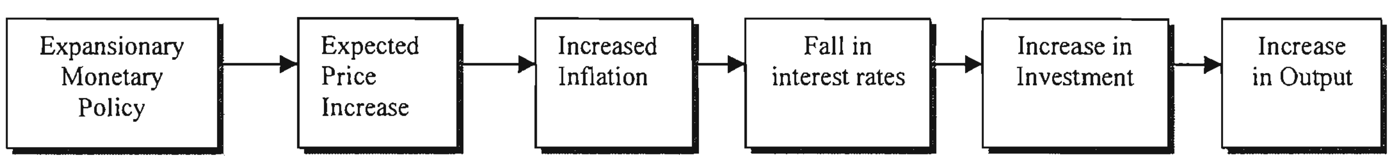
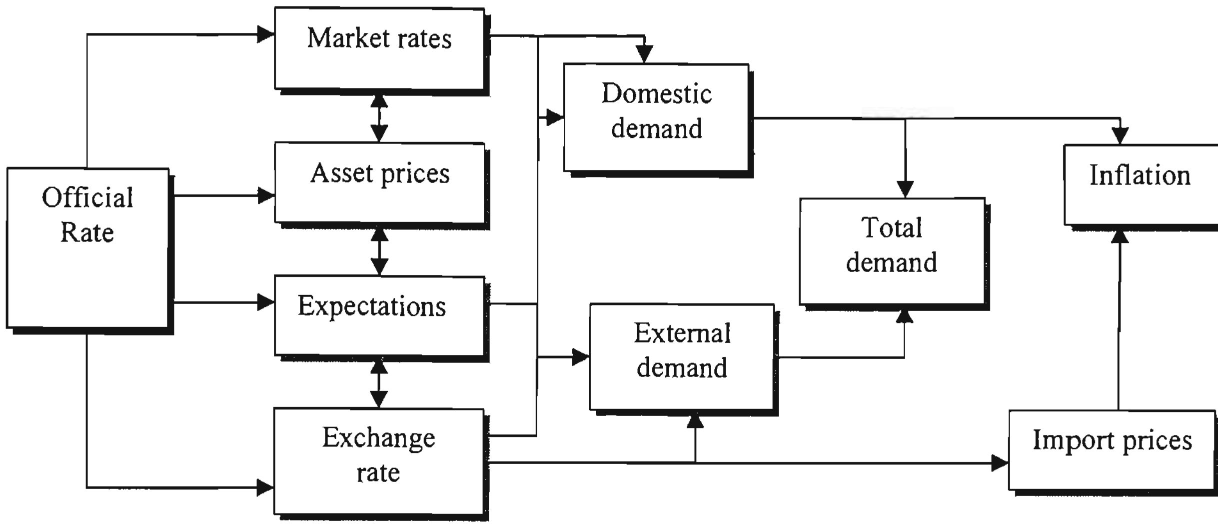


Figure 2.2: Interest Rate Transmission Mechanism

With respect to the interest rate transmission process, the ability of monetary authorities to set the desired level of the short interest rate is unaffected by derivatives. But what is affected is the increasing speed of monetary action transmission in the economy. Derivatives can also affect the link between interest rates and aggregate spending through the redistribution of risk, this in turn means the shift of the very incidence of risk from those with higher risk to those with lower marginal propensities to spend and invest.



Source: Monetary Policy Committee, Bank of England (1999).

Figure 2.3: The Transmission Mechanism of Monetary Policy

Figure 2.3 outlines the main links through which the transmission mechanism works. When the Central bank increases official interest rates it has an impact on other market interest rates. The higher interest rate will lead to a fall in asset prices reducing consumption and investment through wealth effects. If higher interest rates are expected to lead to a future slowdown in the economy consumer and producer confidence will also fall leading to retrenchment of consumption and investment plans. The increase in interest rates will also affect external demand in the economy. Higher interest rates will lead to an increase in exchange rates (assuming exchange rate is defined as number of foreign currency per unit of domestic currency), which will make imports cheaper, in turn putting downward pressure on domestic inflation. Further, the higher exchange rate makes exports more expensive thereby reducing demand in the economy. The overall impact of the increase in interest rates is therefore to reduce demand in the economy. Thus, Figure 2.2 summarises how increases in the price of money, interest rates affect the economy.

The literature (Mishkin, 1995) talks about the following main types of monetary policy transmission channels:

- Inter-temporal Substitution Effect,
- Income Effect,
- The Exchange Rate Effect,
  - Net Exports Effect,
  - Interest Rate Parity Effect,
- Wealth Effect,
- Credit Effect.

We will now discuss each in turn and analyse the likely impact derivatives trading might have on each of these channels.

2.3.1 Inter- temporal Substitution Effect

Decisions have to be made between spending now or later, and interest rates represent the cost of this inter-temporal substitution. The higher interest rates, the more spending decisions are postponed. Likewise for business, interest rates represent the cost of capital and are thus used to decide whether and when to invest. Monetary Policy is implemented through cash rates which directly determine the inter bank lending costs, and thus influence all other existing interest rates in the economy. However, the entire term structure of interest rates are probably important for inter-temporal substitution. Different investment projects have different time horizons, thus different interest rates with varying time horizons are important for making decisions. People's anticipations and expectations regarding interest rates play a crucial role in the successful implementation of monetary policy.

It may be possible to hedge against the adverse impact of the substitution effect. Using derivatives such as options on futures, a hedger can lock in the current interest rate for potential future funding needs. Part of the problem in analysing this effect is the lack of data. The IMF suggests that the volume of options on futures in the major exchange traded derivatives markets is approximately equal to 10% to 30% of the volume in plain vanilla futures. However, there can be many motivations for trading in these products besides hedging "substitution risks". The most common reason for trading can be as an alternative to trading in the futures market, as they tend to be more liquid and have lower capital requirements.

Given the uncertainties and the expense of hedging such a risk, derivatives can only have a marginal impact on reducing the substitution effect. Most firms and households will face the increased costs of capital with or without derivatives. In addition, the impact is felt sooner in the presence of derivatives markets (Vrolijk, 1997).

2.3.2 Income Effect

The income effect can be defined as the change in income or cash flow due to a change in interest rates. The income and wealth effect are closely linked as wealth can be viewed as the sum of discounted future income flows. The direction of the income effect depends on the net holdings of assets and liabilities. A net saver receives a positive income effect following an interest rate increase whereas a net borrower has a negative income effect. An interest rate rise redistributes income from borrowers to lenders. If borrowers have a higher marginal propensity to consume than lenders, as is usually assumed in the New Keynesian literature then the aggregate income effect is negative. However, derivatives aid in transmitting the shock more rapidly to interest rates, so unhedged agents are impacted by a negative income effect slightly sooner. The largest single change in the transmission mechanism caused by derivatives is the ability of the agents to hedge the income effect associated with interest rate fluctuations.

Bodnar and Marston (1995) surveyed all non-financial Fortune 500 firms, and found that 40.5% report having used derivatives. The primary motivation is risk management, with 73% hedging interest rate risk through swaps, options, futures and forwards. The BIS survey of Central Banks reported that the global gross market value of OTC interest rate derivatives was $700 billion at end March 1995, and the notional principal of OTC and exchange markets was $36.7 trillion.

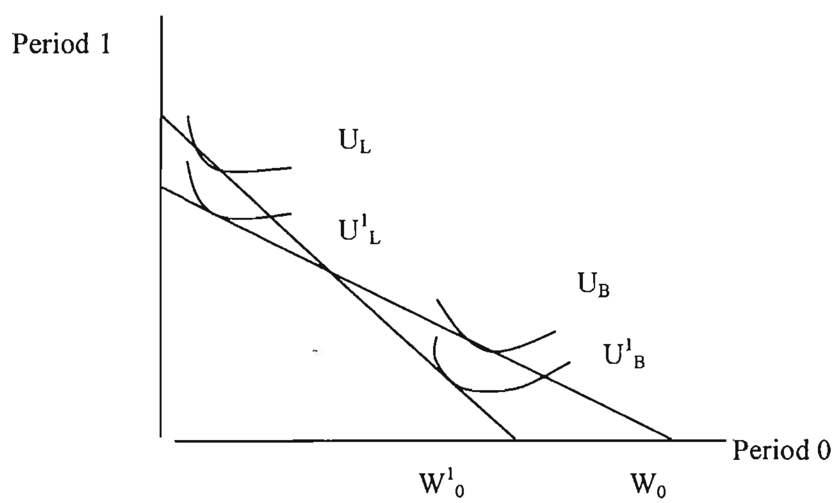


Figure 2.4: Income Effect and Derivatives

Figure 2.4 explains the income effect and the use of derivatives through the activity of borrowers and lenders. Any change in interest rates due to a change in monetary policy will change the slope of the budget line to W^1_0 from W_0. The utility of borrowers is likely to decrease to U^1_B. Trading in derivatives will enable borrowers to hedge themselves against an increase in interest rates thereby bringing about either none or a smaller decrease in their utility. This will further imply that the present wealth of borrowers will not decrease as much. The increase in the present wealth of borrowers can be explained by the increase in the productive investment in the economy.

The ability to hedge for the income effect implies that derivatives may weaken the impact of policy. Due to the faster transmission of policy to asset prices, the risk holding and unhedged agents are impacted upon by a negative income effect more quickly. Derivatives markets thus lead to a two fold change in income effect. First, the income effect begins earlier and second, the effect is weaker. Compared to the income effect of a change in monetary policy prior to derivative usage, the aggregate income effect is less negative when agents can hedge. For agents with maturity mismatches, the income effect may occur with a delay. Hedgers can be exposed to the income effect of a policy action if the hedge has a maturity mismatch with the underlying asset or liability. Assuming no maturity mismatch, hedged agents are never subject to an income effect leading to a weaker overall impact of the policy shock. However, given the difficulty of hedging against the substitution effect, all agents bear the increased cost of capital on future funding needs.

2.3.3 The Exchange Rate Effect

The more open the economy is the more important this channel becomes in the transmission of monetary policy (Gruen and Shuetrium, 1994). Exchange rate affects the domestic price level directly by influencing the domestic currency price of imports. Depreciation raises the consumer price index and since exchange rates respond rapidly to interest rate changes, it speeds up the monetary policy transmission mechanism. There are two effects associated with this channel, namely the net exports effect and the interest rate parity effect.

2.3.3.1 Net Exports Effect

Higher interest rates appreciate the exchange rate, which spills demand into imports (retarding growth in the tradeable sector) directly influencing the price of tradeable goods and services. This channel involves interest rate effects because when domestic real interest rates fall, domestic dollar deposits become less attractive relative to deposits denominated in foreign currencies, leading to a fall in the value of dollar deposits relative to other currency deposits, that is depreciation of the dollar. The lower value of the domestic currency makes domestic goods cheaper than foreign goods, thereby causing a rise in net exports and hence aggregate output. The schematic for the monetary transmission mechanism operating through the exchange rate is represented by Figure 2.5:

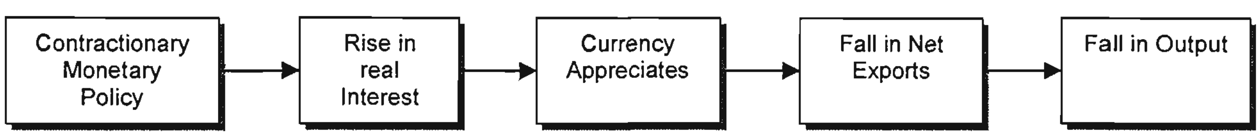


Figure 2.5: Exchange Rate Channel of Monetary Policy Transmission

This exchange rate channel plays an important role in how monetary policy affects the domestic economy as is evident in research, for example (Bryant, Hooper and Mann, 1992) and (Taylor, 1995).

Derivatives can have an impact on the net exports effect as both exporters and importers can hedge nominal exchange rate fluctuations in the short run. Given the size of the OTC currency markets, there may be a large amount of nominal exchange rate hedging, reducing the impact of this transmission channel. Results from the Bodnar and Marston (1995) survey of US non-financial firms indicate that more firms use currency derivatives (76%) than interest rate derivatives (73%). The Touché Ross survey (1995) of UK non-financial firms indicates that 85% of derivative users use foreign exchange derivatives to hedge cash flows. Only 12% of the United Kingdom derivative using companies used foreign exchange derivatives for speculation. The BIS survey reports that the global OTC and exchange traded notional principle of foreign exchange derivatives is \$17.8 trillion. Considering that 21% of OTC gross market value was to non-financial institutions, this suggests that one fifth of the notional principal represent hedgers. In fact the BIS reports that globally, non-financial institutions hold an underlying notional principle of \$3.6 trillion. This represents hedged principal against nominal exchange rate fluctuations. Thus, there might be an impact on the monetary policy transmission channels.

2.3.3.2 Interest Rate Parity Effect

The Mundell Fleming model develops an interest rate parity effect. Interest rate parity transmits the impact of domestic policy abroad and foreign policy home (Taylor, 1995). In the early 1960s Marcus Fleming and Robert Mundell independently extended the open-economy Keynesian model of macroeconomic policy to systematically incorporate the role of capital flows. Both contributors became influential contributors to the development of the open-economy macro model. In 1976 Rudi Dornbusch published a series of articles that codified these contributions as the Mundell Fleming model. Therefore, the Mundell Fleming Model is essentially Fleming's equation combined with Mundell's policy analysis. Robert Mundell (1960) developed the interest rate parity relationship which states that the interest rate differentials between any two countries is always equal to the expected rate of change in the exchange rate between those two countries. He said that if this relationship did not hold then capital would flow to the country with higher returns, until the expected returns were equalised in both countries.

The Fleming Model (Fleming, 1962, p.377) can be reduced to three excess-demand equations that can be solved for y, r, e or (r, if e is fixed) as functions of m, g, and r (or e, if r is fixed).

$y\,(y,g,r,e) = 0 \qquad (2.1)$

$v\,(y,r,m) = 0 \qquad (2.2)$

$f(y,r,e,R) = 0$ (2.3)

where,

y = national income,

r = interest rate,

m = money stock,

e = exchange rate,

g = government expenditure,

p = ratio of domestic to foreign price levels.

Mundell (1960, p.256) presented his model in a semi reduced form that may be compared directly with the solution of the Fleming model derived above.

$y(r,r,p.e) = 0$ (2.4)

$m(y,r,m) = 0$ (2.5)

$f(y,r,p.e) = 0$ (2.6)

where,

$p.e$ = real exchange rate,

y = national income,

r = interest rate,

m = money stock,

This equation system can thus be solved for y, m, p.e as a function of r.

It can be argued that the arrival of large-scale OTC currency markets increases the strength of the covered interest rate parity relationship and through the link from derivatives markets to spot markets, will ultimately strengthen the uncovered interest rate parity relationship. Increased derivative use has created more cross currency pairs that are readily hedgeable as well as increasing market liquidity, thus leading to less expensive and greater arbitrage trading across more current pairs. In addition, the ability to hedge currency risk and the increased availability of funding through derivative use will only serve to increase the level of international capital flows following policy changes that change interest rates. Rapid movements in exchange rates increase the speed with which real import and export prices change, impacting the real economy sooner. Thus, under exchange rate mechanism analysis two opposing effects have been analysed. First, the existence of derivatives can strengthen the exchange rate mechanism due to enhanced asset substitutability. A given change in the difference between domestic and foreign interest rates would be expected to produce larger changes in exchange rates because of derivative activities. But this effect is counteracted by the enhanced capacity for foreign exchange rate hedging. Through hedging, those most sensitive to exchange rate fluctuations can shift the incidence of such fluctuations to those less sensitive. While currency hedging has long been available through forward markets, derivatives have substantially increased hedging opportunities and reduced the cost of hedging. Agents whose spending and investment activities are more sensitive to currency fluctuations can more easily insulate themselves from high exchange rate risk to those with less risk. This effect would be expected to weaken the exchange rate transmission mechanism at least in the short run. Thus the overall effect of derivatives on the exchange rate mechanism is indeterminate.

Again, there is a link between the interest rate and exchange rate transmission mechanism. Because of improved asset substitutability due to derivatives, monetary policy-induced changes in one country's yield curve might be expected to produce more rapid and larger changes in other countries yield curves. This effect leads to fast adjustments in market expectations. Thus it can be said, that these changes reinforce the expectations transmission mechanism through which policy actions change market expectations, and effect real economic decisions by economic agents.

2.3.4 Wealth Effect

The wealth channel has deep roots in the literature on monetary policy and economic stabilisation and dates back to discussions stimulated by Keynes' General theory. Changes in consumer spending generated by countercyclical changes in the real value of the money stock could help provide an automatic stabilising force to an economy subject to inflationary and deflationary forces (Gilbert, 1982). The wealth channel of the monetary policy transmission mechanism can be reflected in the changes in asset values which in turn affect consumer spending on nondurable goods and services because of changes in monetary policy. The wealth channel can be seen as an important channel of monetary policy, to the extent that asset values and consumer spending have a predictable relationship with the level of interest rates.

Franco Modigliani has advocated this channel through his analysis on the real balance effect of the impact of wealth changes induced by monetary policy (Modigliani, 1971). In Modgilani's life cycle model, consumption spending is determined by the life-time resources of consumers, which are made up of human capital, real capital and financial wealth. A major component of financial wealth is common stocks. When stock prices rise, the value of financial wealth increases thus, increasing the resources of consumers leading to a rise in consumption. Point estimates from this model suggest that roughly one-half of the impact of monetary policy changes on real economic activity through time periods of policy interest could be attributed to changes in spending arising from policy-induced changes in stock market values. To arrive at the consumption function of an individual in an economy consider a consumer who expects to live another T years, has wealth of W, and expects to earn income Y until they retire R years from now. The consumer's life-time resources are composed of initial wealth W and lifetime earnings of R x Y (for simplicity it is assumed that interest rate is zero). The consumer can divide his/her lifetime resources among T remaining years of life. It is also assumed that the consumer wishes to achieve the smoothest possible path of consumption over their lifetime. Therefore, the consumer will divide the total of W + RY equally among the T years and each year consume:

$$C = (W + RY)/T, \qquad (2.7)$$

and hence this person's consumption function can be written as:

$$C = (1/T)\,W + (R/T)\,Y. \qquad (2.8)$$

The above equation says that consumption depends on both income and wealth and if every individual in the economy plans consumption like this, then the aggregate consumption function is much the same as the individual one. In particular, aggregate consumption depends on both wealth and income. That is the economy's consumption function is:

$$C = \alpha W + \beta Y, \qquad (2.9)$$

where the parameter α is the marginal propensity to consume out of wealth, and the parameter β is the marginal propensity to consume out of income. For any given level of wealth W, the life cycle-model yields a conventional consumption function. However, the intercept of the consumption function is not a fixed value. Instead, the intercept here is αW and, thus depends on wealth. According to the life-cycle consumption function, the average propensity to consume is:

$$C/Y = \alpha(W/Y) + \beta. \qquad (2.10)$$

Summing up, the life-cycle model says that consumption depends on wealth as well as income.

Incorporating the life-cycle model into the transmission mechanism we find that an expansionary monetary policy generally leads to a rise in stock prices and the monetary transmission mechanism would look like Figure 2.6:

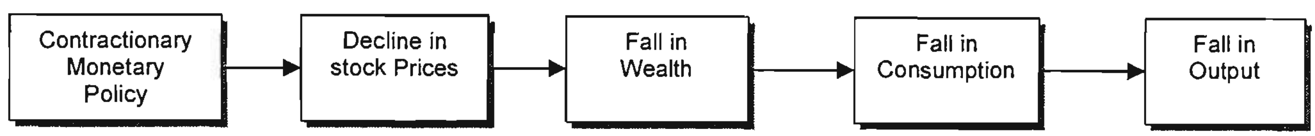


Figure 2.6: Transmission Mechanism through Wealth Effect

Hedging techniques against detrimental wealth effects are similar to those of the income effect. For example the use of options can be used to hedge against a drop in equity prices. However, hedging price changes in illiquid assets such as real estate is extremely uncommon. As reported by the BIS survey, notional and gross market values of equity, stock index and commodity price OTC derivatives represent only 2% of the equivalent interest rate derivative figures. This suggests that there is much less wealth hedging than income hedging. In a survey conducted of US non-financial firms (Bodnar and Martson, 1995) 9% of derivatives users reported using derivatives for earning or cash flow management as opposed to 9% for market value maintenance. Although wealth effect hedging does occur, it is small when compared with changes in the income effect. Considering the fact that most of the wealth effect stems from changes in illiquid asset prices that cannot be hedged, then theoretically the presence of derivatives markets will not significantly change the transmission mechanism through the wealth effect.

In the absence of particularly large monetary changes in recent years, specific discussion of the wealth channel of monetary transmission has diminished. But there are many analysts who contend that the massive run-up in the stock market in the second half of the 1990s has been a decisive element behind the strong growth of consumer spending and the economy in that period. For instance, the increase in stock market wealth from 1994 into early 2000 raised consumption growth by about one third of one percent per year (Council of Economic Advisors 2001, p.61). This brings up the line of thought that perhaps monetary policy helped to sustain the surge in the market and the growth of spending. If the effects of the wealth channel are still visible, it is possible that economic agents might recourse to hedging in larger numbers.

2.3.5 Credit Effect

Many economists have argued that monetary policy has direct effects on aggregate spending that do not operate through traditional interest rate or exchange rate channels. A large body of literature in recent years has focussed on credit markets as a channel of monetary policy transmission. The credit view stresses the role of assets and liabilities. Credit channels arise because of asymmetric information. Due to asymmetric information the lenders build a risk premium into interest rates. When the Central bank raises the cash rate the lenders also raise the risk premium that they charge from borrowers, influencing the cost of credit.

According to the advocates of the credit channel, monetary policy not only affects the general level of interest rates, but also the size of the finance premium and the opportunity cost of internal funds. The complementary movement in the cash rates and the risk premium can better explain the composition, timing and the strength of the monetary policy transmission effect, and if they both work in unison the impact of the monetary policy is more heavily felt. Two underlying factors probably explain the link between monetary policy action and the risk premium: the balance sheet channel (or the net worth channel) and the bank lending channel. An analysis of the credit transmission mechanism shows a weakening of these channels of policy transmission. Monetary policy affects spending through the credit channel due to imperfections and friction, which limit individual and firm access to easy credit. These frictions are mainly in the form of asymmetric regulatory constraints. Such frictions worsen during tight monetary conditions. The presence of derivatives normally reduces such frictions thereby weakening the credit channel of monetary policy transmission. Derivatives generally improve the access of firms to capital markets. Derivatives can be attached to issued securities, enhancing their marketability and increasing their supply and dissemination of information about the firm (Mullins, 1994). Capital market penetration unleashes market analysts and credit rating agencies to underwrite the issue. Moreover, derivatives improve a banks' ability to lend through risk unbundling. This allows banks to undertake risks that they are best able to bear. It also facilitates portfolio diversification. Non-financial firms also use derivatives to manage and reduce risks. This too can improve the creditworthiness of firms and reduce financing constraints.

As emphasised earlier, the broad credit channel arises from an asymmetry of information between borrowers and lenders, which adds a premium to the cost of external funds. This premium compensates lenders for the expected costs of monitoring and evaluation of investment projects. The size of the premium depends on the monetary policy stance. A tightening of policy can boost the premium for external funds, which could further lead to a fall in the volume of investment.

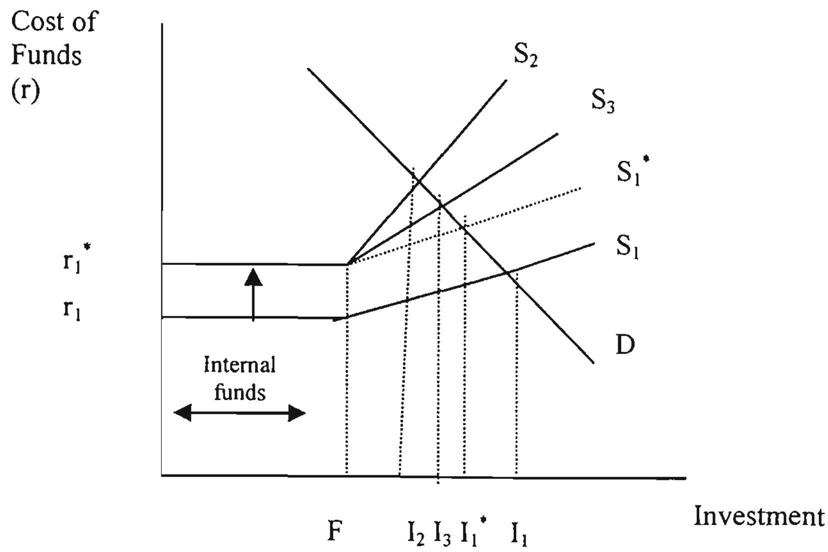


Figure 2.7: Magnification Effect of an Interest Rate Increase

In Figure 2.7, F is the amount of internal funds a firm has on hand. The cost of internal funds r_1 can be decomposed into $r^f_1 + \theta$, where r^f_1 is the risk-free interest rate that is taken as the instrument of monetary policy and θ is the risk adjustment appropriate for the firm. In perfect capital markets external funds are also available at r_1, but because of asymmetric information the cost of external funds is above r_1 by a premium denoted by Ω. The size of Ω depends on two factors. First, the premium will increase with the level of borrowing as the associated moral hazard also increases. Second, Ω also increases with the level of the risk-free rate. These two factors can be expressed in the equation as:

$$\Omega = \Omega\,(B, r^f),$$

Where both $\frac{\partial\Omega}{\partial B}$ and $\frac{\partial\Omega}{\partial r^f}$ are positive. The dependence of Ω on the risk-free rate implies that credit market imperfections can act to magnify monetary shocks - the essence of a broad credit channel. According to Oliner and Rudebusch (1995) a rise in the risk free rate increases the costs of external funds by $\frac{\partial \bar{r}}{\partial r^f} + \frac{\partial \Omega}{\partial r^f}$, where the second term is the magnification effect. The increase in the risk free rate increases the costs of funds schedule S_1 to S_2 and investment falls from I_1 to I_2. The fall in investment is magnified by the increase in the premium for external funds, which causes the new supply schedule to be S_2 rather than S_1^*.

Using the Oliner and Rudebusch (1995) framework the impact of derivatives markets on the credit channel of monetary policy is analysed. In the presence of derivative markets the premium on the costs of external funds will not increase as much as before, because of a tightening of monetary policy. As a result, the cost of the funds schedule will not increase to S_3 over S_2. As a result, investment falls to I_3 rather than I_2. Lower investment decline further means less impact on the real economy.

2.3.6 The Balance Sheet Channel

The theoretical explanation of the bank lending channel, rests on the view that the balance sheet channel operates through changes in the worth of agents, and is similar to the wealth effect operating through the interest rate channel. Its main proponents are Bernanke and Gertler (1995) who argue that unlike the bank-lending channel, financial innovation has little impact on the balance sheet channel. The balance sheet channel also arises from the presence of asymmetric information problems in credit markets. The lower the net worth of business firms the more severe are the adverse selection and moral hazard problems in lending to these firms. Lower net worth means that lenders have less collateral for their loans, and therefore losses from adverse selection are higher. The lower net worth of the firms also increases the moral hazard problem because it means that owners have a lower equity stake in their firms giving them more incentives to engage in risky investment projects. Since taking on riskier investment projects makes it more likely that lenders will not be paid back, a decrease in business firms' net worth leads to a decrease in lending and hence in investment spending.

Monetary policy can affect a firms' balance sheet in several ways. Expansionary monetary policy, which causes a rise in equity prices, raises the net worth of the firms and so leads to higher investment spending and aggregate demand, because of the decrease in adverse selection and moral hazard problems. This leads to the following schematic for the balance sheet channel of monetary transmission:

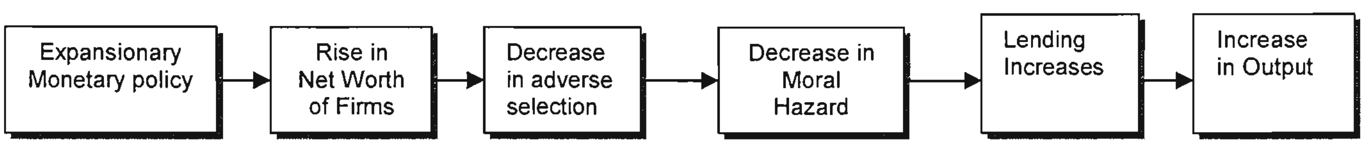


Figure 2.8: Balance Sheet Channel of Monetary Policy Transmission

In the short run until the derivative contracts expire, agents can hedge against a decline in net worth due to asset price changes. The net result is that agents are still faced with the increased costs of capital, even if collateral levels are unaffected. Thus, derivatives do offer the possibility of removing the balance sheet effect, contrary to Bernanke and Gertler. Like the changes in the income effect, this can also serve to weaken the policy.

2.3.7 Household Balance Sheet Effect

Although most of the literature on the credit channel, impact on a firms' spending behaviour, it should also apply to consumer spending, particularly on consumer durables and housing. A fall in bank lending caused by monetary contraction should cause a decline in consumer spending. As most consumers do not have access to other sources of credit, a rise in interest rates reduces the cash flow of consumers. Another way of looking at the balance sheet channel of consumers is to consider the liquidity effects on consumer durables and housing expenditures – found to be important factors during the great depression (Mishkin, 1978). In the liquidity effects view, the balance sheet effect works through the consumers' desire to spend rather than on the lenders' desire to lend. Because of asymmetric information about the quality of household consumer goods these goods are considered to be illiquid assets. Raising money through the sale of consumer goods will end in big losses (This is the "lemons problem" described by Akerloff (1970) which led to further research on the credit channel). In contrast, if the consumer held financial assets such as stocks, bonds and so forth, they could easily sell them at their full market value. Hence, if consumers expect financial distress, they would rather hold fewer illiquid assets as compared to liquid financial assets.

When consumers have a large amount of financial assets relative to their debts, their estimate of financial distress will be low, and they will be more willing to purchase consumer durables and housing. When stock prices rise, the value of financial assets rises as well, consumer durables expenditure will also rise because consumers have a more secure financial position. This leads to another transmission mechanism for monetary policy operating through money and equity prices.

2.3.8 The Bank Lending Channel

Banks play an important role in monetary transmission mechanisms, but the traditional approach stresses the role of bank liabilities as part of the money supply. The bank lending channel operates when Central bank actions affect the supply of loans from commercial banks. Two conditions must be satisfied for the bank lending channel to operate. First, banks do not fully insulate their supply of loans from changes in reserves induced by the monetary authority. Second, borrowers cannot fully insulate their real spending from changes in the availability of bank loans. When the first condition holds, a tightening of monetary policy directly constrains bank lending. After a fall in reserves, banks rearrange their portfolio of assets and liabilities by reducing the volume of loans. The second condition implies that bank loans are an imperfect substitute for other sources of finance for businesses, and therefore firms cannot easily arrange for other sources of finance, like commercial paper, trade debt and so forth. Part of the reason for the continued focus on the liabilities side is the lack of convincing empirical evidence that bank lending plays a distinct role in the transmission process through which monetary policy affects the real economy. As Romer and Romer state:

> "A large body of recent theoretical work argues that the Federal Reserve's leverage over the economy may stem as much from the distinctive properties of the loans that banks make as from the unique characteristics of the transactions deposits that they receive. Examining the behaviour of financial variables and real output in a series of episodes of restrictive monetary policy, we are unable to find any support for this view." (Romer and Romer 1990, p.196 -197)

Edwards and Mishkin's (1995) survey provides evidence on the decline of traditional bank lending because of financial innovation. Bank lending fell from 35 % to 22% in 1994. In so far as derivatives contributed to financial innovation by providing additional funding avenues, derivatives have reduced the importance of the bank lending channel. An alternative explanation for a decrease in the importance of this channel stems from the hedging opportunities available to lenders such as financial institutions. Derivative usage allows these institutions to safely hedge long term lending, and thus circumvent contractionary policy by securitisation of assets, resulting in less vulnerability to a policy shock.

For example, the BIS survey reports that 41% of the OTC notional principal outstanding in Deutsche Mark denominated interest rate derivatives have maturities between one and five years, and 16% have maturities greater than five years. This suggests that even in Germany firms can hedge interest rate changes for extended periods, in some cases longer than the business cycle that drives policy changes. Vorlijk (1997) explains the impact of derivatives on the balance sheet channel, as derivatives are likely to weaken the impact of monetary policy. Until the derivatives contracts expire the agents can hedge against any declines in their net worth due to asset price changes. But agents are still faced with the increased cost of capital, even if collateral levels are unaffected. Thus, contrary to the findings of Bernanke and Gertler (1995), Vorlijk (1997) suggests that derivatives can remove the balance sheet effect.

Table 2.1:Impact of Derivatives Trading on Transmission Channels of Monetary Policy

Transmission Channel	Impact	Speed
Inter temporal substitution	No	Yes
Income effect	Weaker	Yes
Exchange Rate effect	Indeterminate	Yes
Wealth Effect	No	Yes
Credit Effect	Weaker	Yes

Table 2.1 summarises the effect of derivatives on the various transmission channels of monetary policy as discussed in the section above in terms of impact and the speed of the transmission of policy.

2.4 Summary and Conclusions

The volume of trading in the exchange traded derivative remains vigorous. Despite inevitable market incidents, which arise from time to time as a result of individuals using derivatives for speculative purposes, the bulk of the activity is still sourced from investors wishing to protect themselves from rapid price fluctuations that reduce the value of their cash market portfolios. It appears inevitable, that as benefits are more widely appreciated their use will increase and as such, these markets will assume an increasingly important position in the operation of the global financial system. It is true that with an inadequate regulatory system in place the use of derivatives have certainly been at the centre of a number of trading losses, most notably that of Barrings Bank. At the same time the use of exchange traded and over-the-counter derivatives continues to increase. Further, the catalyst behind this growth has been a desire amongst investment institutions to use derivatives for leveraging purposes, but this has stemmed from the need of the investors to find products which enable then to manage interest rates, currency and commodity price exposure. Derivatives fulfil these criteria by offering flexibility, liquidity and the capacity to quickly modify market exposures in response to changed market conditions.

The above chapter also outlines the different channels of monetary transmission and the likely impact of derivatives markets on these channels. Researchers such as Taylor (1995), see traditional interest rate channels operating through the cost of capital as very important. On the other hand Bernanke and Gertler (1995) attach more importance to the credit channel. Thus, dissatisfaction with the conventional literature on the transmission mechanism led to a number of economists exploring the role of imperfect information on the potency of monetary policy. Bernanke and Gertler do not think of the credit channel is an alternative to the traditional monetary transmission mechanism, but rather is a channel that amplifies the conventional interest rate effects. The economics of imperfect information has provided numerous insights into the structure of credit markets. Adverse selection and moral hazard, account for many of the distinctive features of credit contracts when monitoring is costly. Walsh (1998):

> "Credit market imperfections commonly lead to situations in which the lender's expected profits are not monotonic in the interest rate charged on loan; expected profits initially rise with the loan rate but can then reach a maximum before declining. As a result, it is possible for equilibrium to be characterized by credit

rationing; excess demand fails to induce lenders to raise the loan rate because doing so lowers their expected profits." (Walsh, 1988, p.361-362).

Thus, we can say that the balance sheet matters. Variations in borrowers' net worth affect their ability to gain credit. A recession that lowers cash flows will reduce credit availability and increase the wedge between the costs of external and internal finance. The resulting impact on aggregate demand can generate a financial accelerator effect.

The reasons to believe in the importance of credit channels lie in the large body of cross sectional evidence found in the literature (Hubbard, 1995) that indicates that credit market imperfections do affect firm spending and employment decisions. Evidence found in Gertler and Gilchrist (1993) also show that small firms are more likely to be affected by tight monetary policy than large firms that are relatively less credit constrained.

This study aims at aggregating the impact of derivatives on monetary policy transmission to the real economy through empirical analysis, as it is difficult to weigh the importance of individual channels on monetary policy. If the impulse response functions are less lagged in the sample period, then it will indicate that derivatives do affect monetary transmission, and hence real economic activity. However, theoretically two things can be concluded. First, all unhedged agents are exposed to policy shocks sooner and secondly, agents can easily hedge against each transmission channel effect.

CHAPTER 3

IMPACT OF DERIVATIVES ON FINANCIAL MARKETS AND MONETARY POLICY

3.1 Introduction

The likely impact of derivatives on specific channels of monetary policy was analysed in Chapter 2. However there are other ways in which derivatives have affected the operation of monetary policy and thus the real economy. The explanation being that if monetary policy works through the financial system and if derivatives do affect the efficiency of the markets, then indirectly the operation of monetary policy is also likely to be affected. Chapter 2 was a review of the impact of derivatives markets on the macroeonomy from an economic perspective.

However, the present chapter has been developed with the specific aim of highlighting the changes that have been brought about by the extensive use of derivatives on the financial markets, and therefore takes a financial view of the impact of derivatives on monetary policy. Derivatives can affect financial markets and monetary policy in the following ways (BIS, 1992):

- Derivatives markets and underlying markets are closely linked, making the market complete by reducing friction in prices across two markets.
- By reducing friction derivatives increase the trading volume thereby increasing market size.
- Derivatives can alter international transmission by making arbitraging less expensive through reduced transactions costs. This again explains the increase in the market size.

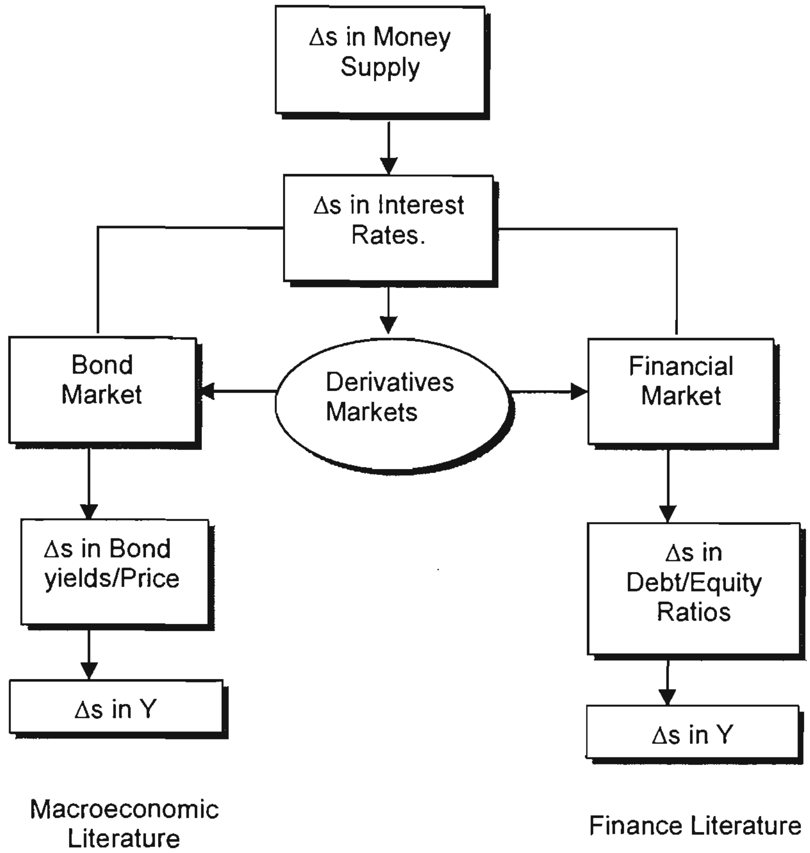


Figure 3.1:Transmission Process of Policy Change

Figure 3.1 is a schematic representation of the effect of any change in monetary policy stance on aggregate output or economic activity. From a macroeconomic literature viewpoint changes in money supply and interest rates influence aggregate output through changes in bond markets. On the other hand, from the point of view of the finance literature, changes in interest rates influence debt/equity ratios of financial firms, thereby indirectly influencing aggregate output. Derivatives trading play a key role in influencing this transmission process.

3.2 Real and Nominal Effects of Monetary Policy

In order to provide a foundation upon which a comprehensive analysis can be conducted regarding the likely impact of derivatives markets on monetary policy and real output, it is first important to start with a theoretical analysis regarding the same. The main aim of any Central Bank is maintaining the target rate of inflation without excessive restraints on real economic growth. Arguments over whether and how monetary policy has real effects have raged since Hume (1752). It is very likely that derivatives have the potential to decrease any real effects of monetary policy.

To analyse this issue it can be initially assumed that markets are perfect and complete. In a frictionless economy, with complete contingent contracts and no information costs, money would purely serve as a unit of account, and any changes in money supply would have an impact on the unit of account.

Any deviation from the assumption of perfect markets would actually mean that information is costly and incomplete. Lucas (1972) argues that monetary shocks can have real effects when agents have insufficient information to accurately differentiate between nominal shocks from unanticipated changes in monetary policy, and real shocks to the economy, such as productivity increases.

As argued in the previous section derivatives are a step closer towards complete markets. As mentioned in Chapter 2 in a more complete market, investors would have the choice of reducing uncertainty by creating customised derivative products. They lower the transaction costs, and thus it is possible to say that their prices provide more accurate information about the nature of monetary shocks. This information should help agents to differentiate between real and nominal disturbances, thereby reducing any potential real effects of monetary policy. A reduction of the real effects of monetary policy is likely to reduce the powers of the Central Bank, as there will be a limited role for them to influence real output.

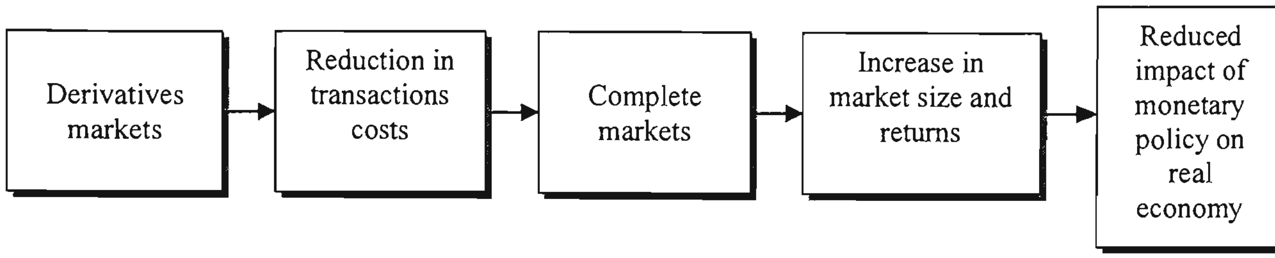


Figure 3.2: Impact of Derivatives Markets on Real Economy

Figure 3.2 is a simplified diagrammatic presentation of the likely impact of derivatives trading on the impact on the efficacy of monetary policy on the macro economy.

3.2.1 Theoretical Analysis of Derivatives on Monetary Policy

In this section an attempt has been made to further investigate the effects of derivatives on a Central bank's ability to conduct monetary policy. It is initially assumed that capital markets are perfect and complete in terms of information about current and past events. Therefore, there are no transaction costs and it would be plausible to assume that in the absence of transaction costs, securities with identical payoffs will trade at the same price. This law of one price is the primary pricing tool for derivatives. This arbitrage pricing of forward contracts has been understood since Keynes (1923) and Hicks (1939), the pricing of other derivatives took longer to formalize even though the fundamentals are the same. Black and Scholes (1973) and Merton (1973) show that options also can be priced via arbitrage arguments. Hicksler and Chen (1986) and Smith and Henctshel (1997) have formalized arbitrage-pricing principles for swaps. Virtually all these models provide prices that correspond closely to the observed prices. In this idealized setting derivatives are redundant financial instruments as arbitrage-pricing methods imply that payoffs identical to those of derivatives could be achieved by trading in a replicating portfolio. If derivatives are equivalent to portfolios of underlying securities then they cannot introduce new payoffs or risks into the market. Therefore, in such an idealized market the presence or absence of derivatives is completely irrelevant. However, in practice, incomplete markets, transaction costs and incomplete information costs justify the existence of derivatives.

In the following section the analysis moves away form the assumption of complete markets by investigating important deviations. As mentioned in the previous paragraph the various deviations from the assumption of complete markets can take the form of transactions costs, incomplete information and costly information. These are discussed in detail below.

Transactions costs: Providing traders with access to derivatives lowers transactions costs. A major cost of trading in financial contracts is the bid-ask spread. Informational asymmetries and trading volume are important factors in determining the spread. Traders can be divided into two types. Those who trade for liquidity purposes and those who trade to take advantage of their private information (Bagehot, 1971). On average, research has shown that traders loose when they trade with better-informed parties. In order to reduce these losses traders must quote higher spreads than they would offer to traders who trade purely for liquidity purposes. With larger information differences between traders the bid-ask spread will be higher. Derivative markets attract well-informed traders because of the higher spread. As more trade takes place in derivatives markets the private information of the traders are transformed into publicly observable high prices. Arbitrage between the derivatives markets and the underlying markets keeps the prices linked in the two markets. Dissemination of information through prices eventually lowers the spread as more traders start trading in derivatives markets, thus increasing the trading volume. Both these factors eventually lead to lowering of transaction costs (Damodaran, 1990). Damodaran and Lim (1991) examined the effects of option listing on the returns processes of the underlying securities by looking at a sample of 200 firms which had options listed on them on the Chicago Board of Exchange between 1973 -1983. They start with a simple model which distinguishes between intrinsic value V_t and the observed price P_t, by allowing for both market-structure related and information noise as well as imperfect price adjustments to value changes:

$$P_t - P_{t-1} = g\,(V_t - P_{t-1}) + u_t \quad , \qquad (3.1)$$

where:

V_t and P_t are logarithms and g is the price adjustment coefficient (0<g<2). The term u_t is the noise term, the magnitude of which is determined by information related factors (such as liquidity trading and noisy information) and market related factors (such as bid-ask spread, and dealer inventory positions). If ν^2 is used to define the variance of the intrinsic value process and σ^2 to be the variance of the noise term, the observed return variance can be decomposed into three components as follows.

$$\mathrm{Var}\,(R_t) = \nu^2 + 2\,\sigma^2 + \left[\left(\frac{g}{2-g} - 1\right)\nu^2 + \left(\frac{2}{2-g} - 2\right)\sigma^2\right] \qquad (3.2)$$

intrinsic variance noise price adjustment effect

If prices adjust slowly to information (g<1), the price adjustment effect will be negative and lead to lower observed return variances. When the market overreacts to news (g>1) the opposite impact occurs. Concurrently, higher (lower) bid-ask spreads will lead to more (less) noise and higher (lower) return variances.

The study traced a speedier price adjustment process to increased information collection, reduced noise and decline in the bid-ask spread after the option listing, partially because of competition between the market makers and more and better information collected and disseminated leading to a decline in return volatility.

Incomplete markets: Ross (1976) argues that options can complete markets efficiently. Derivatives whose payoffs are non-linear functions of an underlying asset can generate a range of payoffs that may be more costly to generate from underlying assets in the presence of transaction costs. Ross argues that in an uncertain world options written on existing assets can improve efficiency by permitting an expansion of the contingencies that are covered by the market. The following example illustrates the use of options to improve efficiency. Let x contain a single asset x with returns in three states:

$$x = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \quad . \qquad (3.3)$$

By itself x cannot span $\Omega = \{\theta_1, \theta_2, \theta_3\}$ since ρ (x) = 1<3. Forming calls on x with exercise prices 1 and 2 we have:

$$c(x;1) = \begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix} \quad , \qquad (3.4)$$

$$\text{and } c(x;2) = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad . \qquad (3.5)$$

Now the rank of the augmented matrix shown below is full, and the call options permit the market to attain efficiency:

$$[x \; c(x;1) \qquad c(x;2)] = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 1 & 0 \\ 3 & 2 & 1 \end{bmatrix}. \qquad (3.6)$$

Thus a possibility of writing options contracts opens up new spanning opportunities. Although there are finite numbers of marketable assets, there is an infinite number of options and derivatives assets that can be generated from an underlying asset. It is also less costly to market a derived asset than to issue a new underlying asset itself, making markets more efficient.

As discussed in Chapter 2 Arrow (1954) is of the view that individuals are more willing to assume risk if they have the means of insuring against all possible future states. Derivatives instruments make the market complete by providing more numerous options for risk takers.

Costly information: Black (1976) and Grossman (1988) argue that the presence of derivative markets has considerably reduced information costs. For example, agricultural futures and options provide information on the market's assessment of the returns on future production. The derivative market collects private information and makes it public through the prices of derivatives. This process lowers the information costs for producers even if they do not trade on derivatives markets. Again options markets reveal traders' expectations about the volatility in prices. Such information is difficult to observe by simply observing the actual prices in the underlying markets. By lowering the costs of transactions and by making prices more explicit, derivatives increase the return to investments in information about factors relevant to price setting processes. This should increase the production of such information and make markets more efficient. Therefore, it can be said that derivatives produce positive externalities.

3.3 Effect of Derivatives on Markets

Derivatives have largely influenced the financial markets by increasing the efficiency of markets by reducing friction, increasing trading and hedging opportunities and by creating a cost efficient market. Research shows that markets with derivatives respond more quickly to new information. Information is more rapidly incorporated into the prices of underlying securities in the presence of derivatives because of the link between the derivatives markets and underlying markets (Jennings and Stark, 1981; Damodaran and Lim, 1991).

The increase in the volatility in interest rates and exchange rates in recent decades has lead to financial innovation and development of derivative products. However, at the same time there is another point of view, which claims that derivatives are the root cause of an increase in the volatility in underlying markets. In its report on derivatives the BIS Euro Committee of the G-10 central Banks argued that:

> "Derivatives can be seen more as a consequence than a cause of increased volatility in exchange rates and interest rates." (BIS, p.1,1994)

In many markets there is evidence that the introduction of derivatives has reduced underlying price volatility. This is true particularly with respect to US stock options (Hayes Tennenbaun, 1979). A broad range of studies confirms that futures on bonds either reduced underlying volatility or have no discernible effects. Reduced volatility has been found in the case of Italian government bonds (Esposito and Giraldi, 1994) and either reduced volatility or no significant effect was found in empirical studies of US government bonds (Froewiss, 1978; Simpson and Ireland, 1982; Edwards, 1988). The rationale is that derivatives, by lowering transaction costs, increase liquidity.

There is also evidence that the existence of derivatives and the associated lower cost of transactions have changed the short run dynamics of the U.S. yield curve. A study by the Federal Reserve Bank (BIS, 1994) argues that in early 1994 the shape of the US yield curve was altered by portfolio realignment, and the hedging provided by the derivatives. The study also concluded that this financial innovation has altered the transmission mechanism of monetary policy, from short-term interest rates through long-term interest rates to the real economy.

The use of derivatives should increase the price level of underlying securities. Lower transactions costs, and increased hedging should enhance liquidity, thereby lowering the returns investors require, to hold the underlying security. While the effect is difficult to prove empirically, some studies do confirm that the introduction of derivatives has increased underlying securities' prices. This is true in the case of US stock options (Conard, 1988; DeTemple and Jorion, 1990).

It is often argued that derivatives tend to make underlying markets more resilient to shocks due to increased liquidity and better risk distribution. At the same time there continues to be concern about the possibility that in times of stress it is possible that derivatives could amplify price volatility in underlying securities. Dynamic hedging and feedback effects of large moves through derivative pricing models can reinforce abrupt market forces. These factors played a role in the1987 US stock market crash (Report of the Presidential Task Force on Market Mechanisms, 1988, BIS, 1994). One of the reasons for these types of disturbances could be attributed to the fact that innovation in derivatives has outpaced the developments in infrastructure and market participants' understanding. At the same time it is also plausible that increased risk management capabilities produced by derivatives dampened the impact of market events such as the breakup of the European exchange rate mechanism in 1992. In any case there is no comprehensive evidence that derivatives do amplify market risks in times of stress.

Overall empirical results show that the development and spread of derivatives activities have resulted in a better functioning market in terms of efficiency, capital raising, hedging and lower transactions costs. Because monetary policy works through the financial markets, the presence of financial derivatives can have a significant impact on monetary policy.

3.3.1 Impact on Risk Transmission

The strongest argument for reduced policy efficacy comes from examining the underlying process of risk shifting facilitated by derivative activities. Such risk shifting is the most important force driving the derivatives markets. Some economic agents are more risk sensitive than others. Those more sensitive to risk are willing to pay a price to cover the risk and those less sensitive are willing to accept risk for a given price. Such a market for risk systematically shifts risk from one party to the other. The total undiversifiable risk remains unchanged, but there is a redistribution of risk in favor of risk takers from those who are relatively risk free. Monetary policy feeds into interest rates and foreign exchange risks. Through derivatives these risks are systematically shifted among the economic agents. Risk is shifted from economic agents whose real activity is more sensitive to these risks, that is, from those who are more likely to curtail spending and investment, to agents better able to bear these risks, and are therefore less likely to be forced to alter real economic activity.

This systematic redistribution of risk results in real activity that is less sensitive to risks including those induced by monetary policy. The growth of the derivatives market has occurred because of their capacity to reduce friction and reduce risk through diversification. The efficacy of monetary policy depends on such frictions and risk sensitivity. It can be said that derivative activities support the hypothesis of reduced policy potency. This obviously does not mean that derivatives have made the mechanism of monetary policy redundant, but have definitely made it less effective. Financial innovations and derivatives result in a better-functioning financial system and a sound economy.

Overall it can be said that financial innovations and derivatives have substantially changed and improved the functioning of the financial system (Ross, 1976). Monetary policy works through the financial system, these innovations have changed the policy transmission processes as well. Policy makers are used to confronting change in the financial and economic environment. The nature of change highlights the importance of new theoretical and empirical research to provide insight into the nature of the transmission process. It also argues for further research into the different range of financial indicators, varying financial conditions and policy implementation. The development of derivatives has provided policy makers with new financial indicators and new instruments potentially of use in implementing the policy.

As mentioned in Chapter 2, shifts in the transmission channels of monetary policy have important implications for the behavior of econornic agents in the financial and non-financial sectors. It is likely to alter their spending and saving behavior for the agents in the non-financial sectors. It is possible to say that the shifts in transmission channels have weakened the ability of monetary policy to influence the economy (see Wojnilower,1980, Davis, 1981). As discussed earlier, changes in the financial system have led to a higher degree of substitutability of various types of financial assets, so that any changes in interest rates alter the rate of return on the whole range of financial assets to physical assets. This will tend to increase the total extent of interest rate influence; because financial assets can now be easily substituted with each other, rather than with physical assets. Derivatives do not just influence the domestic economy but also have an impact on the international transmission of risk.

Access to derivatives markets has made international asset substitutability much easier. Currency risks can be easily hedged away by the use of derivatives. In the absence of currency futures and forwards, agents bear the full risk of the exchange rate changes. This risk emanates from the differences in the nominal returns due to changes in expected exchange rate changes and the differences in country specific risks. This results in greater divergence of returns on similar assets in different countries. But if countries have derivatives markets, agents can lock in contracts, thus completely eliminating exchange rate risk. By pricing away all currency risks, agents will demand identical returns on similar assets in different countries. Differences in each country's nominal returns can only be due to the expected exchange rate changes and a difference in country specific risk, such as default risk. Without derivatives like futures and forwards, agents will have to bear the full burden of exchange rate risk. This can result in divergence in returns for similar assets across countries. The arbitrageur can borrow in a low interest country, exchange it in the spot foreign exchange market, then save the money in the high interest rate country (by going long on a Treasury bill with equal maturity) and finally buy a currency forward for the face value of the Treasury bill. This action will drive up the interest rate in the low interest country and drive down the interest rate in the high interest rate country until interest rate parity is achieved. This would tend to harmonize the yields curve in different countries and therefore reduce the scope of monetary policy. Large interest rate differentials will be hard to maintain without a constant depreciation of the currency.

The Asian financial crisis has demonstrated that sharp adjustments in markets in one location can suddenly affect price movements in distant locations and cause productive hedging activities to unravel. As a result of structural changes in financial markets, financial adjustments to shocks may have become faster and less predictable posing challenges to market agents and supervisors alike (BIS, 1994).

3.3.2 Spot Price Changes and Derivatives

This section examines the impact of derivatives on spot markets. Spot prices are the basis for derivative prices as by definition the price of a derivative is dependent on the price of the underlying asset. Spot market prices impact upon real economic decisions such as investment and consumption. According to Vrolik (1997) derivatives have feedback effects on spot prices. Derivatives are valued through both demand and supply of the secondary derivative market in addition to the pricing formulae. An imbalance between the buy and sell order in the derivative market will lead to disequilibrium between the theoretical derivative price and the market derivative price. Arbitrageurs can benefit from this situation by taking opposite positions in the derivative and the underlying market. For example, suppose a portfolio consisted of a long position in the derivative and a short position in the derivative's underlying asset. Then the price of both the derivative and the underlying asset is driven back to a theoretical equilibrium, with a subsequent disequilibrium in the derivative market causing a price movement in the underlying spot market. Effectively, the derivative and the spot markets are linked by an 'elastic band'. The theoretical relationship given by the Black and Scholes (1973) formula, determines the equilibrium relationship between prices, but temporary imbalances in either market have a rapid impact on the price level in the other market, bringing each market back to the equilibrium. This linkage is explained diagrammatically in Figure 3.3.

Where,

S = supply,

D = demand,

P = price,

Q = quantity.

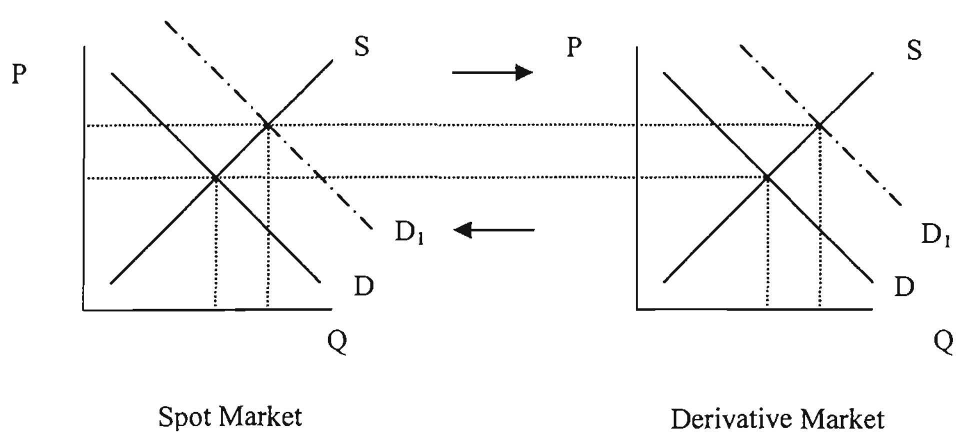


Figure 3.3:Linkage between the Spot Market and Underlying Market

The greater liquidity in the financial markets accelerates the transmission of shocks to financial prices, such that the changes in the derivative prices take place earlier and more rapidly due to expectations following a policy shock. This in turn feeds through the spot price movements. Derivatives provide higher capital leverage than the underlying markets especially for speculation and short-term hedging purposes. For this reason transactions in derivatives are far less expensive compared with corresponding underlying markets. Flockerts-Landu (1994) found in their study that the bid ask spreads in derivative markets are often tighter than in spot markets, suggesting a greater liquidity for derivatives.

If the trading volume shifts from the underlying spot market into the less expensive derivative market, then it is possible that total spot price movement will remain unchanged. This suggests that derivatives markets will only contribute to greater spot price movement if the turnover in the underlying markets has not shifted into the less expensive derivatives markets. This does not appear to be the case. For example as reported in a recent BIS survey (1995), results for the global foreign exchange markets, the turnover of spot transactions grew by 7% annually between 1989 and 1995, whereas the turnover of derivatives transactions increased by 19% annually over the same period. Daily spot foreign exchange turnover was $520 billion in April 1995, whereas daily derivative foreign exchange turnover was $740 billion during the same period. Since the global underlying market appears relatively unchanged in size, we can expect the regular market transmission mechanism to work as usual. Also any changes in the derivative price following a shock will filter through into the underlying prices thus increasing the speed of transmission.

3.4 Systemic Risks and Derivatives

Even in the absence of substantial evidence relating derivatives to systemic risks and market failures there has been a lot of debate pertaining to this issue. There has been substantial evidence that derivative activities have improved the functioning of the financial system, at the same time there is also concern that it has tended to aggravate the fragility of the financial system, the world over, and thus increased the risk of systemic failures. A systematic crisis is a disturbance, which severely impairs the working of the entire financial system; and at the extreme causes its complete breakdown. Any system is a set of interrelated parts, which recognizably constitute a connected whole. In that sense any financial market is a system of components that include its trading and regulatory arrangements and participants in the market. The interactions between the different financial markets are a part of the international financial market, and they in turn, are part of the world economy. Losses that put derivatives in the headlines include the global banks like Metalgeschelshaft, Barings and Orange (IMF,1993). Expansionary fiscal policy of governments and lender of last resort interventions by the Central Banks have greatly reduced the dangers of systemic risks. But since the 1980s, the rapid growth of the derivatives market has increased the threat of systemic failure. Because of the high proportion of cross-border derivative transactions, systemic risk takes on a more international character.

The main cause of systemic risks is the dealers' desire to hedge market exposure which leads to large inter dealer dependencies. Therefore, the failure of any single dealer can cause the whole system to collapse. Derivative disasters, huge financial losses, and failed financial institutions are being reported with surprising frequency. These have led many to identify derivatives as a potential source of global systemic risk. Derivative instruments are very powerful instruments. The low cost of transacting and a potentially high level of leverage allow the traders to produce massive losses, large enough to question the viability of a large financial institution. Derivatives' complexity makes internal risk management difficult and their opaqueness makes market discipline more challenging. The financial institutions most actively involved in derivative activities with significant exposure are large institutions, and they are the ones most significantly involved in the global markets and payments system. Hence, acting as a potential transmission mechanism for systemic risks.

The problems encountered with derivatives have occurred essentially because financial innovation has in some cases outpaced requisite improvements in system wide regulatory instructions. The continued growth of derivatives will bring benefits but also increased responsibilities for regulators and central bankers. The Promisel Report, prepared by the BIS, argues a number of key developments in derivatives markets have led to greater systemic risk (BIS, 1992, p.25-34). In particular, the Promisel Report noted the following developments. First, increased competition between financial intermediaries has broadened the potential sources of systemic failure as well as spread the impact of any systemic failure over a wider range of institutions and markets. For example, commercial banks face greater exposure to hedge funds because of the large lines of credit they supply to these speculative institutions. Second, some derivatives markets have become more concentrated in the hands of relatively few market makers. Larger exposures to one another among these key market participants increases the repercussion effects of shocks should any one of the players default on their obligations. Third, domestic and international linkages between financial markets have intensified through derivatives trading. Though designed to reduce price volatility, derivatives can actually amplify fluctuations. Options positions, for example are usually not hedged by an equal or opposite position; rather, they are hedged through a series of transactions in the underlying cash market upon which the derivative is based. This strategy of dynamic hedging not only creates a closer linkage between derivative and underlying asset prices but may also multiply the amplitude of initial price changes. Portfolio insurance strategies during the stock market crash of 1987 and currency options trading in the European currency crisis of 1992 are examples where dynamic price hedging has increased price instability. Finally, financial and technological innovations have increased the speed at which markets shocks are transmitted. Price fluctuations may be transmitted well before the accompanying information as to the source of the fluctuations. Through dynamic hedging and other strategies, an initial price change may be quickly amplified into a larger change. Faster transmissions of shocks may have significantly compressed the time within which both individual institutions and Central Banks have to react to systemic shocks.

While derivatives have received attention as a potential source of systemic risk, it is worth noting that derivatives are also useful in reducing systemic risk. According to Mullins (1994) derivatives offer market participants including those most vulnerable to risk, increased opportunities for hedging and risk management. Thus the development of derivatives markets has more likely made the financial system better able to absorb shocks, reducing the chances of contagion and systemic failure. Moreover derivative flexibility and customisation capability can be employed to counteract the weak components of the financial system. Perold (1995) provides an illustration of this by exploring the impact of derivatives on payments and clearance systems. When derivatives substitute in a variety of ways for trading in underlying instruments, the result is often reduced reliance on settlement systems.

Inherent in many derivatives is implicit forms of netting. With such instruments, the amount settled is often far less than the amount that would be needed to settle an equivalent transaction in the underlying asset. Of course, the implicit netting inherent in derivatives is offset to some extent by transactions in underlying securities used to hedge derivatives. Perold (1995) argues that compared with equivalent transactions in underlying assets, derivatives can reduce the occurrence of large funds transfers and thus lower the risk of systemic failures. The other ways derivatives can be designed to reduce risk is by the shifting of the location of settlement. Exposure to foreign bonds or stocks through futures effectively transfers settlement from foreign securities settlement systems to a futures clearing house.

Derivatives can also be used to reduce legal risk, for example, Swap transactions can actually specify which jurisdiction applies to agreements/disagreements as well the jurisdiction for adjudication of disputes. This can be specified regardless of the domiciles of counterparties or the underlying security. This allows for transactions to avoid the risks associated with home country laws (Smith and Ludger,1997).

In short, greater linkages between financial markets created by derivative trading, and the lack of transparency associated with swaps have all contributed to greater risk of systemic failure.

3.4.1 Risks of Derivatives and Regulatory Issues

For all the low cost, risk-hedging, profit gaining features that derivatives provide there is also a down side to derivatives trading. Regulators have had a lot of difficulty understanding the opaque, off balance sheet trading of many financial institutions. Losses that have put derivatives in the headlines include the well-known global banks as Metalgeschelsaft, Barrings and Sumitomo's experience with bankruptcy proceedings. The problem is further compounded by derivatives' global nature.

Derivatives trading can be rightly called a zero sum game. For each agent's gain is associated with another agent's loss (Smith and Ludgar, 1997). The most important advantage that derivatives provide, in terms of economic welfare is the ability to precisely target risk. However, this may cause adverse effects in capital markets. The 1990s have seen increased concern about the risks inherent in derivative financial products and the implications for financial stability. Concerns cover the following issues:

- Dynamic hedging amplifies price movements. As the underlying price falls, the dynamic hedger sells the underlying asset, amplifying the price drop. In times of panic dynamic hedging increases illiquidity in both the underlying and derivative markets, a situation that may lead to a complete financial market collapse.
- Systemic risk: Derivatives may increase systemic risk – this is the risk that a default or shock in one institution or market will set off a chain reaction in other institutions leading to the collapse of the core financial system. Derivative business tends to increase linkages between markets, because of active arbitrage (and hedging) between derivative markets

and the physical markets. The fundamental cause of systemic risk is the dealer's desire and need to perfectly hedge market exposure.

- Adverse global capital movements: Poor policy choices can result in rapid withdrawal of capital.
- Lack of transparency: Derivative business may not be sufficiently transparent in the sense that there is insufficient information available about the pricing and volume in the markets and about the involvement of individual firms and the risks they are taking.
- Legal uncertainties: Legal uncertainties entail a further source of risk. These include the validity of derivative transactions if some parties do not have explicit power to enter transactions, and the applicability of new laws to new instruments. The very fact the derivative instruments can be customised further aggravates the problem.
- Credit risk: derivatives also give rise to credit risk while transforming other market risks. Credit risk is defined as the risk that a party may default on its obligation. Credit risk is not limited to the current market value of the contract but also includes a component, which includes potential future price movements before the contract matures.
- Model pricing errors: with the growing complexity of derivative instruments and the pricing models the opportunities for human error, system failure, or fraud increases.
- Clearing and settlement risk: Clearing and settlement risk have increased as the volumes of contracts traded have gone up. In times of crisis attempts to close derivative positions might overload settlement system.

The social loss of systemic failures manifests themselves in the form of lost output and employment. The insolvency of the financial institutions leads to cutback in lending activity and in loss in industrial production.

3.4.2 Circumventing Prudential Regulation

In addition to the usual functions of derivatives in portfolio diversification and risk reduction, derivatives can be used to increase risk. In weakly regulated markets, derivatives provide a perfect opportunity for financial intermediaries to acquire risky positions in an attempt to recover capital. Banks can readily avoid regulations either by going offshore or engaging in off-balance sheet activities, which violate the intent of regulations.

3.5 Implications of Derivatives on Central Banks

In the following section we are going to look into the likely areas, which might be affected with the widespread use of derivative instruments. These are likely to affect transmission of monetary policy indirectly by Central Bank authority on the use of policy indicators, payments systems, intervention in exchange markets, the money multiplier and velocity of money. We will now discuss these in turn.

3.5.1 Impact of Derivatives on Policy Indicators

The growth of derivatives has affected traditional quantity indicators of monetary policy such as monetary and credit aggregates (BIS, 1994; Townend, 1995). First, derivatives have altered the demand for money. It is argued that precautionary and speculative demands for narrow money have been reduced. The availability of derivatives has reduced transaction costs allowing economic agents to operate with lower transaction balances. Derivative activities have also provided low cost risk management alternatives reducing precautionary and speculative money demand. To some extent, these effects might be increased by the increase in the volume of financial transactions and an increase in economic activity because of an increase in derivative activity.

The usefulness of broader monetary aggregates has been adversely affected as derivatives have provided competing alternatives. Low cost hedging of price risk of traded assets, (for example hedged government bonds,) transforms market instruments into lower risk instruments competing with interest bearing components of broad aggregates. Credit aggregates have also been influenced by the growth of derivatives.

Improved risk management capabilities allow banks to offer more flexible, better-tailored credit alternatives on improved terms to borrowers. However, by enhancing trading environments derivatives have contributed to the securitization of credit and disintermediation from banks and other financial institutions. The impact of derivatives is only one component of the broader force of financial innovation. An article in Deutsche Bundesbank Monthly Report states that:

> "It is true that derivatives impede an empirically meaningful definition of the economically relevant money stock but concludes that the problem is not new, simply a component of increased complexity in the financial system." (Deutsche Bundesbank, 1994, p.56)

While there may be no impact on the efficacy of policy from the policy of aggregates, these developments have eroded the usefulness of aggregates as a tool for communicating the process to the markets and the system as a whole.

To cope with the problems of financial innovation, the central banks of most countries have adopted a wider range of policy indicators. Some countries no longer adhere to the strict targets for money supply, but allow for deviations from them in the short and the long run. Some examples are the US and the UK, where the targets have been adjusted in midyear in order to allow for overshoots. Also in these countries monetary policy has been forced to set multiple targets. OECD countries have also made changes in the conduct of monetary policy. In France and Italy the authorities have been compelled to redefine monetary aggregates (BIS, 1994).

3.5.2 Payments Systems and Derivatives

Failures associated with payments systems could take the following three forms:

- Risk of default on demand deposits by banks (Merton, 1992).

- Access to payments system is mis-priced (Bagehot, 1971).
- Risks that the failure by one individual institution to honour its obligation could snow ball a chain of failure among other institutions (Faulharber and Santomero, 1990).

In case of risk of default on demand deposits the probability of the cheque being honoured depends on both the writer of the cheque and the solvency of the writers' bank. If the payment system is secure then the only risk is the risk arising from the writer of the cheque rather than the writer's bank. In this case derivatives do not pose a threat to the payments system.

Again if the payment system is secure, individuals and businesses will not need to invest their time and money in obtaining information about the writers' bank, because the banks themselves will not default; and therefore, the only concern is the credit risk of the cheque writer. Thus bank risks in derivatives markets have no direct implications for the mispricing of payments system services.

Banks do not face any risk in the derivatives markets, which are fundamentally different from the risks that they face in loan and security portfolios. Diversification is a more effective tool in managing default risks in derivatives than in loans. Also the fact that a banks' derivatives subsidiary can shield its parent from making losses at the subsidiary, reduces a banks' default risk further and isolates the payments system from any form of risk. A good example is the collapse of the Barrings Bank, which did not result in any form of systemic risk, nor did it cause any problems for the payments system. Rather, the operation of Barrings Bank was simply wound down or was absorbed by ING. The introduction of derivatives does not alter the basic operation of the discount window nor the effectiveness of the rules limiting access to the discount window.

3.5.3 Exchange Rate Intervention and Derivatives

Another deviation from that of a perfect market world are the consistent frictions between the domestic and international markets. Any deliberate intervention by the Central Banks can be useful only if domestic and international markets are not perfectly integrated. If money flows freely between the domestic and foreign markets, then a Central Bank cannot intervene in the foreign exchange market without affecting the domestic monetary base. By better integrating the markets, derivatives reduce a Central Bank's ability to conduct exchange rate intervention.

3.5.4 The Money Multiplier

Two factors that jointly determine the money multiplier are the statutory reserve requirements set by the Central Bank and the excess reserves held by the commercial banks. Reserve requirements are regulations imposed on banks by the Central Bank that specifies a minimum reserve-deposit ratio. Reserves are the deposits received by the banks that do not have to be loaned out. Minimum reserves are used in face of unexpected demands on commercial banks and are voluntarily maintained by the commercial banks. If commercial banks use derivatives to hedge their exposure to interest rates, exchange rates and commodity prices then the desired excess reserves in the banking system will be lower than it might be without derivatives markets. Since the use of derivatives reduces the exposure, the need to voluntarily maintain excess reserves will decline. This would further mean an increase in the money supply and the money multiplier. If access to derivatives reduces the demand for excess reserves by providing alternate risk management opportunities, then access to derivatives should also reduce the volatility of the money multiplier. Such a reduction would increase effective control over money supply by the Central Bank.

3.5.5 Velocity of Money

Firms and individuals hold precautionary money balances to deal with unexpected shocks. Access to derivatives should reduce the level of velocity of these precautionary balances, since derivatives act as tools to manage the various market risks. Reducing the velocity would mean increased Central Bank control over the money supply.

3.6 Other Issues for Financial Markets and Monetary Policy

Several issues have emerged relating to the effect on monetary policy of increased derivative security use. We will now discuss each of these in turn.

3.6.1 Information from Derivatives

Options provide a new source of information concerning market sentiment. Implied volatility can be extracted from option prices, indicating the markets' expected volatility until the contracts end. Empirically, the predictive power of implied volatility for actual volatility is significant (see Scott, 1991). Differences between call and put prices can be used to arrive at the distribution of expected price changes. This information is practically important for interest rate and exchange rate changes. The BIS reports that the Bank of England, the Federal Reserve, the Bank of Japan, the Banque de France and the Bank of Italy all analyze option prices on interest and exchange rates (see Hannoun Report, p. 41-42). Futures and options markets provide an alternative method of obtaining expected price paths. Cash markets, such as forward interest rates implied from yield curves can also be used, but the greater liquidity in derivatives markets may result in superior information.

3.6.2 Derivatives as Open Market Instruments

As a form of security, derivatives can offer a new channel for open market operations. Merton (1995) observes that the process of open market operations undertaken by Central banks to stabilize or influence short-term interest rates could be replaced by a policy of selling options (or traditional instrument with options attached to it). For example, a Central bank could sell put and call options on short-term money market instruments. If interest rates rise, the falling price of the money market instrument could result in the exercise of put options. This would mean Central Banks would have to buy securities to increase the liquidity in the cash market thus pushing interest rates down. If interest rates fall, the increase in the price of money market instruments would lead to the exercise of call options, requiring the Central Banks to sell securities, reducing liquidity hence putting an upward pressure on interest rates. Merton (1995) felt that such an option stabilization policy would produce identical results as the traditional open market operations. Merton notes several advantages:

- Such policy measures would be, literally speaking, automated and pre-programmed and hence will enhance credibility.
- Since these policy measures are automatically triggered by market fluctuations it could be used effectively at all times like weekends and domestic non-trading hours.
- The private sector pays for the options at issue, which effectively means they pay for the stabilization program.
- Another advantage will be that derivatives markets are often larger in size and much more liquid than the underlying markets.

Thus Merton argues that such an option based stabilization approach is superior to the traditional approach of open market operations. Such programs can easily be modified at all times by repurchasing options and selling other options, which alter the parameters of stabilization.

Just as the private sector has found some derivative instruments superior to traditional instruments, similarly, the Central Banks might find it advantageous to intervene using derivatives. Thus Central Banks could use money market derivatives such as Forward Rate Agreements (FRAs), futures and options to influence money market interest rates or risk.

3.6.3 Understanding Financial Markets and Technology

The spread of financial engineering and financial technology has made the global financial markets more complex than ever before. This has broad implications for monetary policy as monetary policy works through markets. As the financial markets continue to grow in size and complexity it is important to understand their interaction with the real economy. The creation of new financial instruments, derivatives in particular, need special attention. To operate effectively the Central Banks need the required technical and operational expertise. This no doubt holds challenges for the Central Bank but also provides opportunities. Financial innovations have not only produced benefits in improved financial and economic efficiency but provide new sources of information to assess the various policy actions.

3.6.4 Derivatives as New Sources of Information

Derivatives markets constitute new sources of information useful to central banks in assessing market sentiment. Futures, forwards and swaps markets can be used to assess the markets' views concerning the expected future values of a wide range of assets with varying time horizons. Sources of information to assess future short-term interest rates include the futures on deposits, futures on short-term government debt, futures on interbank lending rates (federal fund rates futures). Various interest rate swap rates provide useful information. Commodity price expectations are available through commodity futures (for example, various oil-related futures).

Alternative assessments of market expectations have long been available through markets in underlying instruments. In many cases, research has shown that market expectations derived from derivatives markets are superior to traditional estimates. The reason is that in comparison to other markets, derivatives markets respond more quickly to new information, often leading to cash market movements.

Derivatives have also expanded the quantity of indicators providing new sources of information. An excellent example is the usefulness of derivatives markets' information in assessing the dispersion of market participants' expectation of future asset prices. Advances in option pricing theory have made it possible to derive the implied volatility inherent in an option price. Implied volatility is an estimate of the standard deviation of future price distribution for the underlying asset. Implied volatility derived from option prices thus provides an estimate of a markets' assessment of the future fluctuations of interest rates and exchange rates. An increase in implied volatility suggests market participants expect greater fluctuations in the underlying asset price or it reflects greater uncertainty about future prices.

In addition, option prices can be used to reveal information concerning the shape of the distribution of expected price changes. Available techniques employ option prices or implied volatility on a number of options on the same underlying asset. The output can include the expected distribution of the underlying asset price and the evolution of expected distributions through time.

Innovation in securities design further augments the information set. The inflation index linked bonds and derivatives, such as options based on these bonds, reveal very useful information about the markets' expectations of future real interest rates and of future inflation. Such estimates should be most useful in assessing a Central Bank's success in securing credibility with respect to the objective of price stability. Table 3.4 (Indicators from Derivatives Market Data) summarises a few indicators produced by financial innovation as explained in the discussion above. As discussed in Table 3.4 quantity indicators like call and put options can be useful in assessing the market sentiment. Implied volatility derived from option prices thus provides an estimate of the market's assessment of the future fluctuation of interest rates and exchange rates. The market view of the future asset prices and any changes in exchange rates can be reflected in derivative instruments like futures and forwards.

Table 3.4: Indicators from Derivatives Market Data

	Market view on future asset prices (forward type derivatives)	Expected volatility (option type derivative)	Distribution of expectations of price changes
Exchange Rates	Foreign exchange forwards and futures	Implied volatility of currency options	Call put price ratios
Short-term interest rates	Futures contracts on interest rates e.g., interest rates swaps	Implied volatility of option on three month interest rates futures contracts, caps, floors	Call/put price ratios Call /put volume ratios
Long-term interest rates	FRAs on long term interest rates Interest rates swaps	Implied volatility of options on government bond contracts, caps, floors, swap options	Call/put price ratio Call /put volume ratios

Source: Adapted from BIS (1994) Annual Report.

In a speech, John Townend of the Bank of England argues that:

> "Derivatives are a vast and exciting source of useful information, and it is incumbent on Central Banks to study them intensively in order to extract as much information from data as possible." (Townend, 1995, p.3)

3.6.5 Implications of the Evolving Financial Environment for Monetary Policy

The evolving financial environment has a number of implications for monetary policy makers. The growth of markets and their emerging importance to the real economy underscore the need for a Central Bank to build credibility with markets. Credibility with markets is essential if Central Banks are to be successful in achieving price stability. Credibility also strengthens the stabilisation policy and enhances the effectiveness of monetary policy as an economic stabilisation tool. If market expectations are such that they favour price stability then monetary authorities can ease the policy without fuelling fears of inflation.

Also, reduced frictions have substantially increased the speed of transmission of shocks in the global market. This has necessitated close consultation among the different Central Banks of the world. The contagion systemic crisis has also increased risks, and highlights the need for a proper infrastructure to combat these risks.

3.7 Summary and Conclusions

The above analysis of monetary policy and derivatives suggests that derivatives have reduced the efficacy and the credibility of monetary policy by influencing the financial markets, particularly by reducing transactions costs and by making markets more complete. Credibility refers to the revision of expectations by market participants in line with the policy stance of the Central Bank. Hence, expectations play a major role in the overall effect on the real economy. The fact that derivatives serve to complete the markets and provide information through more explicit prices might make it difficult to surprise the public, reducing real policy effects. Some Central banks view this reduction of the real effects of their policies as an erosion of power and influence (BIS, 1994).

Derivatives also facilitate gains from specialization. We can recall Adam Smith's theory of the division of labour and specialization. According to Smith productivity increases can be witnessed if each workman concentrates on those tasks he does best. Similarly an industrial firm can concentrate on production, and transfer undesired risk to investors who in effect specialize in risk bearing, further making markets more complete, thus speeding up the transmission mechanism of monetary policy. Development of derivatives markets is an offspring of the modern globalization and liberalization process of the world economy. A closed economy can be predictable but poor. On the other hand, open economies are wealthier as gains from trade are realised but also riskier. Derivatives markets allow this risk to be hedged by individual firms.

Presence of derivatives reduces the force of monetary policy on real economic activity (that is a given amount of monetary stimulus will have a smaller effect) and increases the speed with which monetary policy is transmitted through the economy. So the conclusion is that money is neutral in a friction less economy and the sources of monetary non-neutrality must lie in economic frictions, such as informational imperfections and transaction costs. For example, they provide a more efficient mechanism for price discovery, so they speed the information transmission and reduce informational asymmetries. It follows that, by reducing frictions, derivatives markets reduce the real effects of monetary policy actions. Monetary policy shocks are transmitted more rapidly through an economy in the presence of derivatives markets. It does represent a dilemma for monetary policy makers and raises the question as to whether monetary policy will become a weaker tool for counter-cyclical stabilization? Or as is claimed by the Hannoun Report (BIS, 1994) agents may be able to temporarily shelter themselves from fluctuations in interest rates, exchange rates, and other price indicators thus increasing the lag with which monetary policy influences the target variables. The report suggests that all agents will ultimately bear the full brunt of policy changes, the only difference being that the timing of the country's response may change.

In short we can say that Central Banks cannot ignore a financial markets' capability to influence the operation of monetary policy. The growth of financial markets in particular, derivatives markets have enhanced the effectiveness of monetary policy, by speeding up the transmission process and by influencing expectation thus adding power or credibility to the process. The same market can exert enormous negative pressure if policies are perceived contrary to the expectations. Markets thus act as an amplifier, or a damper, of policy impulses depending on their judgements and the economic situation. Therefore, it is important to conduct an empirical analysis to capture the effect of derivatives markets on real economic activity, and this is the subject of the following chapters.

CHAPTER 4

FINANCIAL INNOVATION, TRANSMISSION PROCESSES AND REAL SECTOR ACTIVITY

4.1 Introduction

Chapter 3 was an attempt to explain the impact of derivatives on financial markets in general and their impact on monetary policy. So far the impact of derivatives on the real sector and on the financial sector have been discussed separately. In this chapter we combine and discuss the theoretical and empirical research pertaining to derivatives, and their impact on the transmission processes and real sector activity. The literature on money, credit and finance is vast and therefore it is not intended to review all this literature, but rather efforts are made to include the major contributions by researchers that specifically relate to derivatives markets as financial innovations, and their impact on transmission processes.

The following chapter provides a review of the more historical academic research and goes on to explain some of the more recent empirical work. The major theoretical contributions to the nexus between financial markets and real economic activity are outlined, followed by an empirical estimate of the nexus. Having established the relationship between the real and monetary sectors, the discussion moves on to the recent debates about the channels of the monetary policy transmission mechanism. This chapter provides a perspective on the recent empirical work on the existence of some of the channels of the monetary transmission mechanism. The chapter finally concludes with the impact of innovations on monetary policy.

Consequently, this Chapter is split into three parts. The first section highlights the nexus between the real and the monetary sectors. The second section discusses empirical results from various channels of the monetary policy transmission mechanism and the last section provides an overview of the theories of financial innovation and empirical estimates of their impact on monetary policy.

4.2 Theoretical Considerations

There are several theoretical considerations regarding the transmission mechanism by which monetary changes spill over into the real sector. However, a concensus on what exactly this is, still causes debate. The direction of causation has yet to be agreed unequivocally by most economists. Hicks (1967, p.156) believed that:

> "...monetary theory (to be) less abstract than most economic theory: it cannot avoid a relation to reality, which in other economic theory is sometimes missing."

4.2.1 The Early Quantity Theory of Money

The classical approach to the early theory of money comes from David Hume (1772) in his essay "*Of Money*". In Hume's words 'the prices of commodities are always proportioned to the plenty of money'[1]. His view grew in repute following the celebrated *Report of the Bullion Committee* of 1810, which attributed the inflation of the time to an uncontrolled increase in paper money. The modern renaissance in monetary theory began with the American economist Irving Fisher and his famous work in 1911.

[1] Discussion of the inflationary gap', American Economic Review, Vol.32 June 1942, p. 314-20.

4.2.2 Fisher's Version of the Theory

To Fisher, the volume of payments made in an economy can be considered as the product of price and quantity. He developed and popularised what has come to be known as the quantity equation:

$$MV = PT \qquad (4.1)$$

Fisher not only presented this equation but also applied it in a variety of contexts. He wrote a famous article interpreting the business cycle as the "dance of the dollar", in which he argued that fluctuations in economic activity were primarily a reflection of changes in the quantity of money. The quantity equation was also known as the Fisher equation where M represents the total quantity of money in the economy, V represents the average number of times each unit of money is used to make a purchase (the transactions velocity of money), P represents a suitably chosen average price, and T represents a suitably chosen aggregate of quantities traded during the period under examination. Fisher made two assumptions. If T was supposed to be constant (in a full employment economy the physical volume of transactions will reach its maximum as no more goods can be produced), and V is supposed to be constant as well (being determined by traditional practices, habits and banking institutions) the strict quantity theory will hold that is:

$$M\overline{V} = P\overline{T}\,. \qquad (4.2)$$

The relationship between the volume of money and the value of money would be straightforward: increases in the quantity of money would produce rising prices, so that each unit of money would purchase a smaller amount of goods. In other words changes in the quantity of money would be reflected either in prices or output. Short-term fluctuations in the economy reflected changes in the quantity of money. In economic policy it was widely accepted that monetary policy was the primary instrument for stabilising the economy.

A frequent criticism of the quantity theory concerns the mechanism whereby a change in the nominal quantity of money is transmitted to prices and quantities. The criticism focuses on the fact that the transmission mechanism is not specified, that is the proponents of the quantity theory rely on a black box connecting input and output. In an attempt to answer this criticism, Friedman and Schwartz (1963) examined the relationship between the variability of money and income (nominal) for both the US and the UK, and found that over the post WW II period, the variability of money tended to be greater relative to that of income. Friedman and Schwartz concluded that over long periods, differential rates of monetary growth are reflected primarily in differential rates of inflation and have little effect on output. Whereas over brief periods, differential rates of monetary growth had an impact on both prices and output. Friedman and Schwartz have confirmed these results in a more recent study (1982) for the U.S, but not for the U.K. Generally, they found that a permanent one-percentage point increase in the rate of monetary growth will ultimately be reflected in a one percentage point increase in the rates of growth of both nominal income and prices, leaving the rate of growth of output unchanged. In their view money illusion is a transitory phenomenon, if it occurs at all. Friedman and Schwartz (1982) argue that deviations of nominal income from the anticipated growth path, produced by deviations of monetary growth from its anticipated path, will produce deviations in output from the path that would be mandated by real factors alone[2]. Unanticipated changes in nominal income alter the demand for particular products. Output

[2] The Friedman and Schwartz view is that average growth of output over long periods is determined by real factors such as natural resource endowment, social institutions, human capabilities, technology, and invention. Over shorter periods, output will also be affected by real factors, but only to the extend that over such periods output will be affected by unanticipated changes in nominal magnitude.

is affected (in the short run) because sellers and producers of these products have no way (at the outset) of knowing whether the change in demand for their products is a change relative to the demand for other products or a change in general nominal demand. The central idea in the monetarists book is that changes in the money supply explain changes in money income, real output (in the short run only), and the price level in the long run.

4.2.3 The Income and Cambridge Version

There are a couple of problems associated with Fisher's quantity theory of money. For the monetary policy to affect market concentration, it is required that monetary policy shocks have real effects, and the impact of these shocks differs depending on the firm's size. Besides the credit view, there are two other main approaches, which do not incorporate these two aspects when analysing the effects of monetary policy shocks. According to the Complete Markets Approach, which is also known as the Modigliani-Miller Theorem (Modgiliani, 1963) if markets are assumed to be complete, a firm's choice of financing between debt and equity is economically irrelevant. In competitive markets with perfect information, real economic decisions are only determined by consumer tastes and available technologies. As a result, if the Modigliani-Miller theorem holds, monetary policy does not have real effects. For example, if the Central Bank follows a contractionary monetary policy this will lead to changes in the proportion of deposits and certificate of deposits (CD's) on the liability side of a Banks' balance sheet. Hence, there should be no effect on market concentration (Fama, 1980 and Bernake, 1986).

The second view is the Traditional Money view. According to this view, credit creation also works smoothly, and can therefore be ignored. However, contrary to the Modigialini-Miller theorem, monetary policy can have real effects. The Fed may affect spending by using open market operations to change the supply of money relative to demand. For instance, if the Fed aims to slow down aggregate demand, it will use open market operations to buy back securities from the banking system. This will depress aggregate demand by increasing the cost of funds. Two major criticisms are made against these views of monetary policy transmission. First, a contractionary monetary policy has only transitory effects on interest rates but GDP and other variables continue to react to changes in interest rates for a longer period of time. Secondly, although changes in interest rates maybe small and last only for a short period of time, the responses in real variables are large and long lasting. The change in short-term interest rates is supposed to have a significant affect on long-term assets. Another form of Quantity Theory developed in Cambridge met some of the shortcomings of the old Quantity Theory. The Cambridge version emphasised factors that bring about a change in the demand of money and also aim to answer questions relating to the motives behind the holding of money. Instead of being concerned with the total number of transactions, the emphasis was upon the level of income. Fisher's equation can be rewritten in terms of level of money income by multiplying price by output, instead of the number of transactions.

The Cambridge Theory can be expressed as:

$$M = KY \quad . \qquad (4.3)$$

Where:

M = quantity of money in the country,

Y= level of national income,

K= proportion of annual income people wish to hold in the form of money.

Changes in M can be attributed to changes in monetary policy. Changes in K are said to be constant in the long run, but in the short run influenced by the state of confidence in the economy. For example, in a period of crisis people will tend to hold a larger quantity of money. If the supply of money is constant, this rise in K means that Y, the level of income, must fall. Thus, the Cambridge version explained both short run and long run changes in the level of money. In the short run any change in the desire to hold money can be attributed to changes in confidence. In the long run, changes in money income would be related to the changes in the quantity of money.

Although the Cambridge version of the Quantity Theory is a big advance over the Fisher version, it is not in itself an adequate monetary theory. Its weakness is that it is too simple to deal with complex economic situations (Day, 1957).

4.2.4 Exogenous versus Endogenous Money

Exogenity and endogenity of money has been at the back of every controversy surrounding the Quantity Theory of Money. A change in money supply is said to be exogenous when it is not itself explained by the economic model and is said to be endogenous when it is explained by some phenomena, which is part of the model itself. The exogeneity-endogenity of money issue is of course intimately connected with the famous difficulty of defining what "money" is. With the passage of time, the definition of "money" itself has changed. The definition of "money" has broadened from gold and silver in the days of Hume to coins and bank notes in the Currency School, to coins, notes and bank deposits, time deposits, bank reserves and the liabilities of financial intermediaries in modern monetarism (Laidler, 1985, p. 295).

In the orthodox view, monetary authorities control the money supply via control over the volume of bank reserves, giving rise to the following formula:

$$M = m.B \qquad . \qquad (4.4)$$

Where:

M = the money stock,

m = the money multiplier,

B = base money defined as the bank reserves plus currency held by the non-bank public.

The direction of causation runs from B to M; exogenous money assumes that Central Bank actions determine its size.

In the classical world, money is neutral. It can only affect nominal not real values. Monetarists believe that the economy is basically stable, and only exogenous events such as wars, droughts, strikes, shifts in expectations, and changes in foreign demand may cause variations in output around the trend path. Over the short-run, monetarists believe that the major source of economic instability is the mismanagement of the money supply by monetary authorities. While monetarists believe that monetary authorities control the money supply, they reject changes in money supply as a counter cyclical measure. The reason for this is due to the presence of time lags that are of unpredictable length, such that the time interval between changes in money stock and the effect of this change on other variables is completely unknown.

According to Keynes (1936, p.120), money plays a role of its own. It is not neutral. He believed that the rate of interest is determined by people's demand for money and the choice of portfolio consisting of money and bonds. If monetary authorities want to influence the money supply in the economy they will induce people to sell bonds, and this in turn will influence interest rates and the level of economic activity in the economy, since there is an inverse relationship between bond prices and interest rates.

In a post Keynesian and institutional framework, money is regarded as endogenous. Arestis (1988) provides the main elements of what constitutes post Keynesian monetary theory. Essentially "money is viewed as the outcome of credit creation; it is a residual and as such cannot be the cause of changes in any economic magnitudes" (Arestis, 1988. p. 66) and "a system of payments based on checks makes it possible, through the process by which banks make loans, to vary the amount of funds in circulation in response to changes in the level of real economic activity" (Arestis and Eichner, 1988, p. 1005). In the post-Keynesian and institutionalist analysis, the direction of causation is completely reversed compared to the analysis where money is viewed as exogenous:

$$B = (1/m)\,M \quad . \qquad (4.5)$$

Here the causation is from M to B. According to Arestis and Eichner (1988, p.1005) in the U.K :

> "monetary authorities have consistently followed an accommodating policy, providing banks with reserves they need to meet the credit needs of their customers.... For the monetary authorities to act in any other manner would, in fact, be contrary to the purpose for which Central banks would have been established... to acts as a lender of last resort and preserve liquidity of the banking system."

Moore (1988) observes that while Post-Keynesians argue that the growth of money wages is more exogenous, compared to money, Central banks are forced to accommodate money wage increases to prevent unemployment rates from rising to politically unacceptable levels. Moore also points out that until the Post Keynesians are able to specify more closely the mechanism by which changes in money wages influence money stock, they are like the monetarists open to the accusation of having a "Black Box".

In summary, the role of money in business cycle fluctuations is still a controversial issue. Keynesians and monetarists (in the short-run only) hold the view that money affects economic activity. By contrast, Post-Keynesians believe that money does not affect real economic activity. The role of money in the post-Keynesian world is to solely accommodate the demand for money and credit from a bank's customers. The implication of this is that money supply can accommodate itself to changes in the level of GNP, or from a Keynesian perspective, that money can influence GNP via the level of investment. While the classical, Keynesian and monetarist positions do delineate the major dividing lines on the issues of whether or not monetary factors can permanently affect real variables in the economy, they are nevertheless, not the only competing views about the impact of changes in monetary variables on output and employment, real wages, inflation and the balance of payments. The new Keynesian view provides a rationale for nominal price rigidities in terms of menu costs, custom pricing, wage contracts and so forth. Table 4.1 summarises the main schools of thought, and their respective views on the role of money in the macroeconomy in the short run, and the long run.

Table 4.1: Role of Money under Various Macroeconomic Views

Schools of Thought	Macroeconomic Beliefs	
	Does money affect real activity in the short run?	**Does money affect real activity in the long run?**
Classical	Yes	No
Monetarist	Yes	No
Keynesian	Yes	Yes
Post Keynesians	No	No
New Keynesians	Yes	Yes

Having established the role of money in the macroeconomy we now move on to the next section, that is a discussion of the nature of the transmission mechanism between money and prices in the classical model.

4.3 Empirical Evidence on Money and Output

In this section an attempt has been made to review some of the basic empirical evidence on money, inflation and output both in the long run and short run. This will help serve as a benchmark for judging the theoretical models in the previous section. It will also help to analyse the approaches taken by monetary economists to estimate the effect of money and monetary policy on real economic activity.

McCandless and Weber (1995) provide a summary of the long run relationship between real output, money and inflation. They examine data covering 110 countries over a period of 30 years using different definitions of money. By examining average rates of inflation, output, growth and the growth rates of various measures of money over a period of time and for many different countries, McCandles and Weber provide evidence on relationships that are unlikely to be dependent on unique, country-specific events that might influence the actual evolution of money, prices and output in a particular country. Based on their analysis two primary conclusions emerge.

First, the correlation between inflation and the growth rate of money supply is almost one ranging from 0.92 to 0.96 depending on the definition of money supply used. This correlation supports the basic tenets of the quantity theory of money: a change in the growth rate of money induces an equal change in the rate of inflation. However, this causation however, does not have any implications for causality. The second general conclusion is that there is no correlation between either inflation or money growth and the growth rate of real output. Thus, there are countries with low output growth and low money growth and inflation and countries with low output growth and high money growth, and inflation and countries with every other combination as well.

4.3.1.The Transmission Mechanism

4.3.1.1 The Direct Effect

The Quantity theory is an equilibrium condition, which states that money, and prices will tend to move together.

The direct mechanism refers to the straightforward effects on demand and hence prices of an increase in money stock. This mechanism has been known since the writings of Hume (1752). If the stock of money rises but the volume of goods for which money is exchanged remains the same, then, because more money will be chasing the same quantity of goods, the price of goods will necessarily rise and will continue to rise until they have risen in proportion to the increase in the stock of money.

4.3.1.2 The Indirect Effect

The indirect effect was first proposed by Thornton (1802) in An Enquiry into the Nature and Effects of Paper Credit of Great Britain. The indirect effect was developed to introduce the banking system into the analysis. When the money supply is increased some of the extra cash is deposited in a bank. The bank would then have excess funds from which to increase the supply of loans to others. Subsequently, the market rates would fall below the rate of return required to clear the loans market. The demand for loans would rise, as entrepreneurs would borrow at the market rate to invest in capital goods. This process would continue until the market rate of interest was equal to the required rate of return. While stimulating the loans market the monetary expansion would also boost the demand for goods, indirectly raising prices.

Whilst money has been shown to be an efficient and desirable social institution it has no long run real effects in the classical view. The implications of the direct and indirect mechanisms of monetary policy operate only over the short term. Ultimately money is a veil and has neutral effects on the real aspects of the economy. The direct and indirect effects form the building blocks of the classical transmission process, in which the indirect mechanism becomes more varied as the financial system becomes more complex.

4.3.2 Policy Transmission Models

Monetary policy includes Central Bank actions that affect monetary and financial conditions in pursuit of broader objectives. These actions are undertaken in a number of markets and operate via a network of financial institutions. In a complex financial system the thrust of monetary policy towards the policy objectives proceeds through a transmission mechanism. The precise way in which the policy actions feed through the financial and economic system is called the transmission mechanism and the various influences represent the channels of monetary policy. The three main models of the transmission mechanism, which have been developed in the economic literature, are:

- Insular Economy View (Friedman,1980),
- Financially Open Economy View (McKinnon, 1984),
- Policy Transmission View (Jonson,1987).

Friedman enunciated the Insular Economy View in 1980. Friedman's monetarism was essentially a closed economy doctrine. In such an economy the exchange rate is just an output variable with no feedback effect. In the Financially Open Economy View the exchange rate plays an important part. The exchange rate has important implications for pricing decisions. In the Policy Transmission View the money market interest rate became the main information variable, which provides information about subsequent information in non-financial economic activity. The schematic diagram in Figure 4.2 explains the chain of causation sequence as propagated by the three main models of the monetary policy transmission mechanism.

Insular Economy View

Money Supply → Interest Rate → Output → Prices → Exchange Rate

Financially Open Economy

Money Supply → Interest Rate/ Exchange rate → Output → Prices

Policy Transmission View

Market Operations → Interest Rates → Exchange Rate/ Money Supply → Output → Prices

Source: Mckinnon (1984), Jonson (1987).

Figure 4.2: The Monetary Policy Transmission Mechanism

Besides having various views regarding the transmission process there has also been some debate in regard to the different channels that help aid this transmission process. The most widely accepted channel of monetary policy depends on the interest rate sensitivity of spending. Blinder and Bernanke (1992) tried to test a model for monetary policy transmission. They developed a model to show that Central Bank policy works by affecting bank assets as well as liabilities.

Asymmetric information was recognised as one of the reasons for the existence of a credit view channel of monetary policy. Banks normally extend credit to customers who normally find it difficult to obtain credit in the open market. As a consequence when the Federal Reserve reduces the volume of reserves, the amount of loans extended to customers reduces, thereby reducing spending by customers who depend on bank credit, further reducing aggregate demand. Under this assumption, reduced-form responses of the economy to observed policy shocks, will correctly measure the dynamic structural effects of a monetary policy change. The economy is represented through the following structural model:

$$Y_t = B_0Y_t + B_1Y_{t-1} + C_0P_t + C_1P_{t-1} + U_t \qquad (4.6)$$

$$P_t = D_0Y_t + D_1Y_{t-1} + GP_{t-1} + V_t \qquad (4.7)$$

Where:

Y = is a vector of non-policy variables,

P = is a vector of policy variables,

U and V = are orthogonal disturbances.

The two types of identifying assumptions that can be made are $D_0 = 0$ or $C_0 = 0$, so that policy variables affect real variables with a lag.

The conclusion reached is that monetary policy does seem to affect the real economy and that monetary transmission works through bank loans as well as through deposits. Loans seem to respond slowly to monetary policy innovations because loans are contractual commitments. However, loans do respond to a change in funds rate with a timing that corresponds closely to that of the unemployment rate.

Many authors have focussed on the bank-lending channel of monetary policy. This lending channel operates when actions of Central Banks affect the supply of loans from depositary institutions (banks) and in turn the real spending of bank borrowers. One of the first attempts to test for a distinct bank-lending channel was that of King (1986)[i]. He found that monetary aggregates were better predictors of future output than bank loans. More recently, Romer and Romer (1990) and Ramey (1993) reached similar conclusions. Kashyap, Stein, and Wilcox (1993) do find evidence for the bank-lending channel when they examine aggregate U.S data on bank versus nonblank sources of finance; the latter measured by the stock of outstanding commercial paper. While the bank-lending channel as part of the monetary policy transmission process may not be operative, it might still be the case that a shift in bank loan supply causes economic fluctuations. Oliner and Rodebusch (1996) conducted empirical research using data for the U.S manufacturing sector, to investigate the existence of a credit channel for monetary policy that operates through bank lending. Their test was based on the behaviour of the mix of bank and non-bank debt after a shift in monetary policy. In the United States, the 1989-1992 period generated a renewed interest in credit channels, and monetary policy, an unusually large decline in bank lending, as well as evidence of firms in New England facing difficulty borrowing. This led many to seek evidence that credit markets played an important role in contributing to the 1990-1991 recession.

Using short-term debt instruments the author constructed three measures of a mix of bank and non-bank debt. The first measure is simply the ratio of short-term bank debt to the sum of this debt plus the commercial paper.

This measure is denoted as:

$$MIX_{KSW} \equiv B/(B+CP) \quad . \quad (4.8)$$

Where:

B = bank debt,

CP = commercial paper,

MIX_{KSW} = mix of bank and non-bank debt developed by Kashyap, Stein, and Wilcox (1993).

Since MIX_{KSW} omits several important sources of non-bank short-term debt a broader measure was employed to capture the important substitution between bank and non-bank finance. The second measure is the ratio of short-term bank debt to total short-term debt (excluding trade debt) which is denoted as:

$$MIX_o = B/(B+CP+O) \quad . \qquad (4.9)$$

Where: MIX_o = ratio of short-term bank debt to total short-term debt,

B = bank debt,

CP = commercial paper,

O = short-term debt.

Finally the third measure is defined to include trade debt and is denoted as

$$MIX_{TD} = B/(B+CP+O+TD) \quad . \qquad (4.10)$$

Where:

MIX_{TD} = short-term mixed variable including trade debt,

B = bank debt,

CP = commercial paper,

O = short-term debt,

TD = trade debt.

The long-term debt is defined as debt with original maturity of more than one year. If substitutions do occur between short-term debt and instruments with a maturity of more than one year then a mix of short-term debt alone will not fully characterize loan supplies. Given the importance of long-term debt two measures of the mix of total debt denoted can be considered as:

$$TMIX_o \equiv TB/(TB+CP+TO) \quad . \qquad (4.11)$$

Where:

$TMIX_o$ is the ratio of total bank loans to total debt excluding trade debt, TO = other debt,

TB = total debt,

CP = commercial paper.

$$TMIX_{TD} \equiv TB/(TB+ CP+ TO+ TD) \quad . \qquad (4.12)$$

Where:

$TMIX_{TD}$ is the corresponding ratio that includes trade debt,

TD = trade debt,

TO = other debt,

TB = total debt,

CP = commercial paper.

For the empirical analysis of total debt Oliner and Rudebusch (1995) regressed the change in either $TMIX_{TD}$ or $TMIX_o$ on four quarterly lags of itself, eight lags of a monetary policy indicator, and a constant. The results show that there is no evidence of a significant change in the total debt mix after a monetary contraction. Thus, at a disaggregated level, there is no evidence that monetary contractions limit the supply of bank debt relative to other forms of finance.

One difficulty facing attempts to isolate the impact of credit supply disturbances, is the need to separate movements caused by a shift in credit supply from movements that result from changes in credit demand.

The broad credit channel for the transmission of monetary policy is based on the view that credit market imperfections are not limited to the market for bank loans, but instead are important for understanding all credit markets. If agency costs create a wedge between internal and external finance, measures of cash flow, net worth, and the value of collateral should effect investment spending in ways not captured by traditional interest rate channels. The evidence in support a of broad credit channel has been provided by Bernanke, Gertler, and Gilchrist (1996, p.14), who concluded that: "we now have fairly strong evidence – at least for the case of firms – that downturns differentially affect both the access to credit and the real economic activity of high agency – cost borrowers." Frictions such as imperfect information, agency problems, and costly reinforcement of contracts creates a premium between the costs of externally raising funds and opportunity costs of internal financing (Akerlof, 1970, Townend, 1979). According to Bernanke (1993) two mechanisms allow the credit market to function despite the existence of imperfect and asymmetric information: the existence of financial intermediaries and the structure of financial contracts. Financial institutions play a central role in credit markets because of their expertise in acting as financial intermediaries. Banks are able to create credit more efficiently because of potential economies of specialisation, scale and scope.

Bernanke and Blinder (1988) provided a modified version of a traditional IS-LM framework in which they incorporate a bank lending channel. The standard IS-LM model distinguishes between money and bonds as the only two financial assets. Money is assumed to pay a zero nominal interest rate, so the nominal rate determined in the IS-LM analysis is the return on bonds. Bernanke and Binder (1988) modify this framework by distinguishing between money, bonds and bank loans. With three financial assets, the model will determine the interest rate on bonds and loans and the level of output, consistent for a given price level, with equilibrium in the money market, the market for bank loans and the equality of output and aggregate demand. The focus is how monetary policy affects aggregate demand.

The bank lending channel was explained by introducing the banking sector to the standard IS-LM model. Banks are assumed to hold reserves (R), bonds (B) and loans (L) as assets. Their liabilities are deposits (D). The representative bank's balance sheet is:

$$B + L + R = D \quad . \qquad (4.13)$$

Assuming that excess reserves are zero so that reserves are held only to meet the reserve requirement:

$$R^d = \sigma D \quad . \qquad (4.14)$$

Where σ is the required reserve ratio on deposits. Loans and bond holdings must then sum to (1-σ) D. Bernanke and Blinder specify directly the banking sector's portfolio demands for bonds and loans as functions of total available assets after meeting reserve requirements and the return on bonds I_b and loans I_l:

$$\frac{B}{(1-\sigma)D} = B\,(I_b,\, I_l), \qquad (4.15)$$

Where:

B = Bonds,

D = Deposits,

R = reserves.

$b_b \geq 0$, $b_l \leq 0$.

Where:

b_j = is the partial derivative with respect to I_j,

I_b = reserves held as bonds,

I_l= reserves held as loans.

The fraction of the bank's net of required reserve assets held in loans is assumed to be decreasing in I_b and increasing in I_l:

$$\frac{L}{(1-\sigma)D} = 1\text{-b}\ (I_b,\ I_l) \equiv I^s(I_b,\ I_l), \qquad (4.16)$$

Where:

$I^s_b \leq 0,\ I^s_l \geq 0.$

The above equation gives the supply of loans. In equilibrium, bank reserve demand must equal the reserve supply determined by the central bank. Thus, equating reserve supply and demand we can approximate the deviations around the steady state as:

$$r^s = y_t - ci_b + \nu \quad . \qquad (4.17)$$

Loan demand is assumed to depend on the interest rate on loans and the level of economic activity:

$$L^d = I^d\ (I_l, Y) \quad . \qquad (4.18)$$

Where $I^d_l \leq 0$, $I^d_y \geq 0$.

Assuming no credit rationing, equilibrium in the market for loans requires

$$I^d(\ I_l, Y) = I^s(\ I_b,\ I_l)(1-\ \sigma)D = I^s(I_b,\ I_l\ )\ (\frac{1-\sigma}{\sigma})\ R\ . \qquad (4.19)$$

Which can be approximated around the steady state as:

$$I^d_l i_l + I^d_y y = I^s_b i_b + I^s_l i_l + r^s + \omega^1 \quad , \qquad (4.20)$$

or $\quad i_l = h_1\ i_b + h_2 y + h_3 r^s + \omega.$

Where:

$h_1 = - l^s_b/(l^d_l - l^d_l)$,

$h_2 = - l^s_y/(l^d_l - l^s_l)$,

$h_3 = - l/(l^d_l - l^s_l)$ are all positives and $\omega = \omega^1/(l^d_l - l^s_l)$ is a random disturbance, that could incorporate both credit supply and credit demand shocks. An adverse credit supply shock would correspond to a positive realisation of ω that increases the loan interest for given levels of reserve, output and the bond rate. A positive credit demand shock would also correspond to a positive realisation of ω. An IS relationship that links output demand to the interest rates on loans and bonds and a random disturbance can be represented as:

$$y = - \phi_1 i_l - \phi_2 i_b + u \quad . \qquad (4.21)$$

Substituting the loan market condition into the IS function, the loan rate can be eliminated yielding:

$$Y = \frac{\phi_1 h_3 r^s - (\phi_2 + \phi_1 h_1) i_b + u - \varphi_1 \omega}{1 + \phi_1 h_2} \quad . \qquad (4.22)$$

This modified IS curve reveals the key difference between a model that distinguishes between bonds and loans and a standard IS-LM model. Thus, the framework suggested by Bernanke and Blinder attempts to capture in a simple way, additional linkages that arise from the bank lending version of the credit view.

Using data for the US manufacturing sector, Oliner and Rudebusch (1996) tested for the existence of a broad credit channel for monetary policy, which operates through the total supply of loans. In recent theoretical and empirical research, interest has been rekindled in the credit channel for the transmission of monetary shocks to real output. This line of research stresses that Central Bank actions affect output by causing shifts in the supply of loans. In contrast the traditional Keynesian analysis of the transmission mechanism makes no mention of loan supply. As mentioned in Chapter 2 a broad credit channel arises from asymmetry of information between borrowers and lenders, that induces a premium in the cost of all forms of external finance over the cost of internal funds. Under a broad credit channel the cost of external finance relative to internal finance rises after a monetary contraction. This shift in relative finance costs causes investment to be more sensitive to fluctuations in internal funds after a monetary contraction. As a result, under the broad credit channel, the correlation between investment and internal funds for firms facing significant capital market imperfections should be closer after a monetary tightening than during normal times. To bring this key relation into focus Oliner and Rudesbusch (1996) considered the following supply and demand equations:

(Demand) $\quad r = \kappa I + \nu \quad ,$ (4.23)

(Supply) $\quad r = \bar{r} + \Omega(B, rf) = r^f + \theta + (\lambda r^f)\,(I\text{-}F) \quad .$ (4.24)

Where:

$\Omega(B, r^f) = (\lambda r^f)\, B$, $B = I\text{-}F$, and the parameter κ, λ and $\nu > 0$. With $\lambda > 0$, Ω depends positively on r^f which is the risk free interest rate and B. Equating supply and demand, the sensitivity of equilibrium (Ie) to changes in internal funds is:

$$\varphi \equiv \frac{\partial I^e}{\partial F} = \frac{\lambda r^f}{\kappa + \lambda r^f} \quad . \qquad (4.25)$$

The correlation φ varies directly with r^f because:

$$\frac{\partial \Phi}{\partial r^f} = \frac{\lambda \kappa}{(\kappa + \lambda r^f)^2} > 0 \, . \qquad (4.26)$$

The empirical test for the broad credit channel is straightforward: Investment is regressed on cash flows - (the proxy for internal liquidity) - and a set of control variables. The above equation suggests that the coefficient on cash flow, φ, should be relatively high during the period of high-risk free rates, after a monetary tightening. As r^f increases the cost premium of external funds also increases, and internal funds take on special importance as a source of finance. A significant increase in φ after a monetary contraction would provide evidence of a broad credit channel.

The baseline investment equation used to test the above hypothesis takes the following form:

$$IK_t = \alpha^1 X_t + \beta CFK_{t-1} + U_t \quad . \qquad (4.27)$$

Where:

IK_t = denotes gross investment in period t scaled by the capital stock at the end of period t-1,

X_t = is a vector of control variables,

CFK_{t-1}= denotes cash flow in period t-1, scaled by the capital stock at the end of the previous period.

$$IK_t = \alpha^1 X_t + \beta CFK_{t-1} + \delta(DMKT_t^{*} CFK_{t-1}) + U_t \quad . \qquad (4.28)$$

Where:

$DMKT_t$ = the dummy variable that equals unity after monetary tightening and equals zero otherwise.

Under a broad credit channel δ should be positive for small firms, indicating that investment is more closely tied to internal liquidity during periods of monetary contraction. The data set for the empirical research was for the period 1985Q4 to 1992Q4. Results suggest that that a broad credit channel does exist for the transmission of monetary policy and that it operates through small firms.

Hubbard (1995) and Bernanke, Gertler, and Gilchrist (1996) list three empirical implications of the broad credit channel. First, there is large body of cross sectional evidence that supports the view that credit market imperfections do indeed affect firm employment and spending decisions. Second, there is evidence, such as that found in Gertler and Gilchrist (1994) indicating that small firms face the credit-constrained problem, and are hurt more by tight monetary policy as compared to large firms. Third, the asymmetric information view of credit market imperfections, at the core of the credit channel analysis, is a theoretical construct that has shown to be highly useful in explaining many other important phenomena. An important feature of credit channels is their emphasis on the ways that monetary policy affects the economy through other asset prices, besides interest rates.

Li (1988) evaluated the importance of household credit in the transmission of monetary policy, and explained the important positive correlation between money and credit services. This was analysed in a general equilibrium framework of cash and household credit with two distinguishing features. First, there is an explicit financial sector with firms specialising in the production of credit services. Second, the financial sector also contains financial intermediaries who provide interest-bearing accounts for households and loanable funds to credit producers. Monetary injections in this set up can generate a liquidity effect, which positively influences the availability of household credit services and real activity. The model is solved using a linear-quadratic (L-Q) approximation technique that involves linearizing Euler equations with a Taylor's series approximation about the steady state. A method of undetermined coefficients is then used to solve for decision rules, which are linear in the model's state variables. The money growth rate in the model is assumed to follow a stationary AR (1) process:

$$x_{t+1} = (1-\rho)\, x^{*} + \rho\, x_t + \varepsilon_{t+1}, \qquad (4.29)$$

where:

x^{*} = the steady state value for x_t, $\rho < 1$,

ε_t = a white noise disturbance with zero mean and constant variance,

x_t= money growth.

Li (1988) found that monetary injections through financial intermediaries and credit producers generate a liquidity effect, by which real activity is influenced through an expansion of household credit services. Moreover, since monetary injections increase the availability of household credit services it is possible to circumvent the inflation tax effect on consumption. Thus consumption responds positively to monetary shocks as well.

4.3.3 Money and the Open Economy

New channels through which monetary factors can influence the economy arise in open economies. Exchange rate movements, for example, play an important role in the transmission process that links monetary disturbances to output and inflation movements. Open economies face the possibility of economic disturbances that originate in other countries, and these raise questions of monetary policy design that are absent in closed economies.

This section begins with a two-country model based on Obstfeld and Rogoff (1995, 1996). The two-country model has the advantage of capturing some of the important linkages between countries, while still maintaining a degree of simplicity. It can be used to examine monetary policy interactions that are absent from the closed economy models utilised in previous chapters. Because an open economy is linked to other economies, policy actions in one economy have the potential to affect equilibrium in other economies. Thus, spillovers can often occur often, and because of these spill overs countries try to coordinate their policy actions.

In the small open economy literature, a small open economy denotes an economy that is too small to affect world prices, interest rates, or economic activity. Since many countries are small relative to the world economy the small open economy model provides a framework that is relevant for studying many policy issues. In these models, behavioural relationships are specified directly rather than derived from underlying assumptions about the behaviour of individuals and firms. As a result, the frameworks are of limited use for conducting normative analysis, since they are not able to make predictions about the welfare of the agents in the model. This is one reason for beginning the discussion of the open economy with the Obstfeld-Rogoff model; it is based explicitly on the assumption of optimising agents and therefore offers a natural metric (in the form of utility of the representative agent) for addressing normative policy questions. Linear approximations to the basic Obstfeld-Rogoff model serve to make the linkage between two economies clear. The equilibrium conditions can be expressed as (Obstfeld and Rogoff 1995, p.624-660):

$$p_t = np_t(h) + (1\text{-}n)\,[s_t + p_t^{*}n\ (f)] \quad , \qquad (4.30)$$

$$p_t^{*} = n[p_t(h) - s_t] + (1\text{-}n)\ p_t^{*}(f) \quad , \qquad (4.31)$$

$$y_t = \frac{1}{1-q}\,[\ p_t\text{-}\ p_t(h)]\ c_t^{w} \quad , \qquad (4.32)$$

$$y_t^* = \frac{1}{1-q}[p_t^* - p_t^*(f)] + c_t^w \quad , \quad (4.33)$$

$$nc_t + (1-n)c_t^* = c_t^w \quad , \quad (4.34)$$

$$c_{t+1} = c_t + r_t \quad , \quad (4.35)$$

$$c^*_{t+1} = c^*_t + r_t \quad , \quad (4.36)$$

$$(2-q)\, y_t = (1-q)\, c_t^w - c_t \quad , \quad (4.37)$$

$$(2-q)\, y^*_t = (1-q)\, c_t^w - c^* \quad , \quad (4.38)$$

$$m_t - p_t = c_t - \delta(r_t + \pi_{t+1}) \quad , \quad (4.39)$$

$$m^*_t - p^*_t = c^*_t - \delta(r_t + \pi^*_t) \quad . \quad (4.40)$$

Where:

$\delta = \beta/(\pi-\beta)$ and $\pi = 1$,

y_t = home production,

y^*_t = foreign production,

r_t = real interest rate,

c^w = world consumption,

p(h) = price of home production,

p(f) = price of foreign production,

m_t = money balances,

s_t = nominal exchange rate.

Equations (4.30) and (4.31) express domestic and foreign price levels as weighted averages of the prices of home and foreign produced goods expressed in common currency. Equations (4.32) and (4.33) give the demand for each country's output as a function of world consumption and relative price. Equation (4.34) define world consumption as the weighted average of consumption in two countries. Equations (4.35) to (4.36) are the Eulers condition for the optimal intertemporal allocation of consumption. Equations (4.37) and (4.38) are implied by optimal production decisions and equations (4.39) and (4.40) give the real demand for home and foreign money as functions of consumption and nominal interest rates.

The above model is explained in terms of percentage deviations around the steady state. Equilibrium between the foreign and domestic economies can be achieved through changes in nominal and real exchange rates.

4.4 Relationship between the Monetary Sector and the Real Sector

This section provides a broad overview of the relationship between the monetary and real sector, starting from the classical view of the neutrality theory of money, and that it can affect nominal and not real variables, through to more recent empirical research. Money is neutral when changes in money stock lead only to changes in the price level, with no real variables (output, employment, and interest rates) changing. The Monetarists (Friedman and Fisher) make an important distinction between the long and the short run effects of changes in money. They argue that in the long run money is more or less neutral, but it does have important real effects in the short run. An extreme contrast to the above view comes from Keynes (1963), that money does play a role of its own and:

> "...affects motives and decisions and is, in short one of the operative factors in the situation, so that the course of events cannot be predicted, either in the long period or in the short run, without a knowledge of the behaviour of money between the first state and the last, and this is what we ought to mean when we speak of a monetary economy." (Keynes 1963, p.120)

Keynes believed that the interest rate is determined by people's demand for money and the choice of portfolio consisting of money and bonds. If monetary authorities want to influence the money supply in the economy they will induce people to sell bonds. This in turn will influence interest rates and the level of economic activity in the economy. With prices and nominal exchange rate free to adjust immediately in the face of changes in either the home or foreign money supply the model below explains the classical dichotomy.

Evans (1984) used Barro's methodology to find out whether money growth and interest rate volatility affect the level of output.

Barro's model is essentially monetarist in character but modifications of it turn out to have non-monetarist implications. Barro based his model on the hypothesis that only unanticipated money growth affects real variables like output or the unemployment rate. His model explains money growth in terms of readily observable variables - past money growth, current fiscal policy, and the past unemployment rate. Barro (981, p.15) in his book Money Expectations and Business Cycles obtained the following equation:

$$\Delta \ln M_t = \underset{(.015)}{.098} + \underset{(.09)}{.41}\Delta \ln M_{t-1} + \underset{(.07)}{.18}\Delta \ln M_{t-2} + \underset{(.009)}{.081}FEDV_t + \underset{(.005)}{.031} \ln\left[\frac{U_{t-1}}{1-U_{t-1}}\right] + DMR_t. \quad (4.41)$$

Using annual US data over the sample period 1941-78.

where:

t = index of time,

M = M_1money supply,

FEDV = the proportional gap between real Federal spending and its normal level,

U = the unemployment rate,

DMR = residuals.

Standard errors have been reported in parentheses. Using the residuals DMR as the measure of the unanticipated part of money growth, Barro fits the output equation to data for the sample period 1946-78 as follows:

$$\ln Y_t = \underset{(.03)}{2.88} + \underset{(.0004)}{.0829t} + \underset{(.09)}{1.01DMR_t} + \underset{(.22)}{.99DMR_{t-1}} + \underset{(.014)}{.081\ln G_t} + EY_t \quad . \qquad (4.42)$$

where :

Y = output,

G = real Federal purchase of goods and services,

EY= residuals from the equation,

DMR = residuals.

The coefficient on DMR and DMR with one-year lags are positive and statistically significant at extremely low levels. Therefore, Barro concludes that unanticipated money growth strongly affects output. Moreover, since adding current and lagged values of unanticipated money growth does not raise its explanatory power by a statistically significant amount, Barro further concluded that only unanticipated money growth affects output.

Evans modified Barro's equations and reported the money growth and interest rate volatility equations as follows:

$$\Delta \ln M_t = \underset{(.0255)}{.0552} + \underset{(.083)}{.780}\, \Delta \ln M_{t-1} + \underset{(.0151)}{.0392}\, FEDV_t + \underset{(0.34)}{.0300} \ln \left[\frac{U_{t-1}}{1-U_{t-1}}\right] - \underset{(.0134)}{.0124} \ln \left[\frac{U_{t-2}}{1-U_{t-2}}\right] + DMR_t \quad , \qquad (4.43)$$

$$\Delta \ln VR_t = \underset{(.74)}{-2.64} + \underset{(.0155)}{.0333}T + \underset{(.155)}{.690} \ln VR_{t-1} - \underset{(.177)}{.338} \ln VR_{t-2} + EVR_t \quad , \qquad (4.44)$$

where:

VR = the standard deviation of r_{ti}, the monthly change in the AAA bond rates in month i of year t. Therefore, VR refers to the volatility of interest rates.

Evans found that output responds strongly to unanticipated interest rate volatility. In contrast, anticipated changes in interest rate volatility do not affect output at all. Additionally, Evans also found that the stagnation of the US economy since 1979 stemmed from increased interest rate volatility and reduced money growth. He found that the Federal Reserve policy of disinflation in October 1979 led to an unanticipated increase in interest rate volatility, which reduced output by about 1% in 1980 and by 2.5% in 1981 and 1982. More recent research, discussed below has examined whether growth in financial variables led to an increase in real activity, and the impulse responses quantifying the absolute and relative sizes of these effects. These tests address the fundamental and still controversial issue of whether financial development merely proceeds along with, or follows from economic growth emanating from real sector forces, or whether growth is finance led. The research extends the above idea, but with special emphasis on the derivatives markets.

Minsky (1986) proposed the financial instability hypothesis, which furthers the analysis of the dialectical relationship between the real and financial sectors. It is Minsky's contention that increased dependence on corporate debt as a means of financing investment in physical capital has increased the possibility of substantial deflationary pressures should there be a major downturn in economic activity. Innovations in financial practises are an important feature of any economy. New financial instruments increase the amount of financing that is available. Increased availability of finance bids up the prices of assets relative to the prices of current output, which further leads to an increase in investment. The financial instability hypothesis focuses upon investment decisions as the key determinant of aggregate economic activity.

Aggarwal et al. (1997) have tested the financial instability hypothesis for the Asian emerging markets. They find that hedging currency risks using futures and options in major currencies such as the Japanese yen can be beneficial and can result in an improved Sharpe performance index[3].

Each alternative differs in its payoff. The payoff for the first (unhedged) strategy in U.S dollars per foreign currency (FC) is:

$$E(U) = E(S_2 - S_1) \quad . \qquad (4.45)$$

Where:

E (U) = the expected profit or loss in U.S dollars of the unhedged position,

S_i = are the spot prices of the FC against the U.S dollar at the time the purchase order is placed (i=1) and at the time the actual payment is made (i=2).

When the cross-hedging strategy with futures is selected, the net return is:

$$E\ (F) = E\ (S_2 - S_1) + bE\ (F_2 - F_1)\ . \qquad (4.46)$$

Where:

E (F) = the expected profit or loss in U.S dollars of the futures hedge,

b= the proportion of the cash position hedged with futures contracts,

F_i = the foreign currency futures prices in U.S dollars when the hedge is placed (i=1) or lifted (i=2).

In the case of a currency options hedge, the investor will exercise the option only if it is profitable to do so. Thus, the expected return from this hedge alternative is:[ii]

$$E(C) = E\ (S_2 - S_1) + b\ (S_2 - K - C_1) \text{ if } S_2 > K \text{ or,} \qquad (4.47)$$

$$E\ (S_2 - S_1) - b\ C_1 \text{ if } S_2 < K\ . \qquad (4.48)$$

Where:

E(C) = profit or loss of the call option cross hedge in U.S dollars,

B = proportion of cash position hedged with call option contracts,

K = the strike price,

C_1= the call option premium paid at the time the call option is bought.

By using variance as a measure of risk the optimal hedge ratio can be defined as:

$$b^{*} = \frac{COV(S,F)}{VAR(F)}\ , \qquad (4.49)$$

Where:

F = futures hedge,

[3]The Sharpe Index /Ratio provides a summary of two important aspects of any strategy involving the difference between the return of a fund and that of a relevant benchmark.

S = spot prices pf foreign currency against the U.S dollar.

Thus the optimal or least-risk hedge ratio, b^*can be estimated as the negative of the slope coefficient of a regression a_1, of spot price changes S_t, on futures or options price changes H_t, with the coefficient of determination R^2, of the regressions a measure of the ex post hedging effectiveness for the minimum - risk hedge:

$$S_t = a_0 + a_1 Ht + e_t \qquad (4.50)$$

This study concluded that currency risks in Asian emerging markets could be effectively cross-hedged using futures and options in developed country currencies such as the Japanese yen. Such cross hedging is shown to improve portfolio performance even when the hedge ratios are determined in a prior period.

These results are also consistent with evidence in Aggarwal and Movgoue (1996) of an emerging yen bloc in Asia, as futures and options denominated in Japanese yen are often the most effective currency denomination for hedging investments in Asian emerging markets. Garber (1998) has discussed the role of derivative products in international capitals flows, especially in providing a means of both reducing and enhancing market risks associated with given net flows. It emphasises how derivatives can be used to evade risk control or prudential regulation, obscure true risk positions and thereby undermine the usefulness of balance of payments adjustments.

4.5 Financial Markets and Monetary Policy

Conover, Genson and Robert (1999) examine the relationship between monetary conditions and global stock returns. Previous studies have shown that U.S. stock returns during expansive U.S. monetary periods are significantly higher than returns during restrictive periods. They used monthly stock returns from January 1956 through December 1995. The stock returns came from country stock indices, which exclude dividends, and are examined from Austria, Belgium, Canada, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, South Africa, Sweden, Switzerland, the United Kingdom, and the U.S. The study found that patterns in international equity returns are related to both U.S and local monetary conditions. Stock returns for most countries are higher when monetary conditions are expansive and are lower when monetary conditions are restrictive with respect to both U.S monetary conditions and local monetary conditions. By examining several investment strategies, it is shown that investors could have improved portfolio performance in the period studied by using both U.S. and local monetary conditions to guide their portfolio allocations. Monetary conditions have a significant influence on financial markets, and Rozeff (1975) noted:

> "While few propositions about the stock market are universally accepted, most members of the financial community probably agree that changes in Federal Reserve Board Monetary Policy strongly influence changes in stock prices". Rozeff (1975, p.18).

Fleming and Remolona (1999) explain the effect of public information on the price movements in financial markets. To explain price changes, they have examined the correlation of the price changes with the release times of macro economic announcements. To establish the importance of various announcements regressions of price volatility on dummy variables representing each of the announcements were conducted. Price volatility is measured by the absolute value of the change in log prices in the five-minute interval following an announcement, with prices defined as the midpoints between bid and ask spreads. For explanatory variables, the announcement dummy variable D_{knt}, where D_{knt}=1 if announcement k is made on day n just before interval t and

D_{knt}=0 otherwise. Reliance is on an additional set of dummy variables D_t to control for intraday patterns of price volatility. Y_{nt} denotes the dependent variables.

The regression equation is:

$$Y_{nt} = a_0 + \Sigma_{t-1} a_t D_t + \Sigma_k b_k D_{knt} + e_{nt} \quad . \qquad (4.51)$$

Where:

T = 22 (the number of different intervals corresponding to the release of the different announcements),

k = 25 (the number of announcements analysed),

b_k = the co-efficient of interest that measures the impact of announcements k.

The strongest responses were found to come from the employment, producer price index, and Fed funds target rate announcements. To facilitate a comparison of announcement effect, and to ensure that the estimated coefficients are representative of a typical announcement the authors scale the surprises by the mean absolute surprise:

$$S_k = 1/N_k \Sigma_n | S_{knt}| \quad . \qquad (4.52)$$

Where:

N_k is the number of release announcements in the sample. Hence the regression equation is given by:

$$Z_{nt} = a_0 + \Sigma_{k=1} C_k S_{knt}/S_k + u_{nt} \quad . \qquad (4.53)$$

Where:

Z_{nt} = the signed price change,

C_k = the coefficient that measures the effects of announcement surprises on prices.

In general, the surprise components provide more precise estimates on bond prices, indicating a market that is indeed reacting to information. Recognising the magnitude and sign of the surprise lends significance to six announcements not found to be significant in the regressions with announcement dummy variables. No similar efforts have been made to explain the movements in the derivatives markets because of announcement effects.

Taylor (1995) estimated interest rate elasticity of investments for the U.S, Germany, Italy, U.K and Japan with data from two sample periods, one from the early 1970s through 1985 and the other from 1986 through the mid 1990s. The purpose of his study was to present a simple framework for analysing the monetary policy transmission mechanism: the process through which monetary policy decisions are transmitted into changes in real GDP and inflation. The framework used in his article was international in scope with changes in exchange rates playing a key role in the transmission mechanism. Another important distinguishing feature of this study was the focus on financial market prices, short-term interest rates, bond yields, and exchange rates rather than on financial market quantities - the money supply, bank credit, and supply of government bonds. In his study Taylor proposed a simple interest rate rule in which the Federal funds rate reacts to two variables: the deviations of inflation from the target rate of inflation; and the percentage deviation for real GDP from potential GDP, with the reaction coefficient being one-half for each variable. A comparison of these two sets of estimates gives an idea of the magnitude of a change in monetary transmission over time. In the U.S. interest rate elasticity of investment has declined, but the interest rate elasticity of consumption has increased. However, there is no general pattern of change in these interest rate elasticities when looking at the group of seven major economies. In the case of the U.S., Germany and Japan results showed a shift in monetary policy equal to a 3% increase in the path of the target price level in the Central Banks reaction function, equivalent to a target rate of inflation. It implies a temporary reduction in the interest rate, and thereby provides a temporary boost to real GDP. Real output responded differently to monetary policy in the three countries and on balance the monetary transmission mechanism changed to reduce the impact of any changes in interest rates. The change was largest in the U.S as compared to other countries. The proposed study will be carrying forward the above result in a general equilibrium framework, to analyse the interest rate sensitivity on derivative trading, and its impact on the real economy through the credit channel.

Baks and Kramer (1999) in their research found that global liquidity has influenced financial conditions in the major international markets to an important degree, and that excess liquidity in one financial centre can influence financial conditions elsewhere. In their paper they used three indicies of liquidity (money growth) in the group of seven industrial countries, to explore the international dimension of the relationship between liquidity and asset returns. In this study tests were conducted to find out whether excess money growth in one of the G-3 countries (Japan, Germany, or US) drives real stock returns, and real interest rates in the other G-7 countries. Tests for spillovers from excess money growth in the US to real stock returns in the rest of G-7 focus on the parameters of the lag polynomials F (L) and G (L) in the regression:

$$R_{ROW,t} = A(L)R_{ROW,t} + B(L)\ XBMG_{ROW,t} + C(L)\ XNMG_{ROW,t} + \\ D\ (L)\ RLRROW,t + E(L)\ RSR_{ROW,t} + F(L)\ XBMG_{us,t} + \varepsilon_t \qquad (4.54)$$

Where:

R = is real stock return,

XBMG = is excess broad money growth,

XNMG = is excess narrow money growth,

RLR = the long-term interest rate,

RSR = is the real short-term interest rate.

A (L), B (L), C (L), D (L), E (L), F (L), and G (L) are lag polynomials and ε_t is a disturbance term. ROW refers to the rest of the world. Similar regressions were run using Japan and Germany in place of the U.S.

Evidence suggests that an increase in G-7 liquidity is consistent with a decline in G-7 real interest rates. The evidence was generally stronger for narrow money than broad money and stronger for stock prices than for interest rates.

Patelis (1997) examined whether shifts in the stance of monetary policy can account for the observed predicability in excess stock returns. Using long-horizon regressions and short-horizon vector autoregressions, the article concludes that monetary policy variables are significant predictors of future returns, although they cannot fully account for observed stock return predicability.

This study uses the Fama and French (1989) long horizon multivariate regressions to examine whether monetary policy variables help predict stock returns at different time horizons. The model has the following specification:

$$e_{t+k,\, t+1} = a_k + b_k x_t + \varepsilon_{t+k,\, t+1} \quad . \qquad (4.55)$$

where:

$et_{+k,\,t+1} = e_{t+1} + \ldots\ldots + e_{t+k}$ is the continuously compounded k-period rate of excess return and x_t is the vector of variables contained in the market's information set at time t.

An alternative modelling strategy to the long-horizon regressions uses short-horizon VARs. The accounting identity used is:

$$R_{t+1} = \frac{(P_{t+1} + D_{t+1})}{P_t} - 1\,, \qquad (4.56)$$

Where P_t is the asset price at time t, D_{t+1} is the dividend paid by the asset in period t +1, and R_{t} is the return to the asset if held from period t to period t +1. Rearrnging for P_t, taking lags, approximating by first order Taylor expansion, dropping higher order terms, solving forward, and imposing no bubbles condition the identity can be expressed as:

$$P_t = \text{const} + E_t \sum_{j=0}^{x} \rho^j \left[(1-\rho)d_{t+1+j} - r_{t+1+j}\right] \quad . \qquad (4.57)$$

Where E_t is a constant, equal to the ratio of the ex-dividend to the dividend stock prices. The final step taken was to derive the identity for unexpected excess asset returns:

$$e_{t+1} - E_t\, e_{t+1} = (E_{t+1} - E_t)\left[\sum_{j=0}^{x} \rho^j \Delta d_{t+1+j} - \sum_{j=1}^{x} \rho^j re_{t+1+j} - \sum_{j=1}^{x} \rho^j e_{t+1+j}\right] \quad . \qquad (4.58)$$

In the above equation the measure asset returns denoted by e has been decomposed into innovations to dividend growth expectations, real interest rate (denoted re) expectations, and excess return expectations.

This study concludes that there is evidence that monetary policy variables are related to future expected excess stock returns and is supported by both long-horizon and short-horizon VARs. This study was based on previous works examining the relationship between expected stock returns and monetary policy, which according to some theories represent a leading source of business cycles. It links the macroeconomic literature that interprets interest rate spreads as indicators of monetary policy with the finance literature that uses interest rates spreads to predict stock returns. Assets such as equities are claims on future economic output, so if monetary policy has real economic effects, then shifts in monetary policy should affect stock prices. Building on this research, this thesis will take into consideration the derivative instruments in a similar framework. (Smets, 1997) believe that confidence in the market ability to improve growth has led to deregulation in different financial sectors. These factors have increased price volatility on financial markets, notably for exchange rates and long-term interest rates. Capital movements, in particular, influence exchange rates, more than international trade. Therefore, trade and activity are influenced, at least in the short run, by exchange rate volatility.

4.6 Deregulation and the Rise of Financial Markets

The world's financial markets have undergone dramatic changes in recent decades. This point has been emphasised by the Bank of international Settlements:

> "A sharp acceleration in the pace of innovation, deregulation, and structural change in recent years has transformed the international financial system in important ways. Major new financial instruments...have either been created or have dramatically increased their role in the financial structure".(BIS, 1995)

The international capital markets have become much more internationalised and more sophisticated. Neither the internationalisation nor the sophistication of the capital markets would have been possible without the rapid growth of futures and option exchanges. The magnitude of any market is almost always measured by its turnover or trading volume per day, month, or year; and its growth is often measured by the increase of the trading volume over a previous period. In July 1997, the Bank for International Settlements (BIS) began releasing a semi-annual report on market statistics for over-the-counter (OTC) derivatives. Derivatives may be traded over-the-counter (OTC) or openly on organised exchanges. OTC contracts are negotiated privately between the counter-parties, typically between dealers and end users. They are customised rather than standardised. Available data cover four main categories of derivatives: 1) foreign exchange, 2) interest rate, 3) equity, and 4) commodities. Data released by the BIS on positions in the global OTC derivatives market show continued market growth in the first half of 2000. The total estimated notional amount of outstanding OTC contracts stood at $94 trillion at end-June 2000, a 7% increase over end-December 1999 and a 30% increase since end-June 1998, when the BIS survey was initiated. Growth in the first half of 2000 was led by activity in forward-type contracts, particularly interest rate swaps, outright forwards and foreign exchange swaps. In terms of broad market risk categories, interest rate, foreign exchange and commodity contracts expanded at about the same pace, while equity contracts declined.

4.7 Financial Innovation

Financial markets the world over have witnessed profound changes. The following section highlights some of the reasons for these changes. Change itself is not important but what is remarkable is the extent and the pace of such change. Financial innovation has led to the creation of new financial instruments and markets to cater to growing new demands. The rapid pace of development of these instruments and markets is what makes the study of the impact of these markets on real economic activity so urgent and important. During the 1980s new financial instruments, markets and techniques emerged on a large scale especially in Britain and the U.S.

4.7.1 Nature and Classification of Financial Innovation

A two-dimensional financial classification of financial innovations is given by a study conducted by the Bank of International Settlements (BIS, 1996) and is shown in Table 4.2. The BIS has classified financial innovation into two categories in terms of balance sheet and off-balance sheet transactions and also in terms of functions. The classification is as follows:

- Risk transferring innovations
    - Price risk,
    - Credit risk.
- Liquidity-enhancing innovations,
- Credit generating innovations,
- Equity generating innovation.
-

Risk-transferring innovations reduce the inherent risk in any particular instrument or they enable the holder to protect against a particular risk. Within this category a distinction can be made between price risk (the risk that the price of the asset may change) and credit risk (the borrower may default).

Liquidity-enhancing innovations have the effect of increasing the liquidity of instruments and assets. For example, securitized assets enable loans to be sold in a secondary market, which offers the lending institution the capacity to change the structure of its portfolio.

Credit generating innovations widen the total volume of credit by giving access to particular markets. For exarnple, swaps give borrowers access to a wider range of domestic and foreign credit and capital markets.

Equity generating innovations have the effect of giving an equity characteristic to assets where the nature of the debt-servicing commitment is predetermined. A good example is the debt-equity swap, whereby some Latin American countries are able to transform a floating interest rate loan from a bank into an equity-type liability.

Table 4.2: Classification of Innovation by Financial Intermediation Function

On Balance Sheet	Risk transferring	Credit risk transferring	Liquidity enhancing credit	credit generating	Equity generating
Adjustable rate mortgage	*				
Floating rate loans	*				
Back-to-back loans	*				
Loan swaps		*			
Securitized assets		*	*		
Transferable loan contracts		*	*		
Zero coupon bonds				*	
Junk bonds				*	
Off Balance Sheet					
Futures	*				
Options	*				
Swaps	*			*	
Forward rate agreements	*				
Letters of credit	*	*	*		

Source: BIS 1996.

Some financial innovations perform several functions simultaneously (refer to Table 4.2).

4.7.2 Theories of Financial Innovation

Various views have been put forward with regard to financial innovation. Financial innovation has been viewed as a by-product of regulation (Silber, 1983). According to Siber new financial instruments or practises are innovated to lessen the financial constraints imposed by firms. These constraints have been classified as external and internal. External constraints are those factors that are external to firms like government regulation. Whereas internal constraints are the ones imposed by the firms themselves, such as self-imposed liquidity constraints.

Van Horne (1985) treats 'market completeness' as one of the reasons for financial innovation. In a complete market there is a sufficient number of financial instruments available to hedge every conceivable risk that might arise. An incomplete, or imperfect, market is one where there are insufficient instruments available to enable individuals to hedge against risks. Therefore, financial innovations can be seen as a mechanism to improve risk/return trade offs. Financial Innovation occurs in response to profit opportunities, which in turn arise from inefficiencies in the financial system or incompleteness in financial markets. If markets are perfectly competitive, the profitability of financial innovation will encourage innovation of similar products, which in turn will reduce profit margins and increase consumer benefits. A financial innovation may make the market more efficient by reducing the cost of financial intermediation to consumers of financial services. Either the spread - (the difference between what the borrowers pay and the lenders receive) is lowered, or inconvenience costs are reduced.

The factors that provide a stimulus to innovation can be summarised under six headings:

- Changing requirements of customers, including opportunities to reduce or relocate risk, and arbitrage taxation asymmetries and pricing differentials between retail and wholesale markets.
- Changing conditions of suppliers in terms of capital pressures and altered competitive forces.
- Changes in the economic environment from more volatile interest rates, exchange rates, and inflation.

- Changes to the regulatory, supervisory, and legal structure.
- Developments in information and technology and academic inventions (for example, the option pricing model).
- Factors, which close the market gap lead to more complete markets.
- Changes in the level of economic activity may stimulate financial innovation as well. In periods of economic prosperity, many financial institutions are eager to try new ideas in their pursuit for growth. Whereas, in times of deep recession emphasis is more on risk reduction and liquidity.

4.7.3 Financial Innovation and its Implications for Monetary Policy

Akhtar (1983) provided a detailed analysis of the long-term perspective on recent changes in the banking system and the financial markets and their major implications for monetary policy in the larger industrial countries. In his paper, the discussions of various financial changes were grouped into five broad categories of financial changes that reflect the major long-term trends in the financial systems of industrialised countries. These categories are:

- The increasing use of interest sensitive funds by banks and other financial institutions,
- Variable rate lending or borrowing and maturity shortening,
- The growth of financial markets and of marketable instruments,
- The changing shape of retail banking,
- The diversification of sources of financial services,

These financial changes exert significant changes on the empirical definition of money, the money supply process, the demand for money and the role of interest rates on the rate of the transmission of monetary policy to the rest of the economy.

The main hypothesis was that ongoing changes in a financial system might be increasing the role of interest, in influencing economic activity. The following general equation is the starting point for estimates:

$$PD = F\,(Z, R, X)\,. \qquad (4.59)$$

Where:

PD = the private demand for consumption and investment,

Z = the income-based influences on private demand,

R = the long-term interest rate,

X = is a portmanteau variable, which captures all other over time or permanent influences.

In this general form, equation (1) is consistent with any macro-economic model in which consumption and investment are postulated as functions of actual and expected incomes, interest rates and other important variables.

$$PD_t = a_0 + a_1 Z + a_2\,R + a_3\,RD + u \quad . \qquad (4.60)$$

Where:

PD and Z are expressed in constant prices,

u = a random error term,

RD = an interest rate shift parameter that appears under X in equation (1) and all other X-type influences are assumed to be insignificant.

Using natural logarithms of annual data from 1977 to 1982. The results were highly favourable to the hypothesis. For Japan and Germany the interest rate shift variables are highly significant. For the U.S and Italy the 1977-1982 interest rate shift dummy was also highly significant, but it had a positive sign apparently contradicting the hypothesis. For the United Kingdom and France, the interest rate shift dummies are not statistically significant at 90% or higher confidence levels. However, for the United Kingdom an interest rate shift dummy from 1979 to 1982 indicates a result somewhat favourable to the hypothesis. Akthar and later Dennis (1983) thus concluded that the significant estimates of interest rate elasticities might reflect, at least in part the use for data after 1973. Post 1973 was the time when there were several major financial changes including financial innovations and deregulation. Since the results are not highly statistically significant especially for the U.S, it is likely that financial innovation such as derivatives markets would have made the real sector less sensitive to changes in monetary policy.

Akhtar (1983) is of the view that the financial changes in recent years have greatly enhanced the role of interest rates in transmitting monetary policy effects to the economy. Historically, monetary policy influences have worked partly through interest rates and partly through credit rationing or non-price elements. The latter have consisted of interest rate ceilings and balance sheet constraints on financial intermediaries (e.g. official or institutional bank credit limits for various sectors). Over the years credit rationing elements have been gradually weakening and recently the wave of financial changes has reduced the significance of that transmission channel for monetary policy in most countries. Therefore, non-price constraints on credit availability no longer appear to be an important channel for transmitting monetary policy effects in the United States, the United kingdom, Canada and Germany. As a result of the combined effect of the various financial innovations, changes in interest rates, regardless of their origin tend to spread very quickly over the whole range of financial assets and liabilities. Akhtar (1983) argues that in the new financial environment interest elasticities of private demand are likely to rise over time. His empirical research favours this conclusion. Akhtar also concluded that it is inappropriate to use any one monetary variable as the sole or even the primary guide for monetary policy. Financial changes tend to make the existing relations between monetary and non-monetary variables more unstable and unpredictable than before.

4.7 Derivative Effect on Monetary Policy Transmission

Since derivatives markets are a relatively recent innovation in financial markets, there is very little published research, dealing with derivatives and their impact upon real and financial sectors.

Vorlijk (1997) in his study examined the changes in the monetary policy transmission mechanism in the presence of derivatives markets. The effect of adding derivatives markets is analysed independently for each of the main channels of monetary policy including interest rates, credit and exchange rates. Theoretically, there is a faster transmission to financial asset prices but changes in the transmission to the real economy are ambiguous. He used the structural vector auto regression methodology to conduct an empirical study of the United Kingdom. However, Vrolijk (1997) did not find any definitive empirical support for a change in the transmission process for the U.K. The U.K was chosen for the empirical study because along with the United States, derivatives have been in use there for over a decade, thus providing sufficient time series data. His empirical research did not support the hypothesis that the presence of derivatives markets has changed the transmission policy to the real economy in the U.K. However, the above result should be treated with scepticism for several reasons. Firstly, more robust results would have been possible with more extended time series data. Derivatives markets were not as developed as they are today. Secondly, the model was a closed economy model that took no account of exchange rate and foreign exchange derivative turnover. Introduction of foreign exchange futures could make a significant difference to the result. Finally, it is possible that the bank of England has already taken into account the derivative market responses, and therefore the VAR model is simply picking up the new response in its "normal" response function.

But the question of derivative market impact on monetary policy transmission is still far from closed. The aim of the proposed study is to extend the above analysis for the United States economy, and run empirical results with different SVAR (structural vector auto regression) constraints.

4.9 Alternative Econometric Modelling Approaches

Irrespective of the alternative theoretical developments that have occurred in the debate concerning the transmission mechanism of monetary policy, in the end it is outcomes from empirical research, which tend to shed most light upon whether there is a clear causation process within the transmission mechanism. It is with this in mind that we introduce briefly other empirical methodologies that have been applied to the debate. The Vector Autoregressive (VAR) approach has been the most commonly used methodology in recent years to study the impact of monetary policy shocks on real variables or output. However, other alternative approaches have influenced academic discussions and still attract interest in the field of monetary policy.

4.9.1 Structural Econometric Models

The empirical assessment of alternative feedback rules for monetary policy has traditionally been carried out using structural macro econometric models. During the 1960s and the early 1970s, the specification, estimation, use and evaluation of large-scale econometric models for forecasting and policy analysis represented a major research agenda in macroeconomics. However, Lucas (1976) criticised one of the major assumptions of structural econometric models namely that expectations adjusted adaptively to past outcomes. While large-scale econometric models of aggregate economies continued to play an important role in discussions of monetary policy, they fell out of favour among academic economists during the 1970s, as a result of the Lucas (1976) critique.

Large-scale econometric models have proven useful to Central Banks in providing answers to questions related to the design and irnplementation of monetary policy. These econometric models are designed to address specific questions of relevance for the actual design of monetary policy. The FRB/US model is structured to allow simulations to be conducted under alternative assumptions about expectations formation. However, researchers have found that a simple VAR can give a similar result to a FRB/US model.

4.9.2 Narrative Measures

In recent years, this approach has been taken up by Romer (1989) and Boschen and Mills (1991). Boschen and Mills developed a monthly index to explain the policy stance. Their index is based on the Federal Open Market Committee (FOMC) policy directives and the records of the FOMC meetings. The index takes on integer values ranging from -2 (emphasising inflation reduction) to +2 (emphasising real growth). The index has been multiplied by -1 so that the positive value represents a contractionary policy stance. Boschen and Mills show that innovations in their index as a result of expansionary policy shifts are followed by shifts in monetary aggregates, and a decline in the Federal Funds Rate. Any deviation of the Federal Funds Rate from the sample mean is thus due to a change in the policy stance. They are also of the view that the funds rate is a good indicator of monetary policy.

Romer and Romer (1989) used the Feds "Record of Policy Actions" to identify periods where policy changes were introduced to reduce inflation. The study used the minutes of the Federal Open Market Committee to determine a set of dates at which policy-makers appeared to shift to a more anti-inflationary stance. An appealing aspect of the Romers' approach is that it attempts to use additional information - in this case; statements of policy makers' intentions - to try to disentangle money supply from money demand shocks. The Romers' strategy also has the advantage of being "nonparametric", in that its implementation does not require any modelling of the details of the Fed's operating procedure, or of the financial system, and is potentially robust to changes in these structures.

Romer and Romer (1989) estimated the following regression equation, where x_t is the variable of interest (for example, the growth rate of output) and D_t is a monetary contraction dummy variable:

$$X_t = C\ (L)\ Dt + d(L)X_{t-1} + U_t \quad . \qquad (4.61)$$

They reported the dynamic response of X to D as:

$$\frac{C(L)}{1-d(L)L} \quad . \qquad (4.62)$$

Romers referred to the above equation as the impulse response function of X with respect to D. also, X and D have the following vector autoregressive representation:

$$D_t = a(L)\, D_{t-1} + b(L)\, x_{t-1} + V_{t,} \qquad , \qquad (4.63)$$

$$X_t = c(L)\, D_t + d(L)\, x_{t-1} + U_{t,} \qquad . \qquad (4.64)$$

Where a(L),b(L), c(L0 and d(L) are scalar polynomials in non-negative powers of the lag operator L and the innovations, u and V have covariance matrix Σ.

Romers adopted the narrative approach to solve the identification problem inherent in time series models, where standard measures of policy shocks produce dynamic responses of macro variables that are inconsistent with the predictions of traditional monetary theory.

Leeper (1993) has argued that the Romer-Romer Index is equivalent to a dummy variable that picks up the largest interest rate innovations. A disadvantage of this approach, besides its inherent subjectivity is its difficulty in distinguishing between endogenous and exogenous components of policy change, which is necessary to identify the effects of monetary policy on the economy.

Moreover, the new narrative measures of monetary policy shocks contain a substantial endogenous component and generate dynamic responses to prices and interest rates that are inconsistent with the predictions of traditional monetary theory.

The narrative indices of Boschen and Mills (1991) and the dating system employed by Romer and Romer (1989) to isolate episodes of contractionary policy provide a useful and informative alternative to the VAR approach. The VAR approach attempts to identify exogenous shifts in policy. The narrative indices can provide a better measure of the net stance of the policy, but they capture both exogenous shifts in policy and the endogenous response of monetary policy to economic developments (Walsh, 1998). In fact, most of the movements in monetary policy instruments represent responses, which are endogenous rather than exogenous policy shifts.

4.9.3 Case Study Approach for Disinflation

Various case studies of specific episodes or periods have provided an alternative means of assessing the real impact of monetary policy. One of the most influential approaches has been that of Sargent (1986) who tested the end of hyperinflation during the post world war period in Austria, German, Hungary and Poland. A key hypothesis in academic monetary policy has been whether anticipated changes in monetary policy should affect prices and inflation, with little or no effect on real economic activity. This means that a credible policy to reduce inflation should succeed in actually reducing inflation without causing inflation. This implication is in contrast with the view that a policy designed to reduce inflation would succeed only by inducing an economic slowdown. Sargent tested these competing hypotheses by examining the end of post WWI periods of hyperinflation in Austria, Germany, Hungary and Poland. For each of these countries Sargent found that hyperinflation ended abruptly due to a credible change in monetary and fiscal policy. For each percentage point reduction in inflation there was an associated loss of 0.77% of output relative to trend.

Schelden-Andeson (1992) and Ball (1995) provide more recent examples of the case study approach. In both cases the authors examine disinflationary episodes in order to estimate real output costs associated with reducing inflation. Thus, the case study approach can provide interpreting evidence on the real effects of monetary policy. Unfortunately, as with the VAR and other approaches, the issue of identification needs to be addressed. To what extent has disinflation been exogenous, so that any resulting output or unemployment movements can be attributed to the decision to reduce inflation? If policy actions depend on whether they are anticipated or not, then estimates of the costs of disinflation obtained by averaging over periods may yield little information about the costs of ending any specific inflation.

4.9 Limitations of Current Literature

The past studies have concentrated mostly on the traditional markets like the stock/equity market, the bond market and the currency market, ignoring the importance of the derivatives markets. The recent financial developments of derivatives markets have reduced the impact of some of the channels of monetary policy transmission and thus the overall impact of the policy on macro economic aggregates.

The underlying motivation for this topic stems from the current scale of the derivatives markets as reported by the Bank of International Settlements (BIS). A similar empirical analysis of the United Kingdom was carried out by Vrolijk (1997) to examine the impact of monetary policy in the presence of derivatives markets. The results showed that there was no evidence that derivatives had affected the transmission mechanism of monetary policy. However, the results could have been robust with an extended time series. Since derivatives markets were still in the initial stages of growth it is not possible to capture the true impact of derivative markets on the real economy.

This thesis is an attempt to highlight this important change in the transmission mechanism of monetary policy for the U.S economy. It will provide a deeper understanding of the nexus between the derivatives markets, monetary policy transmission mechanism and its effects on real economic activity. The rationale for studying the relationship between financial and real economic activity arises from both theoretical models and empirical evidence, which indicates that movements in financial asset prices are potentially important for understanding how the economy behaves. The phenomenal growth in the turnover of derivative instruments has made them an important financial sector. This market is relatively new and is growing fast. The literature in financial economics is relatively quiescent with regard to derivative market activity. Past studies have particularly examined the association of the stock market to Monetary Policy and Real Economic Activity. But similar kinds of studies are limited for the derivatives markets. The proposed study will be an attempt to fill this gap.

4.10 Summary and Conclusions

There is general consensus from the empirical literature that in the long run there is a clear relationship between money, prices and output. Money growth and inflation essentially display a correlation of one. There is also general agreement on the impact of monetary policy on real economic activity in the short run. Exogenous monetary policy shocks produce hump shaped movements in real economic activity. These effects occur after a time lag and then slowly die out.

However, there is less concensus on the feedback affect of monetary policy shocks. Different researchers view in different ways the channels through which monetary policy works. Views diverge even about the monetary transmission process in individual industrialised nations. After decades of theoretical and empirical research the process of the transmission mechanism is still unclear in developing countries. An understanding of the transmission process is essential for appropriate design and implementation of monetary policy. Change in the structure of the economy, namely the impact of financial innovations, tend to alter the impact of a given monetary policy measure. Therefore, there is a need to continuously reinterpret the channels of transmission of monetary policy. One of the most important changes in the world economy has been the growth of derivative markets and the growth of derivative instruments to hedge interest rate risk. Theoretically, derivatives speed up the feedback effect of monetary policy, hence the final impact on the real economy. Therefore, it becomes imperative to conduct an empirical analysis of the likely impact derivatives markets have on the monetary policy transmission mechanism and hence its impact on real economic activity.

The question of neutrality of money is a central one in macroeconomics. Classical economists and real business cycles theorists have developed models in which money is neutral. In new classical models, all systematic monetary policy actions are neutral in their effects; only monetary surprises affect real variables. Keynesians, new Keynesians and monetarists have constructed models in which money is non-neutral (at least in the short run). The neutrality of money is not only central to macroeconomics, but is also important to the real economy. Whether or not money is neutral has implications for the proper conduct of monetary policy.

In short, we can say that Central Banks cannot ignore the financial markets' capacity to influence the operation of monetary policy. Markets act as an amplifier or a damper on policy impulses depending on their judgements and economic situations. Therefore, it is important to conduct an empirical analysis to capture the effect of derivatives markets on real economic activity, an analysis that will be carried out in the following chapters.

CHAPTER 5

THE VECTOR AUTO REGRESSION METHOD

5.1 Introduction

Chapters 2 and 3 are mainly a theoretical analysis of the likely impact of derivatives trading on the individual channels of monetary policy transmission and financial markets in general. The previous chapters also explain that the monetary transmission mechanism is the process through which monetary policy decisions are transmitted into changes in real GDP, and inflation. Modern macroeconomics tends to draw a distinction between the short and medium term when distinguishing the effects of monetary policy on the real economy. Over the medium term inflation is primarily a monetary phenomenon, and in terms of the real effects on output, money is considered to be neutral. However, in the short term, monetary policy is considered to have real effects. The effect of monetary policy on output further needs to be analysed, with the introduction of derivative markets and products. Past empirical research has theoretically, explained the likely impact of derivatives on real economic activity as follows:

- Derivatives make financial markets complete by speeding up the transmission across different asset types.
- Derivatives are likely to have an impact on the real economic activity of any economy by transforming the transmission of monetary policy itself.

The main aim of the thesis is to study the interrelationships between macroeconomic variables with respect to the impact of derivatives markets upon the transmission mechanism of monetary policy. Vector Auto Regressive (VAR) Models are very good tools for assessing the dynamics of the economy in the aftermath of a monetary policy shock. VAR methodology is particularly useful for studying the monetary transmission mechanism; as it requires only a minimum number of identifying movements in endogenous variables due to different underlying shocks to other variables in the system. There have been many studies using VAR monetary models in macroeconomics, for example Sims (1980), Taylor (1995), Patelis (1997), and Friedman (1975) to name a few. Keeping with the modern trend of using VAR models this thesis will also apply the VAR technique. The aim of this chapter is to explain the nature of the VAR method and analyse its various tools, like variance decomposition and impulse response analysis. The chapter will also introduce variables and identify their time series properties.

5.2 The Nature of the Vector Auto Regression Method

The purpose of this study is to empirically investigate the relationship between derivatives markets and real economic activity using a disaggregated approach. Furthermore, it is important to adopt an appropriate econometric framework to decompose monetary and real variables for two important reasons. First, disaggregated variables have different cyclical timing patterns from aggregated variables. Second, the factors governing movements in the aggregate variables may differ or may have different quantitative impacts on the components of the aggregate. Decomposing the real and monetary sectors into different components, helps in identifying the channels through which these two variables interact, or impact upon each other.

The VAR technique is used here as the main method of analyzing the relationship between the variables. The nature of the VAR structure helps to track the time factor and account for all the potential interactions and feedback between the variables.

This chapter attempts to apply a VAR process developed by Sims (1980) that is used to analyse and forecast interrelated economic variables. The VAR models are general unrestricted vector "autoregressive" time-series models. The term autoregression is due to the inclusion of the lagged values of the dependent variable in the right-hand side of the models and the term vector relates to the fact that a vector of variables is used.

The general form of models can be described as:

$$Y_t = A_oX + A_1Y_{t-1} + A_2Y_{t-2} + _{...}+ A_pY_{t-p} \quad . \qquad (5.1)$$

Where:

Y_t = a (k x 1) vector of variables generated by a p*th* order vector autoregressive process,

K = the dimension of the VAR system (i.e., the number of times series data included in the process, or the number of sub systems),

P = the number of lags,

A_o = a (k x 1) vector of coefficients and X represents the net deterministic component of Y_t.

A_p = (k x 1) matrices of coefficients,

ε_t = a (k x 1) vector of multivariate white noise residuals at time t, which satisfies the following assumptions:

$$E (\varepsilon_t) = 0,$$

$$Cov (\varepsilon_t, \varepsilon_{t-1}) = 0, k \neq 0,$$

$$Var (\varepsilon_t) = \Sigma_{\delta.}$$

Where Σ_δ is a k x k positive definite matrix.

Equivalently, we can represent equation (5.1) in lag operator form:

$Y_t = A(L)\, Y_t + \varepsilon_t$. (5.2)

Where:

A (L) = a nxn matrix of polynomials in the lag operator L,

N = the number of endogenous variables in the system.

Let Φ_{ij} denote the row i, column j element of matrix A_1. Then the first row of the vector system in (5.1.1) specifies that:

$$Y_{1t} = \Phi^1_{11}Y_{1,t-1} + \Phi^1_{12}Y_{2,t-1} + \ldots + \Phi^1_{1n}Y_{n,t-1}$$

$$+\Phi^2_{11}Y_{1,t-2} + \Phi^2_{12}Y_{2,t-2} + \ldots + \Phi^2_{1n}Y_{n,t-2\ldots\ldots}$$

$$+\Phi^p_{11}Y_{1,t-p} + \Phi^p_{12}Y_{2,t-p} + \ldots + \Phi^p_{1n}Y_{n,tp} + \varepsilon_{t\ \ldots\ldots} \quad (5.3)$$

Where:

Φ = refers to the lag.

Each variable in the method is treated as endogenous and each variable is expressed as a function of its own lags and lags of the other variables in the system and its error term. Any contemporaneous correlation between the variables is captured in the error terms. A distinctive feature of a VAR model is that there is no a priori distinction between endogenous and exogenous variables. All variables included in the model are treated as endogenous variables: each equation in a VAR model includes the same number of lags on each and every variable, and therefore each equation has coefficients on lagged variables.

Compared with single equation regression models and simultaneous equation system models, the VAR approach has a number of advantages.

First, all interrelationships between all variables can be analysed in a VAR system. Second, VAR models are technically simpler than simultaneous equation systems in the following ways:

- All variables in the model are treated as endogenous variables. There is no need to determine which variables are endogenous and which variables are exogenous. The endogeneity issue in the simultaneous systems is typically/usually difficult and complicated.
- Although the structure of a VAR model looks complex, the usual OLS method can be applied to estimate each equation separately.

Third, in a VAR system, using the formal causality test developed by Granger (1988), it is possible to deal with the endogenity issue by examining the "casual" relationships between the variables.

Fourth, the more sophisticated cointegration test developed by Johnson and Juselius (1990), (concerning the long run relationships between the variables) can be used in a VAR context.

Finally, a VAR model is a powerful forecasting tool for forecasting systems of interrelated time series variables.

VAR techniques are used as the main methods to examine short-term relationships between variables. Variance decomposition and Impulse Response Functions from the VAR model are utilised to test the directions and the channels of influence between the variables. Issues related to applying the VAR method and the usefulness of it in investigating the source of causation between the variables are addressed in this chapter.

Traditionally, empirical macroeconomic research begins with the use of theory to construct a structural econometric model to describe the dynamic relationships between economic variables. These models are highly restricted and require complicated econometric techniques to be estimated. An alternative approach to modeling macroeconomic time series has come into wide use. This alternative approach, introduced by Sims (1980), suggests the use of VAR models to analyse time series relationships among macroeconomic variables. VAR models require few theoretical assumptions or restrictions to be placed on the individual regression equations. The VAR model is thus assumed to be free of spurious specification assumptions and consequent specification errors necessitated by traditional macroeconomic procedures. In VARs, all variables can be considered endogenous. Each equation in the model includes lagged values of all the variables in the system.

To sum up, VARs are relatively simple models that have become popular among economists to gather evidence on business cycle dynamics. However, using the VAR method is still somewhat controversial. The main criticism of the VAR method is that the statistics from VARs are sensitive to alternate specifications. Criticisms of VAR methodology appeared at all stages of the analysis. Some authors (Runkle, 1987; Ohanian, 1988; Spencer, 1989) raised doubts about the usefulness of the methodology to cauterize the dynamics of time series data. Litterman (1984) and Sims (1982) argue that criticisms against VAR models are like “precautionary footnotes” that must not deter users of VAR from continuing to use it for data analysis and policy purposes (Gujarati, 1990).

The dynamic nature of VARs is of special importance for this thesis because competing macro theories have different exogenous shocks (shocks to money in the new Keynesian model, and so forth). Allowing all variables to affect, and to be affected, by other variables helps to examine all types of shocks in the economy. The nature of the VAR structure helps to track the time factor and account for all the potential interactions and feedback effects between the variables.

5.3 Structural Vector Auto Regression

More recently, a new class of econometric models has been adopted in applied macroeconomics. Structural vector autoregressive (SVAR) models have the distinctive feature that each structural equation is 'saturated' with lagged variables, that is, the dynamics are essentially unrestricted. It is important to differentiate between VAR and SVAR. The Cowles Commission distinguished between a reduced form and a structure. The reduced form related endogenous variables to lagged endogenous (predetermined) and exogenous variables, while the structure did the same, but also allowed for a contemporaneous interaction between the endogenous variables.

Compared to large-scale macroeconomic models, SVAR are useful tools to analyse the macroeconomic response of an economy to specific underlying shocks, because they require a minimum of identifying restrictions in order to separate the movements of the model's variables into parts due to underlying shocks. The basic method involves regressing each variable on every other variable, including itself, lagged up to a given length. Impulse response functions and forecast error decomposition is easily computed from SVAR estimates. The structural VAR approach builds on Sims' approach but attempts to identify the impulse responses by imposing a priori restrictions on the covariance matrix of the structural errors and/or on long-run impulse responses themselves. This approach is developed by Bernanke (1986), Blanchard and Watson (1986) and Sims (1986), who use restrictions on the long-run impact of shocks to identify the impulse responses. In contrast to the unrestricted VAR approach, SVARs attempt explicitly to provide some economic rationale behind the covariance restrictions used. It thus aims at avoiding the use of arbitrary or implicit identifying restrictions. However, there are two key problems, with using this technique to gauge the response to shocks. The first is with regard to the monetary policy response: the model incorporates the "normal" response of policy makers to changes in underlying variables, and hence the shocks under consideration represent “surprise” deviations away from the regular policy maker response. Thus by shocking the system, the results may not indicate the response of the economy to a typical policy action. The second problem with SVAR methodology is the sensitivity of the results to the type of restrictions used to identify the effect of each shock.

SVAR analysis aims to investigate the effects of an exogenous change in one variable on other variables. The feasibility of this goal requires the structural disturbances to be correlated so that they can be isolated from each other. This corresponds to a diagonal variance-covariance matrix of the error terms. The diagonal form of the covariance matrix implies that the number of parameters to be estimated is equal to the number of endogenous variables in the system (say n). To understand the procedure it is useful to examine the relationship between the forecast errors and structural innovations in an n-variable VAR. Since the relationship is invariant to lag length, consider the first-order variable with n variables (in compact form):

$$Bx_t = \Gamma_0 + \Gamma_1 x_{t-1} + \varepsilon_t. \qquad (5.4)$$

Premultplying by B^{-1} we obtain:

$$x_t = B^{-1}\Gamma_0 + B^{-1}\Gamma_1 x_{t-1} + B^{-1}\varepsilon_t . \qquad (5.5)$$

Using OLS we can obtain the variance/covariance matrix Σ where each element of Σ is constructed as a sum:

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \cdots & \sigma_{1n} \\ \sigma_{21} & \sigma_2^2 & \cdots & \sigma_{2n} \\ . & . & . & . \\ \sigma_{n1} & \sigma_{n2} & \cdots & \sigma 2_n \end{bmatrix} , \qquad (5.6)$$

$$\sigma_{ij} = (1/T)\sum_{t=1}^{T} e_{it} e_{jt} \quad . \qquad (5.7)$$

In order to identify the n^2 unknowns from the known $(n^2 + n)/2$ independent elements of Σ, it is necessary to impose restrictions (an additional $n^2 - [(n^2 + n)]/2 = (n^2 - n)/2$ restrictions) on the system.

The differences between VAR and SVAR are as follows. The reduced form VAR model relates endogenous variables to lagged endogenous and exogenous variables. The SVAR does the same, but it also allows for a contemporaneous interaction between the endogenous variables.

Interestingly, Blanchard and Quah (1989) provide an alternative way to obtain a structural identification. Their aim is to reconsider the Plosser and Nelson (1982) decomposition of real GDP into its temporary and permanent components. Their model distinguishes between demand and supply side shocks. Decomposing the (yt) sequence into its trend and irregular components is to assume that one of the shocks has a temporary effect on (yt),(Enders, 1995).

5.4 Granger Causality

Sprites et al.'s (1969) procedure enables us to determine the casual order for the contemporaneous variables, which allows us to put order into the lagged variables. Casual order through lagged variables is especially important from the perspective of policy control.

The central notion of Granger causality is incremental predicability. If a series y is better predicted by the complete universe of past information than by that universe less the series, then x Granger- causes y (Granger, 1969). The appropriate test is the F test to see whether the gain in explanatory power from adding the lagged independent variables is statistically significant. If it is, then it is possible to conclude that causality has been established, in the statistical sense. For example let,

$Y_t = \sum\beta_{11} Y_{t-m} + \sum\beta_{12} Z_{t-m} + \sum\beta_{13} X_{t-m} + \varepsilon_{it}$, unrestricted model (5.8)

and:

$Y_t = \sum\beta_{11} Y_{t-m} + \sum\beta_{12} Z_{t-m} + \varepsilon_{it.}$ restricted model (5.9)

Where:

$\sum$ = ranges from 1 to M. X granger causes Y if some $\beta^j_{13} \neq 0$ statistically.

The F test takes the form:

$F = [(SSRr - SSRu)/r] / [SSRu/ (T\text{-}K)].$ (5.10)

Where:

SSRr and SSRu = the sum of squared residuals in the restricted and unrestricted model respectively,

r = is the number of restrictions in the null hypothesis (the number of lagged variables omitted in forming the restricted model),

t = is the number of observations,

k = is the number of parameters estimated in the unrestricted model.

Granger (1969) first proposed a causality test by using a lead-lag relationship between two variables in econometric modeling. Later several alternative procedures have been developed in an attempt to improve the size and the power of the Granger causality no-causality test (for example, Johansen and Juselius, 1990, Toda and Philips, 1993, Toda and Yomamoto, 1995). Because of the simplicity in the application in VAR systems, in this study the Block Granger causality procedure is applied to test the bi-directional relationship between derivatives markets and real economic activity. The possibility of bi-directional causality can be tested by reversing the order of the variables, so that the independent variable in the first set of equations becomes the dependent variable, and vice versa, and then running the equations again. In performing the Granger test, there are a number of statistical issues, which have to be taken into account, for example stationarity in levels, or first differences, and the choice of lag length that will be discussed in the latter sections of the chapter.

5.5 Innovation Accounting Analysis

Innovation accounting analysis refers to two tools used to trace the impact of shocks (innovations) in the VAR system. These tools were introduced by Sims (1980) to measure the dynamic interaction among the variables. The first, the forecast error variance decomposition (FEVD), analyses the error the model would tend to make if it were used to forecast its variables. FEVD tells us the proportion of the movements in a sequence due to its own shocks versus shocks to the other variables. If ε_{zt} shocks explain none of the forecast error variance of y_t in all forecast horizons, we can say that the y_t sequence is exogenous. At the other extreme, ε_{zt} shocks could explain all the forecast error variance in the y_t sequence in all forecast horizons, so that y_t would be entirely endogenous. In applied research, it is typical for a variable to explain almost all its forecast error variance at short horizons and a smaller proportion in longer horizons.

Variance decomposition splits the k-step ahead forecast error variance of each variable into percentages attributable to innovations in each of the variables in the system. A variable is said to be exogenous if the entire forecast error variance is explained by its own innovation. This decomposition is based on:

$$\zeta_{tj}^{k} = \sum_{j=1}^{n}\sum_{s=0}^{k-1} b_{ij,s}\mu_{j,t+k-s}$$

Where ζ_{tj}^{k} is the k step ahead forecast error for Y_{tj} with variance:

$$\sigma_{kj}^{2} = \sum_{i=1}^{n}\sum_{s=0}^{k-1} b_{ij,s}^{2} \qquad (5.12)$$

because E ($\mu_{j,t+k-s}$) = 1. The percentage of this variance due to innovations in the ith variable is:

$$\frac{\sum_{s=0}^{k-1} b_{ij,s}^{2}}{\sum_{j=1}^{n}\sum_{s=0}^{k-1} b_{ij,s}^{2}} \times 100. \qquad (5.13)$$

Equation (5.13) is used to assess the exogeneity of a variable. If the value is close to 100 the variable is said to be exogenous and the entire forecast variance is explained by its own innovation. Again innovation analysis is conducted on a system with orthogonalised innovations. The conclusions drawn are sensitive to ordering of the variables in the system, as an innovation in the first variable in the ordering is assumed to influence all variables contemporaneously without being influenced by any other variables, and on the other hand, an innovation in the last variable only influences itself contemporaneously. Enders (1995) pointed out that if $|\rho| > 0.2$, the usual procedure is to obtain the impulse response function and variance decomposition using a particular ordering, and compare the results obtained by reversing the ordering.

The second tool is the impulse response function (IRF), that indicates how one variable responds over time to a single innovation in itself or in another variable. Specifically, it traces the effect on current and future values of the endogenous variable of a one standard deviation shock to one of the innovations. Innovations or movements are jointly summarised by the error terms of the VAR model. An impulse response function traces the response of an endogenous variable to a change in one of the innovations. Specifically it traces the effect on current and future values of the endogenous variable of a one standard deviation shock to one of the innovations. The moving average representation of a VAR (1) in terms of $\{\varepsilon_{it}\}$ sequence is:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{y} \\ \bar{z} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{bmatrix} \begin{bmatrix} \varepsilon_{yt-i} \\ \varepsilon_{zt-i} \end{bmatrix} \qquad (5.14)$$

In compact terms:

$$x_t = \mu + \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i} \qquad (5.15)$$

The moving average representation is an especially useful tool to examine the interaction between the y_t and z_t sequences. The coefficient of ϕ_i can be used to generate the effects of ε_{yt} and ε_{zt} shocks on the entire time paths of the y_t and z_t sequences.

The ambiguity in interpreting impulse response functions arises from the fact that the errors are never totally correlated. When the errors are correlated they have a common component, which cannot be identified with any specific variable. A somewhat arbitrary method of dealing with this problem is to attribute all of the effect of any common component to the variable that comes first in the VAR system. (Hamilton, 1994). Nevertheless, impulse response analysis and variance decomposition (together called innovation accounting) can be useful tools to examine the relationships among economic variables.

5.6 VAR Specification Issues

Although the use of VAR models has become popular in recent times, in many areas of economic analysis, several important considerations need to be accommodated when using VAR models. The following issues are related to specifying VAR models.

5.6.1 Frequency of the Data

The frequency of the data can have implications for the VAR model. The implications can be segregated into two types. The first implication relates to the long and short-run interactions between the variables. And the other consideration is statistical. If the nature of the study is to capture the long run relationship between the variables then a temporally disaggregated series like monthly or quarterly data captures the short run relationships. If the purpose of the study is to investigate the long run relationships, yearly data might be the right level of temporal aggregation to be used.

The other implication is a statistical one. Using temporally disaggreated data increases the sample size. However, monthly data may be too frequent to reflect the natural interval in the relationship between derivatives markets and output. On the other hand, data that have been aggregated by averaging overtime are likely to be less noisy and thus may give a better result. Most of the empirical work done using VAR has employed either monthly or quarterly data. In this research, quarterly data will be used in the VAR analysis because it has the dual advantage of increasing sample size and capturing the relatively short run impacts between the derivatives markets and the real sector.

5.6.2 Lag length

The empirical evidence from a VAR model is very sensitive to the choice of the lag length in the equations. Alternative choices will give different innovation series and will likely make a difference in the variance decomposition results. The appropriate lag length could be tested using the Akaike Information Criteria, the Schwarz Bayesian Information Criterion or the log Likelihood Ratios.

In deciding the lag length (p) one must weigh two opposing considerations: the "curse of dimensionality" and the correct specification of the model. Including too many lagged terms will consume degrees of freedom and may introduce the problem of multi-collinearity. Thus the system can become highly over parameterized relative to the number of observations leading to inefficient or insignificant estimates of short run parameters. On the other hand a lag length, which is too short, produces a statistical model where only a subset of the relevant information is used to characterize the data leading to inefficient estimates.

One way of deciding this question is to use a criterion like Akaike (AIC) or Schwarz Bayesian Information (SBIC) and choose that model that gives the lowest values of these criteria. There is no question that some trial and error is inevitable.

This study is conducted using the Tsp statistical software, which uses the AIC '2' rule, by default to choose the optimum lag length. If j is the number of lags which minimizes AIC '2', then L = MIN (j +2, MAXLAG) is used. AIC '2' avoids size distortions for the Weighted Syrnmetric (WS) and Dickey-Fuller (DF) tests. No direct rule is used for Phillips Perron (PP) tests as an optimum lag from the DF test is used for the PP test as well. The results from the AIC and the SBIC may not be consistent when selecting the order of a VAR model. As discussed by Lutkepohi (1991, section 4.3), the SBIC selects the most parsimonious model (a model with the least number of freely estimated parameters), and the AIC selects the least parsimonious model. In other words the AIC criterion tends to select a higher order model compared to SBIC.

5.6.3 Cointegration Analysis

Cointegration means that although many developments can cause permanent changes in the individual elements of the group, there is some long-run equilibrium relation tying the individual components together. The economic interpretation of cointegration is that if two (or more) series are linked to form an equilibrium relationship in the long-run, then even though the series themselves may contain stochastic trends (i.e. they are non stationary) they will, nevertheless, move closely together over time and the differences between them will be stable (i.e. stationary) (Harris, 1995).

Cointegration analysis is important to obtain meaningful information about long run relationships. If cointegration is not established spurious correlation is likely.

If the group of variables is cointegrated then it is not correct to fit a VAR to the differentiated data (Hamilton, 1994). As argued by Engle and Granger (1987), the VAR estimated with cointegrated data will be mis-specified. However, another representation of VAR, the Error Correction Model (ECM), can be used. In an ECM the short run dynamics of the variables in the group are influenced by the deviation from the equilibrium relationship. For a series to be cointegrated, they must have comparable long run properties. That is, suppose a series must be differenced d times before it becomes stationary; it is said to be integrated of order d, denoted I (d). If a linear combination of any two series y_t and x_t is formed and each is integrated to a different order, then the resulting series will be integrated at the highest of the two orders of integration. Thus if y_t is integrated at I(1) and x_t is integrated at I(0), then these two series cannot possibly be cointegrated as the I(0) series has a constant mean while the I(1) series tends to drift over time and therefore the error would not be stable over time.

5.7 Variable Selection and Variable Definition

The empirical methodology builds upon that of Gerlach and Smets (1995) and Gali (1992), which in turn are based on Blanchard and Quah (1989). The model is comprised of four variables, measured quarterly: real gross domestic product (y), price level (p), Federal funds Rate (r) and a proxy for derivative market size (d). The proxy for derivative market size is the transactions volume of U.S. dollar futures contracts on the Chicago Board of Trade exchange. The VAR model has been estimated using quarterly data over the period 1985(1) to 2001(4). Exact details of the variable definition and the data source are contained below. Table 5.1 presents a summary of the four variables used and their data source.

Table 5.1: Sources of Quarterly Data (1985 Q1- 2001Q4)

ECONOMIC VARIABLES	DATA SOURCE
Federal Funds Rate for US (Frate)	International Monetary and Finance Statistics
Real GDP for US (lRgdp) Seasonally adjusted	International Monetary and Finance Statistics
CPI Index for US (Lprice) (1990= 100)	International Monetary and Finance Statistics
Financial Derivatives Trading Volume on CBOT (lvolume)	Chicago Board of Trade (CBOT)

5.7.1 Federal Funds Rate (DFRATE)

The federal funds rate is the interest rate the banks pay when they borrow federal funds deposits from other banks, usually overnight. It is closely watched in the financial markets because the level of the funds rate can be immediately and purposefully affected by Federal Reserve Open Market Operations (FMOC).

The FOMC, the main policy making arm of the Federal Reserve System, communicates an objective for the Federal funds rate in a directive to the trading desk (Desk) at the Federal Reserve Bank of New York. Actions taken to change an intended level of the Federal funds rate are motivated by the desire to accomplish ultimate policy objectives, especially price stability. Permanent changes in the Federal funds rate level are thus the consequence of deliberate policy decisions. Therefore, Federal funds are at the heart of the U.S. money markets in the sense that they are the core of the overnight markets for credit in the United States. Moreover, current and expected interest rates on Federal funds are the basic rates to which all other money market rates are anchored.

The supply of and demand for Federal funds arises in large part as a means of efficiently distributing reserves throughout the banking system. There are two dimensions to the conduct of monetary policy. One is that Central Banks adjust the instruments of monetary policy – the short-term interest rate in response to changes in variables related to their objectives, the reaction function. The other is that actions taken by the Central bank to adjust the instruments of monetary policy affect the real economy. The interest in this study is on the latter issue as, we are trying to capture the changes in output due to policy-induced actions. Therefore, the focus is on short-term interest rates, or the Fed Funds Rate for identifying monetary policy innovations. The Central Banks change these rates deliberately to change the stance of monetary policy. The consequent changes in money or bank reserves typically reflect demand shocks rather than policy induced shocks, hence the justification for the use of the Fed Funds Rate.

The study takes into account the nominal interest rate as a rise in the nominal interest rate reflects higher inflationary expectations, such that, real interest rates may be assumed to remain constant. This means that the perceived marginal cost of borrowing remains the same, and what changes is the cash flow and balance sheet positions of borrowers; and his happens mainly as the average rate of interest changes. These cash flow effects could have a large impact on aggregate demand. The data used have been obtained from the IMF in International Finance Statistics.

5.7.2 Real GDP (DLRGDP)

Real GDP has been used to measure the level of economic activity. The data used are from the IMF in International Finance Statistics. The figures are seasonally adjusted. Seasonal adjustment removes the average impact of variations that normally occur at about the same time and in the same magnitude each year. After seasonal adjustment, cyclical and other short-term changes in the economy stand out more clearly.

5.7.3 Price Level (DLPRICE)

The data are taken from the IMF in International Financial Statistics. Price level is an important variable as the aggregate demand shocks can be represented by changes in inflation. Moreover, this variable is contained in the information set of the Fed before the monetary authority takes an exogenous action in relation to changes in their monetary stance.

5.7.4 Derivative Market Size (LVOLUME)

The proxy for the derivative market size is the transactions volume of financial futures contracts on the Chicago Board of Trade as published by CBOT. The Chicago Board of Trade is the largest futures exchange in the world. The significance of derivatives can best be understood by analyzing the volume of business transacted. The more volatile interest rate environment of the late 1970s and the early 1980s acted as a major contributor to the expansion of this market.

5.8 Ordering of Variables

Ordering of the variables always matters when an unrestricted VAR is considered. The orthogonalisation procedure requires imposing a particular casual ordering of the variables. This choice is arbitrary and, when there is a contemporaneous correlation among innovations, it can make a significant impact on the variance decomposition. Therefore, the empirical results may depend to a large extent on the ordering of the variables, and no econometric technique is available to determine the right ordering. This problem has been criticized as a deficiency of VAR methods. Noting the potential sensitivity of innovation accounting results to ordering, it is generally recognized that, for results to be considered conclusive, they must be robust to ordering.

To identify the system, the Choleski decomposition is used (Enders,1995). The constraint imposed by the Choleski decomposition is that variables ordered first in the system have contemporaneous effects on all the variables that follow them in the order. Variables ordered last do not have contemporaneous effects on the variables that precede them in the order.

Consider a simple two-variable first-order VAR as follows:

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt} \qquad (5.16)$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt} \qquad (5.17)$$

The time path of y_t is affected by current and past realisations of the z_t sequence and the time path of z_t is affected by current and past realisations of y_t. For the purpose of identification the system requires restrictions to be imposed such that coefficient b_{21} equals zero. Rewriting equations (5.16) and (5.17) with the constraint imposed yields:

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt} \qquad (5.18)$$

$$z_t = b_{20} + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt} \qquad (5.19)$$

Given the restriction it is clear that z_t, has a contemporaneous effect on y_t, but y_t affects z_t sequence with a one period lag. Imposing the restriction $b_{21} = 0$ means that B^{-1} is given by:

$$B^{-1} = \begin{bmatrix} 1 & b_{12} \\ 0 & 1 \end{bmatrix} .$$

Now multiplying (5.18) and (5.19) equation system by B^{-1} yields the equation system as follows:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix} \quad . \tag{5.20}$$

In system (5.12) the restriction $b_{21} = 0$ manifests itself in a way such that both ε_{yt} and ε_{zt} shocks affect the contemporaneous values of yt but only ε_{zt} shocks affect the contemporaneous value of z_t. Decomposing the residuals in this triangular fashion is called the Choleski decomposition.

The ordering of the VAR model will follow the traditional Keynesian IS-LM view of the monetary transmission mechanism. In the study the ordering of the variables will take the following form:

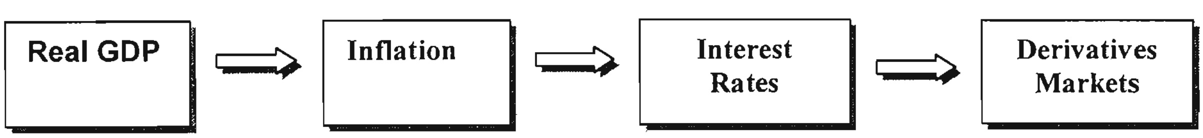


Figure 5.1: Ordering of Variables

Thus, a supply shock operating on output will immediately affect output, prices, interest rates and derivative markets. On the other hand a demand shock operating on prices will impact prices, interest rates and derivative markets immediately, but will impact on output after some time lag. The underlying principle behind this ordering is that an unexpected shock in the first variable (RGDP) will be contemporaneously transferred to all other variables and an underlying shock to the last variable (derivatives volume) will only affect it contemporaneously.

5.9 Transforming Non-Stationary Data

The validity of the VAR approach relies on the presumption that the economic variables under consideration are covariance stationary. Granger causality tests are not applicable if the data are nonstationary. Data are said to be stationary if neither the mean nor the autocovariances including the variances depends on time. To explain this, let {Yt} be the stochastic time series with the following properties:

Mean E $(Y_t) = \mu$,

Variance var $(Y_t) = \sigma^2$,

Covariance cov $(Y_t, Y_{t+k}) = \theta_{k.}$

Where: k = 1,2,3....

In short, if a series is stationary, its mean and variance remain the same no matter at what time we measure them, and covariance (at various lags k) depends only on the lag k on time t.

Using a VAR terminology, the effect of a shock to the error term on the endogenous variables must eventually die out for the data to be stationary. Thus, it may be important to induce stationarity by appropriately transforming any nonstationary series, a process referred to as trend removal. Including a time trend variable in the model is one of the ways of transforming nonstationary data. Alternative de-trending transformations will yield variables with different time series properties and thus generate different variance decomposition results. If a time series has to be differenced d times and the differenced series is stationary, the original series is integrated at order d, that is, the time series is an I (d) process. If d = 0, the resulting I (0) process represents a stationary time series. If d = 1, the time series is integrated at order 1, and is said to have a unit root. In other words, when a process has a unit root, it is said to be integrated at order 1 or greater, and it is a non-stationary time series.

A visual plot of data is usually the first step in analyzing time series data. For this study, the original data was transformed into natural logarithms (LM), because it is not know whether the true economic relationship between the variables is linear or non linear.

There are appropriate tests, such as the DF test, that can be used to determine whether the data are non-stationary. A large literature on unit root tests has appeared, describing alternative tests. The study will use three different types of unit root tests: The Dickey Fuller (DF), Phillips-Perron (PP) and Weighted Symmetric (WS). These are described more fully in the next section. Each test allows for various exogenous variables like time trends and seasonal dummies/trends, and each allows for a series of "augmenting" lags to control for additional serial correlation.

Much of the recent interest in assessing whether a time series is non-stationary is due to the Nelson and Plosser (1982) seminal study of U.S macroeconomic time series, that concluded that most of the series studied had a unit root.

However, earlier work due to Box Jenkins (1976) has also been influential; their approach to modeling univariate time series emphasized the importance of taking d differences of a variable integrated of order d, and so using stationary variables in a regression analysis is designed, primarily to provide forecasts. Although a number of authors after Nelson and Plosser queried their conclusions, there was no doubt that a dominant view was emerging that it is important to assess whether an economic time series is non-stationary.

5.9.1 Unit Root Tests

If a variable contains a unit root then it is non-stationary and unless it combines with other non- stationary series to form a stationary cointegration relationship, then regressions involving such time series can falsely imply the existence of a meaningful economic relationship. Although Dickey and Fuller (1979) were among the first to report a test for the presence of unit roots in time series data, many other tests have been suggested to address a variety of limitations in the DF unit root test. Perhaps the most well known are the Augmented Dickey Fuller ADF (1981), the Phillips Perron (PP) test (1988) and the Weighted Symmetric (WS) test.

Before discussing the details of the ADF, PP and WS tests it is important to understand the DF test. Dickey and Fuller (1979) considered three different regression equations that can be used to test for the presence of unit roots:

$$\Delta y_{t} = \gamma_t y_{t-1} + \varepsilon_t, \qquad (5.21)$$

$$\Delta y_{t} = a_0 + \gamma_t y_{t-1} + \varepsilon_{t,} \qquad (5.22)$$

$$\Delta y_{t} = a_0 + \gamma_t y_{t-1} + a_2 t + \varepsilon_t \; . \qquad (5.23)$$

The difference between the three regressions concerns the presence of the deterministic elements a_0 and a_2t. The first is a pure random walk model, the second adds an intercept or drift term, and the third includes both a drift and linear time trend.

The ADF test is based on the OLS estimation results from two regression equations. For a time series Yt, the ADF test is applied to run in the following forms of regression equations:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta_{t-j} + \varepsilon_t \, , \qquad (5.24)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad (5.25)$$

Where Y_t represents the time series data after first differentiation. Equation (5.24) includes a constant term and equation (5.25) includes a constant as well as a time trend. The number of lagged terms p is chosen to ensure the error terms in the estimated equation are not correlated.

The null hypothesis $\alpha_1 = 0$ (d=1) for a unit root in the above equations will be tested respectively. If the null hypothesis can be rejected by the τ critical statistics, it suggests the time series is stationary. If the null hypothesis cannot be rejected it suggests that the data series are not stationary and integrated at order one, or higher, which requires a differencing transformation to make the data stationary.

To further confirm that the non-stationary data is integrated at order one, that is, I(1), the test using first differenced data should also be carried out to indicate that the non-stationary data are stationary after the first differencing transformation. If the null hypothesis for a unit root of the differenced data can be rejected at the 5% significance level, it further confirms that the data are integrated at I (1); if the test statistics are not significant at the 5% level, it may suggest that the data are integrated at order two, I (2), or a higher order.

The Weighted Symmetric (WS) test is a weighted double length regression. First, the variable being tested is regressed on the constant/trend variables and the residual from this is used as Y in the double length regression. The WS test is recommended over the DF test, because it has (sometimes) higher power. That is, the WS test is more likely to reject the unit root (null hypothesis) when it is in fact false.

The PP test is undertaken using the same Dickey Fuller regression variables, using no augmenting lags. It estimates the slope coefficient from a regression of each of the variables of interest on a constant and its own lagged values. The distribution theory supporting the Dickey-Fuller test assumes that the errors are statistically independent and have a constant variance. In using this method care must be taken to ensure terms are uncorrelated and have constant variance. Phillips and Perron (1988) developed a generalisation of the Dickey-Fuller procedure that allows for fairly mild assumptions concerning the distribution of errors. Consider the following regression equations:

$$y_t = a_0^* + a_1^* y_{t-1} + \mu_t \quad , \qquad (5.26)$$

$$y_t = \tilde{a}_0 + \tilde{a}_1 y_{t-1} + \tilde{a}_2 (t - T/2) + \mu_t . \qquad (5.27)$$

Where T = number of observations and disturbance term μ_t is such that $E\mu_t = 0$. Instead of the Dickey- Fuller assumptions of independence and homogeneity, the Phillips-Perron test allows the disturbances to be weakly dependent and heterogeneously distributed. Phillips-Perron characterise the disturbances and derive test statistics that can be used to test hypotheses about the coefficients a^*_i and a_i under the null hypotheses that are generated by:

$$y_t = y_{t-1} + \mu_t \quad . \qquad (5.28)$$

Thus Phillips-Perron test statistics are modifications of the Dickey-Fuller *t*-statistics that take into account the less restrictive nature of the error process. The critical values for Phillips-Perron tests are the same as those for the Dickey-Fuller test.

This study uses three different types of unit root tests: the Dickey Fuller (tau), the Phillip-Peron (Z, “nonparametric”), and Weighted Symmetric. Each allows for various exogenous variables like time trends and seasonal dummies/trends, and each allows for a series of

" augmenting" lags to control for additional serial correlation.

Table 5.2 shows the AIC and the SBIC lag values for different lags with a confidence level of 95%. The lags are examined up to eight quarters. The best model according to each criterion is a lag of one quarter. Given the fact that the two criteria agree on a lag length of one quarter, the final estimation of this model will be carried out using one lag for each variable. The smallest AIC and SBIC indicate the best lag for each variable.

Table 5.2: Statistics Testing for the Order of the VAR Model

Lags	AIC	SBIC
1	-6.82898*	-12.1730*
2	-6.78084	-11.9883
3	-6.65228	-11.7208
4	-654046	-11.4678
5	-6.39538	-11.3043
6	-6.39538	-11.0330
7	-6.28247	-10.7714
8	-6.13353	-10.4712

AIC is the Akaike Information Criteria and SBIC is the Schwarz Bayesian Information Criterion.
* are the smallest values of AIC and SBIC indicating the best lag.

The overall results of unit root testing using ADF, WS and PP are reported in Tables 5.3. to 5.6. The first difference of the variables using intercept and time trend is used (RGDP, Funds Rate and Price level) in order to ensure that the data are unit stationary. For all the series the data was found to be stationary.

Table 5.3: Unit Root Results for LPRICE
(first difference)

	Test Stat	P-Value	lags
WS	-2.914088	0.10811	5
ADF	-3.55766	0.033614	4
PP	-37.68831	0.0016061	4

Table 5.4: Unit Root Results for DLRGDP
(first difference, no trend)

	Test Stat	P-Value	lags
WS	-2.83749	0.018832	3
ADF	-2.67644	0.078205	3
PP	-52.23806	3.42996D-06	3

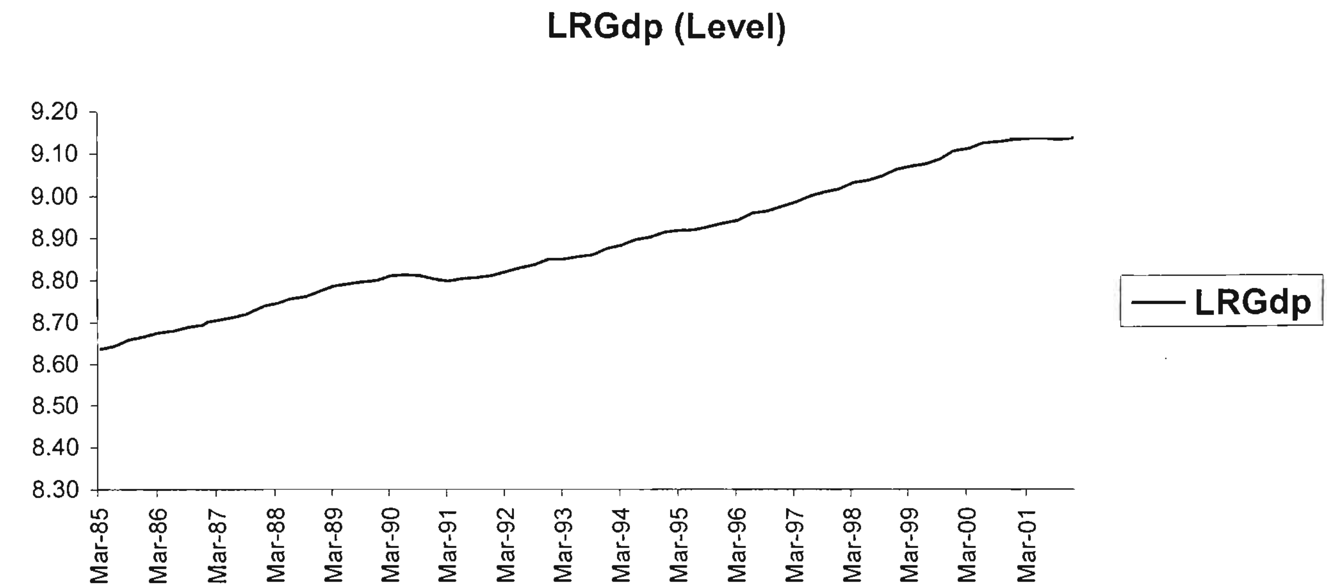
Table 5.5: Unit Root Results for LVOLUME
(level)

	Test Stat	P-Value	lags
WS	-3.04229	0.075651	2
ADF	-3.50132	0.039249	2
PP	-47.48603	0.00017352	2

Table 5.6: Unit Root Results for FRATE
(first difference, no trend)

	Test Stat	P-Value	lags
WS	-2.63636	0.033830	2
ADF	-2.36091	0.15307	2
PP	-21.04679	0.0089849	2

Figures 5.2 to 5.5 provide a graphical illustration of the levels and differences of the four variables (RDGP, Funds Rate, price level, and Derivatives Volume).



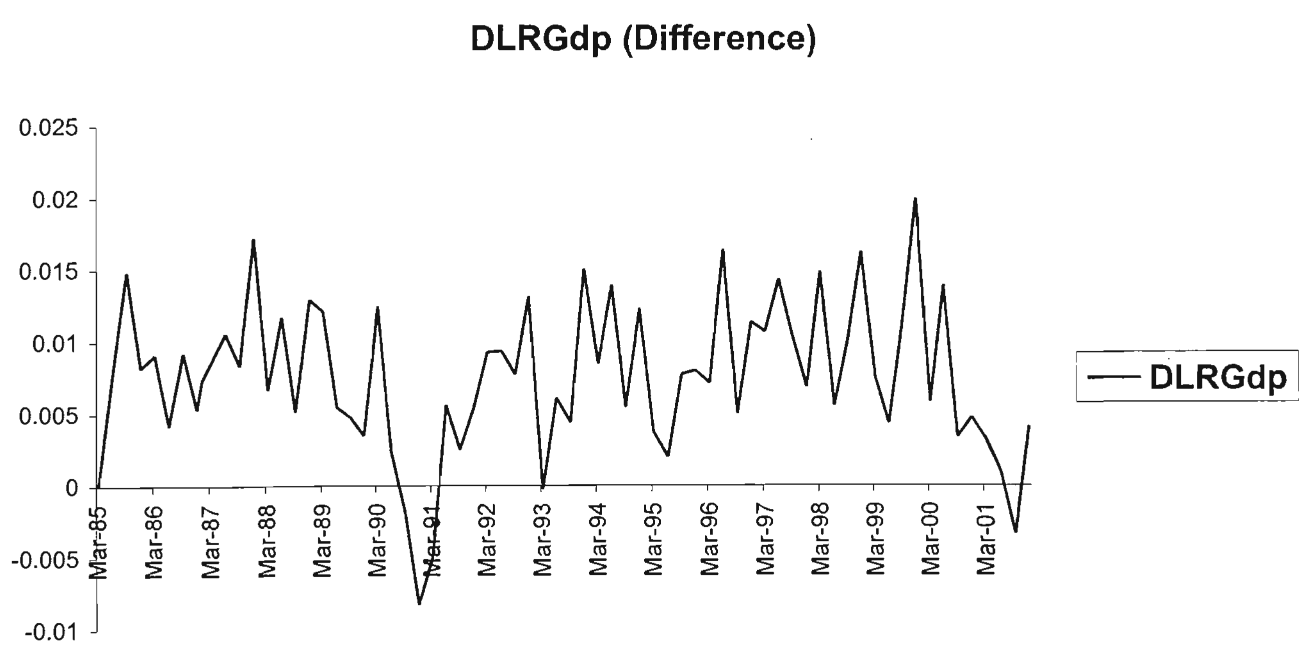
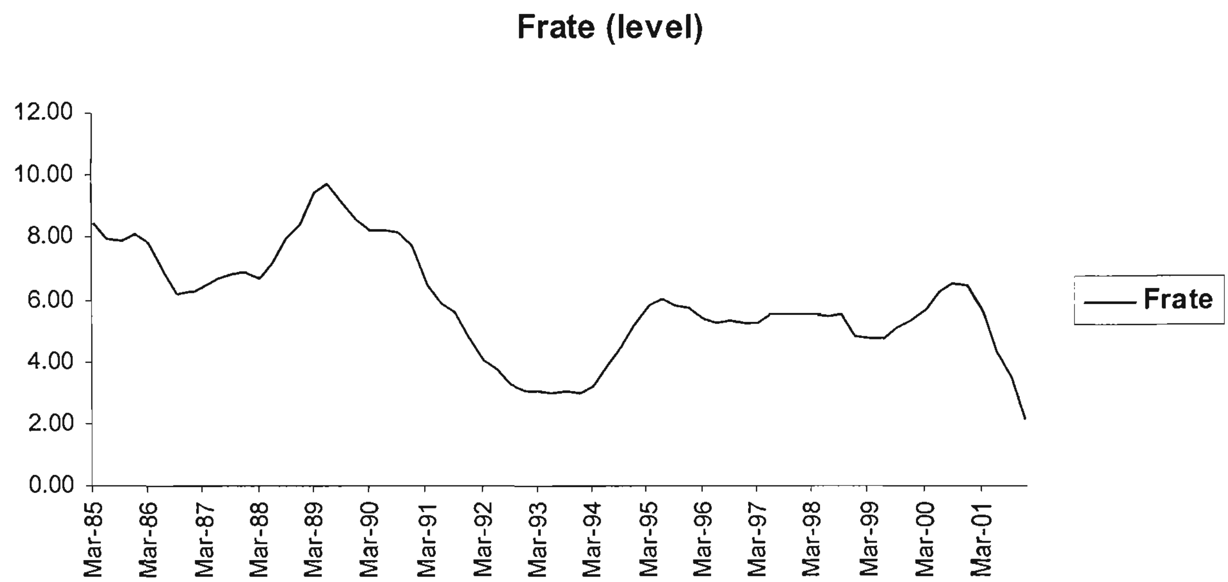


Figure 5.2: Levels and Difference for Logarithm Data of Real GDP



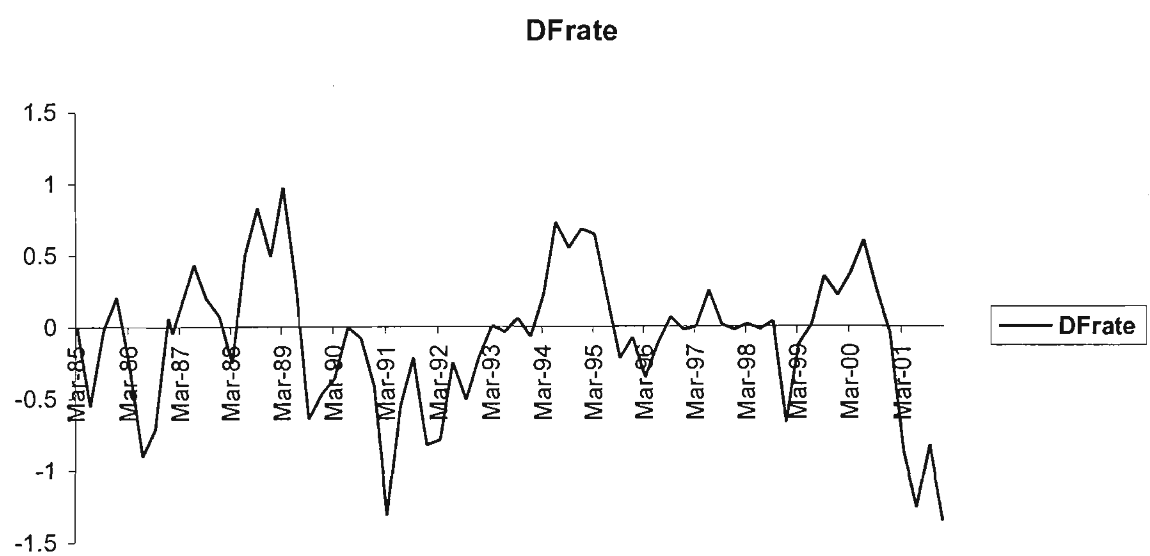
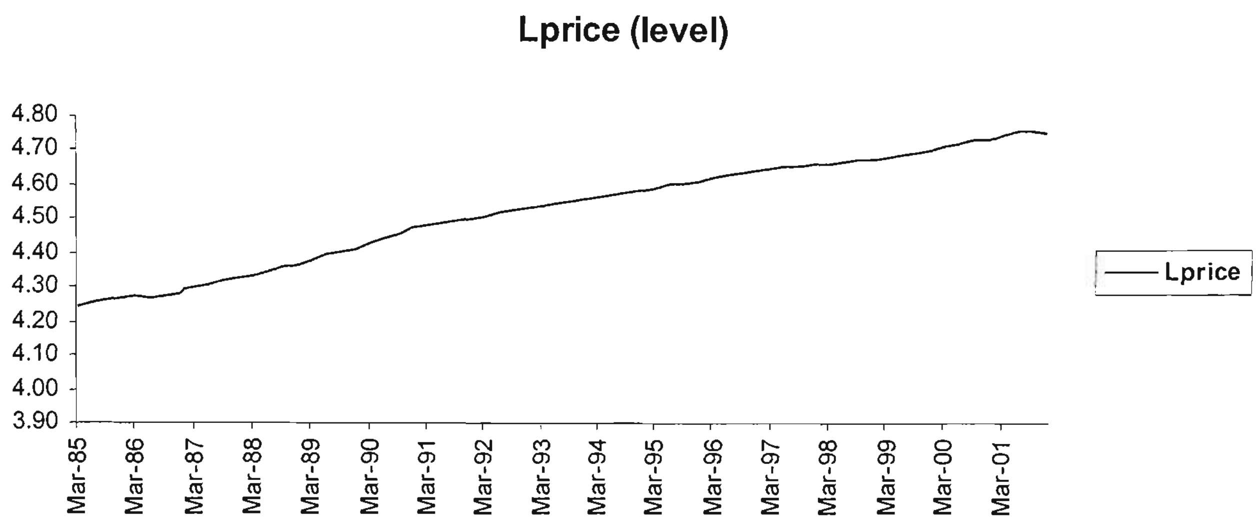


Figure 5.3: Levels and Difference for Federal Funds Rate



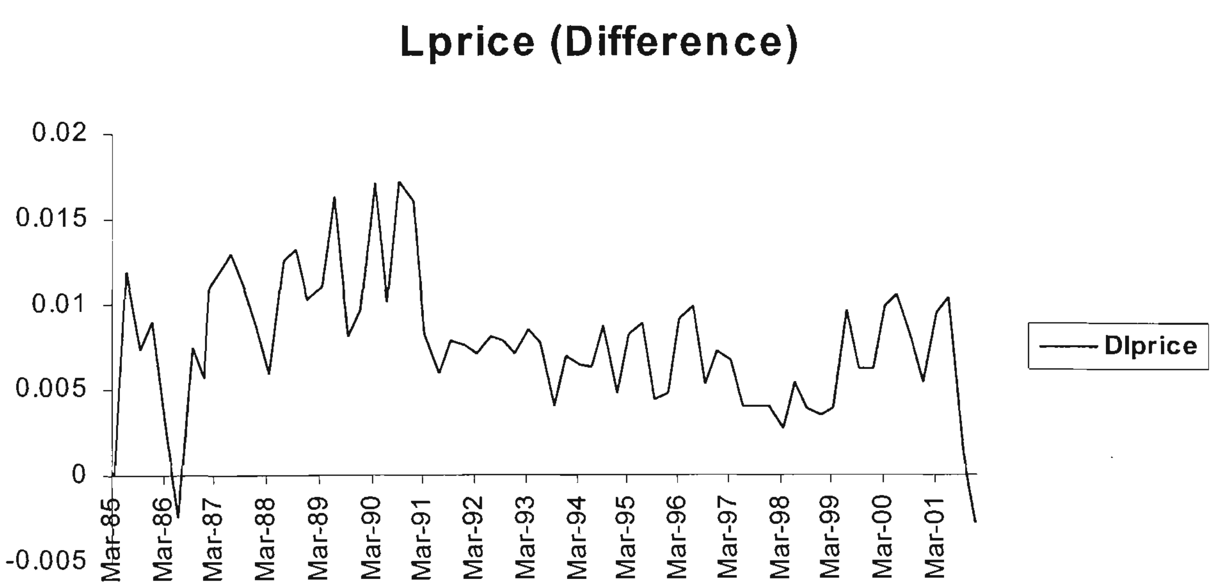


Figure 5.4: Levels and Difference for Logarithm Data of Price level

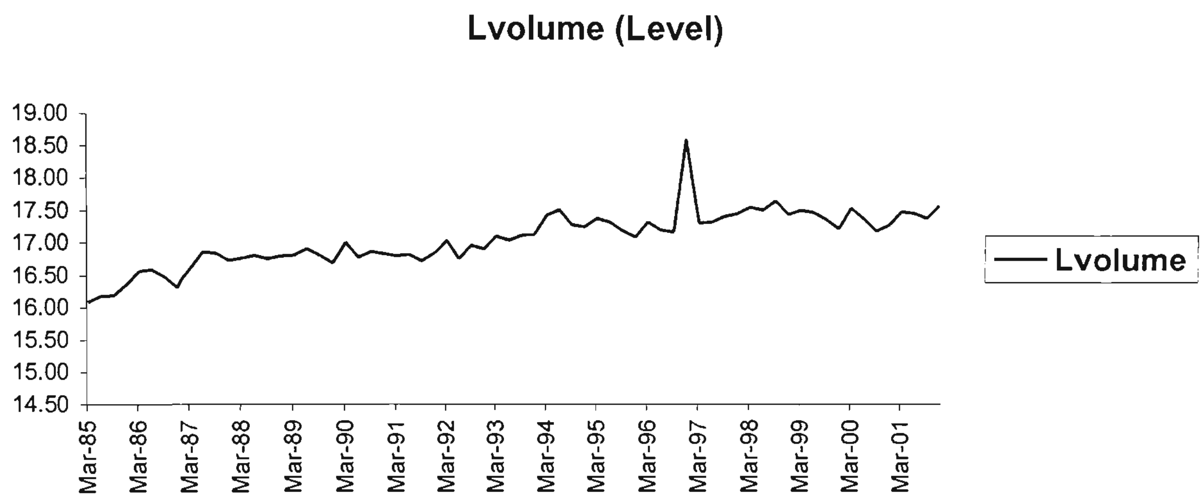


Figure 5.5: Levels of Logarithm Data for Derivatives Markets Turnover Volume

5.10 Summary and Conclusions

In order to carry out appropriate econometric testing of hypotheses relating the growth in derivatives markets to the transmission mechanism of monetary policy, this chapter examines relevant econometric approaches suitable to this question. The chapter also deals with issues concerning the time series propositions of data relevant to this study. Following a consideration of the range of approaches available, it is clear that the use of the VAR model is the most suitable approach for this study.

To sum up, VARs are relatively simple models that have become popular among economists. Using the VAR model is somewhat controversial. The main criticism of the VAR method is that the statistics from VARs are sensitive to alternate specifications. Criticisms of the VAR methodology appear at all stages of the analysis. Some authors (see Runkle, 1987; Ohanian, 1988; Spencer, 1989) raised doubts about the usefulness of the methodology to characterize the dynamics of the data. Litterman (1984) and Sims (1982) argue that criticisms against VAR models are like "precautionary footnotes" that should not deter users of VARs from continuing to use them for data analysis and policy purposes (Gujarati, 1990). VAR is currently used extensively in macro economic research. Keeping up with the trend this study also applies VAR and SVAR to capture the changes in monetary policy transmission.

Having introduced the economic variables relevant to the empirical research and having identified the VAR order and the stationarity of the time series properties, in Chapter 6, the vector autoregressive (VAR) models are developed to further examine the relationship between the real and the monetary variables in the economy based on empirical estimates. This modeling procedure looks feasible and attractive for this study. The innovative analysis of the VAR model allows for examination of the impact in monetary policy transmission due to the presence of derivatives markets. The Granger Causality test allows the capture of the casual relationship between variables. Thus VAR offers an additional tool in exploring the relationship between variables.

CHAPTER 6

EMPIRICAL TESTING TO DETERMINE THE RELATIONSHIP BETWEEN DERIVATIVES MARKETS AND REAL ECONOMIC ACTIVITY

6.1 Introduction

In Chapter 5 the four important macroeconomic variables relevant for measuring the impact of derivatives markets on real economic activity and the monetary policy transmission mechanism were defined. Additionally, the time series properties of the selected data were identified. In accordance with the structure and pattern of time series data, this chapter aims at developing a Vector Autoregressive (VAR) process to analyze the changes in monetary policy transmission in the presence of derivatives markets and the relationship between derivatives markets and real economic activity for the US economy.

In order to test the validity of the results estimated through the VAR system the model is again estimated using Structural Vector Auto regression (SVAR) methodology. Since the work of Sims (1980), the vector auto regression (VAR) methodology has been a popular tool of economics. Originally, the idea was to "estimate large scale macroeconomic models as unrestricted reduced-forms, treating all variables as endogenous." (Sims 1980, p. 15) Sims goal was to eliminate the reliance on prior beliefs. He aimed to abolish the arbitrariness at the model formation stage and instead focus on the reduced-form. Even though a reduced form VAR does eliminate the reliance on a priori assumptions, there are few economic implications that can be drawn from it. The question is whether it is possible to recover information about the structural system from the estimated reduced form. The answer to this question would be "no," unless one has information about the underlying structural form. A VAR can be viewed as the reduced form of a general, dynamic structure model. If one can identify the underlying contemporaneous relationships between the variables (that is, the structural form), it is then possible to trace out the effect of an exogenous change of a variable over the system. This idea of recovering the structural form errors from the reduced form estimates is the motivation behind "structural VARs."

The traditional structural interpretation of reduced form VARs typically relies on identification assumptions that are based on a researcher's a priori beliefs. This traditional approach is unsatisfactory because there are equally defensive alternatives based on different prior beliefs about the underlying casual structure that could emanate from the same reduced form model. Furthermore, the assumptions that impose a lower triangular structural matrix seem to be put forth, due to practical convenience, rather than true beliefs about the underlying structure. In fact, it is naive to believe that the real world has a lower triangular structural form, and the justifications given for this type of ordering are weak in general. Consequently, it is not surprising that different empirical studies have included a common subset of variables. Independent of whether the structural form is assured to be lower triangular or some other form, the bottom line remains the same. As soon as we move from a reduced form VAR to a structural VAR, we essentially go back to the process of identifying the structural form based on prior beliefs, without testing the validity of the assumptions. The SVAR methodology uses economic restrictions to identify underlying shocks. These economic constraints fall into two categories: contemporaneous constraints and long-run constraints. A contemporaneous constraint means that an underlying shock on one variable has no immediate impact on another variable, and a long-term constraint means that an underlying shock to a variable has no long-run impact on another variable. The problem with the SVAR method is that it is substantially more complex as SVAR models have large numbers of parameters and the structural equations underlying them are hard to interpret.

The modeling process in the VAR analysis is done in three stages: identification, estimation and diagnostic checks. Having identified the VAR model in Chapter 5 this chapter aims at performing the diagnostic checks to develop a VAR process to analyze the impact of derivatives markets on real economic activity. This chapter therefore applies the VAR process as developed by Sims (1980) to analyze relationships between the macroeconomic variables. A VAR model is a fairly general multivariate time series model that can be viewed as a set of reduced form equations of a simultaneous equation model, Greene (2000). Unlike simultaneous equation models, a VAR model is atheoretical as it uses less prior information. Again in simultaneous-equation models exclusion or inclusion of certain variables plays a crucial role in the identification of the model. This decision is often subjective and has been severely criticized by Sims (1980). According to Sims, if there is a true simultaneity among a set of variables, they should all be treated as endogenous variables. It is in this spirit that Sims developed the VAR methodology. In a VAR process the series is allowed to reveal the dynamic structure and any causal relations among the variables. The four macroeconomic variables used in the VAR model are Real GDP, Prices or the CPI, Federal funds rate and the turnover in the derivatives markets as a proxy for derivatives markets. As emphasized in the macroeconomic literature the two main variables, which measure the activity in the real sector, are real GDP and inflation, or the price index. Since the monetary transmission mechanism is the process through which monetary policy decisions are transmitted into the real economy, changes in real GDP and prices, it is important to incorporate these two variables as a measure of real sector activity. Any change in the Federal funds rate represents shocks in monetary policy and the turnover in the derivatives markets represents the derivatives sector. The Federal funds rate indicates the monetary stance for two reasons. Firstly monetary authorities generally pursue policy by changing the fed rate to guide the financial system. Secondly, it is a better measure than the monetary aggregates since monetary aggregates are subject to a wide variety of other disturbance, such as shifts in money demand, that can dominate the information contained about the monetary stance.

6.2 The VAR Model

The VAR model used in this study is inspired by the empirical methodology of Gerlach and Smets (1995). The ordering of the VAR representation follows the standard macroeconomic model using the traditional Keynesian IS-LM view of monetary policy transmission. Thus a supply shock operating on output will immediately affect output, prices, interest rates and derivative markets. While a demand shock operating on prices will impact prices, interest rates and derivatives markets immediately but will impact on output after a time lag. As mentioned in Chapter 5 the underlying principle behind this ordering is that an unexpected shock in the first variable (RGDP) will be contemporaneously transferred to all other variables, and an underlying shock to the last variable will only affect it contemporaneously.

The VAR model estimated using all the variables takes the following form:

$$\begin{bmatrix} DLRGDP_t \\ DLPRICE_t \\ DFRATE \\ LVOLUME_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} DLRGDP_{t-1} \\ DLPRICE_{t-1} \\ DFRATE_{t-1} \\ LVOLUME_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{DLRGDP,t} \\ \varepsilon_{DLPRICE,t} \\ \varepsilon_{FRATE,t} \\ \varepsilon_{LVOLUME,t} \end{bmatrix}. \qquad (6.1)$$

The above equation system a VAR (1) with four variables A_0 is a (4x1) parameter vector, ε_t is a (4x1) vector of white noise residuals, X is the deterministic component in each VAR system including a constant.

The error terms in the VAR model capture the unexpected or surprise movements in each variable. The only restrictions imposed are the variables included in the model, the number of lag terms and the ordering of the variables. The unknown parameters can be estimated by applying ordinary least square regressions to each equation separately. To identify the system, the Choleski decomposition is used (Enders 1995, p.303). This scheme gives exact identification to the VAR model. The constraint imposed according to the Choleski decomposition is that variables ordered first in the system have contemporaneous effects on the variables that follow in the order. Ordering of the rest of the variables is based on the following chain of causality (refer to Figure 6.1).

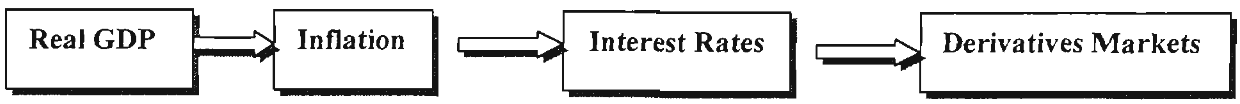


Figure 6.1: Ordering of Variables

The main hypothesis to be tested is whether derivatives markets do have an impact on the real sector for the US economy. Derivatives markets have been measured by the trading volume of financial futures on the Chicago Board of Trade and the aim of the empirical research is to find out whether derivatives trading do have any significant impact on the macro economy as measured by macroeconomic variables such as Real GDP, and CPI.

6.3 Diagnostic Checking

Various statistics on goodness of fit are presented for each equation in Table 6.5 the sum of squared residuals, the standard error of the regression, the R squared and the Durbin Watson statistic for autocorrelation of the residuals. The F tests (block exogeneity) from the estimated VAR equation, and are not significant at the 5% level of significance indicating the variables should have been included in the VAR model. The estimated covariance matrix of the VAR system is reported in Table 6.2 and confirms that the estimated covariance of errors is diagonal, and that the errors are independent because the covariance ratios are very small and close to zero. Therefore, the results indicate that there is no significant evidence of model misspecification in the VAR system. Table 6.1 further specifies the coefficients of the different regressors, and the diagnostics again indicate a robust system.

Table 6.1: Estimation of the VAR Model

Regressor	Standard Coefficient	Standard Error	t-statistic
DLRGDP(-1)	.139997	.132707	1.05493
DLPRICE(-1)	-.407342	.190309	-2.14043
DFRATE(-1)	.221470E-02	.151123E-02	1.46549
LVOLUME(-1)	-.302269E-03	.163077E-02	-.185354
C	.015016	.028360	.529490
DLRGDP(-1)	.228910E-02	.085998	.026618
DLPRICE(-1)	.418538	.123326	3.39376
DFRATE(-1)	.160594E-02	.979323E-03	1.63984
LVOLUME(-1)	-.203367E-02	.105678E-02	-1.92440
C	.039137	.018378	2.12958
DLRGDP(-1)	31.1580	9.21902	3.37975
DLPRICE(-1)	7.22354	13.2206	.546385
DFRATE(-1)	.554734	.104984	5.28398
LVOLUME(-1)	-.032848	.113288	-.289949
C	.220478	1.97012	.111911
DLRGDP(-1)	-7.02206	6.56347	-1.06987
DLPRICE(-1)	-22.3467	9.41239	-2.37418
DFRATE(-1)	.110846	.074743	1.48302
LVOLUME(-1)	.686106	.080655	8.50664
C	5.61399	1.40262	4.00250
Mean of dependent variable			.756617E-02
Std. dev. of dependent var.			.537935E-02
Sum of squared residuals			.160777E-02
Variance of residuals			.263569E-04
Std. error of regression			.513390E-02
R-squared			.145224
Adjusted R-squared			.089173
Durbin-Watson statistic			2.08228
F-stat. (block exogeneity)			1.85617

(Real GDP, Price level, Federal Funds Rate and Derivatives Markets volume are the dependent variables respectively)

Table 6.2: Estimated Residual Covariance Matrix

	DLRGDP	DLPRICE	DFRATE	LVOLUME
DLRGDP	0.000026357			
DLPRICE	-1.25799D-06	0.000011068		
DFRATE	.00059136	0.00026973	0.12720	
LVOLUME	-0.000064181	0.000020443	-0.0028736	0.064473

6.4 Forecast Error Variance Decomposition

As explained in Chapter 5 forecast error variance decomposition (FEVD) is one of the tools of innovation accounting analysis used to trace out the impact of shocks (innovations) in the VAR system. FEVD is used to ascertain the importance of interactions among economic variables in the system. The variance decomposition divides the forecast error variance of a given variable according to the causal strength of the innovation effects of the variable on itself and on other variables in the VAR model (Hakkio and Morris, 1984). As Sims (1980) pointed out, the magnitude of the forecast error variance provides an estimate of the Granger causal strength of the innovating variables on other variables in the VAR model. Variance decompositions for 12 period ahead forecasts were calculated to capture the full dynamics of the impact of Derivatives markets (Lvolume) on real gross domestic product (RGDP) and the results are reported in Tables 6.1 to 6.4. For the purpose of empirical analysis a causality effect exists when a variable explains 20% and above of the forecast error variance of the other variable. While interpreting the variance decomposition results, one should pay attention to the values of the components of the forecast errors over the entire forecast horizon.

The results reported in Table 6.3 suggest that the most important explanation of innovations in Real GDP is due to its own past values (accounting for around 91%) over different forecast horizons. The next important explanation in real activity can be explained by price level (around 7%) and Funds rate (around 2%). The innovations in derivatives trade accounts for a very small proportion (around only half of one percent). This indicates that derivatives markets trading do not play an important role in the real growth of the US economy.

Table 6.4 explains the amount of innovation in price level due to other variables in the VAR system over the 12 period forecast horizon. As expected the most important explanations in variations in price level are explained by its own past values (84%). The next important variable explaining the innovations in price level is derivatives trading volume (8%). Finally, real GDP and funds rate account for 4% of the variation in the level of prices in the US economy.

Table 6.5 provides explanations of innovation in funds rates due to other variables like real GDP, price level and derivatives trading volume. Once again the most important explanation of innovations in funds rate is the past values of the variable itself (funds rate) over the different time horizons (around 57%). The second most important variable is real GDP, accounting for around 38% of the any innovations in funds rate, and this finding relates to the fact that changes in the Federal Reserve policy stance are governed or explained by the level of economic activity in the economy. Around 5% of the innovations are explained by the price level and 23% of the innovations are explained by derivatives trading volume.

The results reported in Table 6.6 further provide evidence of the causal relationship between derivatives turnover and other real variables in the economy. As expected the most important explanation of innovations in derivative volume is its own past values (accounting for about 87%) over different forecast horizons. Again the relationship between derivatives volume and real GDP is very small (less than 1%) further supporting the proposition that derivatives markets do not have an important impact on real economic activity. Economic theory suggests an innovation in price level explains over 10% of the forecast error variance of derivatives turnover volume while the funds rate accounts for only 1.5% of the of the forecast error variance of derivatives volume. Thus the relationship between funds rate and derivatives trading is not very high, suggesting that interest rate exposure is not the only factor encouraging derivatives trading; it is possible that traders have been using derivatives more for speculative rather than hedging purposes. On examining the results from the variance decomposition tables it is important to pay attention to values of the components of the forecast errors over the entire forecast horizon. Results in Tables 6.3 to 6.6 show that the proportions of each component (of forecast error variance) remain more or less constant.

Summarizing the decomposition analysis it can be said that derivatives markets do not have a significant impact on the level of real economic activity for the US economy. Interest rate exposure is not the most important factor promoting derivatives trading, and therefore there is little empirical evidence derivatives have any significant impact on the effectiveness of monetary policy itself.

Table 6.3: Decomposition of Forecast Error Variance for DLRGDP

Horizon	Std.Err.	DLRGdp	DLPrice	DFrate	LVolume
1	0.005133	100.0000	0.00000	0.00000	0.00000
2	0.005420	93.6690	4.53474	1.77622	0.01998
3	0.005494	92.3434	5.60585	1.97675	0.07392
4	0.005518	91.7678	6.04125	2.01174	0.17921
5	0.005527	91.4767	6.22166	2.01355	0.28808
6	0.005532	91.3107	6.30201	2.01116	0.37613
7	0.005535	91.2111	6.34021	2.00911	0.43952
8	0.005537	91.1503	6.35960	2.00776	0.48233
9	0.005538	91.1128	6.37003	2.00692	0.51022
10	0.005539	91.0897	6.37592	2.00640	0.52799
11	0.005540	91.0753	6.37936	2.00607	0.53918
12	0.005540	91.0665	6.38142	2.00587	0.54617

Table 6.4: Decomposition of Forecast Error Variance for DLRRICE

Horizon	Std.Err.	DLRGdp	DLPrice	DFrate	LVolume
1	0.00332	0.54247	99.45753	0.00000	0.00000
2	0.00373	0.53291	95.51507	2.04719	1.90483
3	0.00393	1.86859	91.06219	3.15583	3.91339
4	0.00404	3.04987	87.80024	3.69308	5.45682
5	0.00410	3.76529	85.83726	3.90708	6.49037
6	0.00413	4.12858	84.74914	3.97846	7.14382
7	0.00415	4.29549	84.16374	3.99549	7.54528
8	0.00416	4.36705	83.84945	3.99513	7.78838
9	0.00417	4.39605	83.67840	3.99089	7.93466
10	0.00417	4.40716	83.58335	3.98689	8.02260
11	0.00417	4.41110	83.52932	3.98400	8.07558
12	0.00417	4.41231	83.49797	3.98210	8.10761

Table 6.5: Decomposition of Forecast Error Variance for DFRATE

Horizon	Std.Err.	DLRGDP	DLPRICE	DFRATE	LVOLUME
1	0.35665	10.43107	6.34017	83.22876	0.00000
2	0.46351	29.21931	6.27594	64.47248	0.03227
3	0.50635	34.31143	5.38333	60.17274	0.13249
4	0.52463	36.38207	5.01472	58.41238	0.19084
5	0.53210	37.21029	4.89104	57.68385	0.21482
6	0.53501	37.53140	4.85813	57.38874	0.22173
7	0.53611	37.64999	4.85361	57.27369	0.22271
8	0.53651	37.69136	4.85588	57.23027	0.22249
9	0.53665	37.70479	4.85863	57.21415	0.22243
10	0.53670	37.70866	4.86057	57.20808	0.22268
11	0.53672	37.70951	4.86175	57.20567	0.22307
12	0.53673	37.70952	4.86241	57.20461	0.22346

Table 6.6: Decomposition of Forecast Error Variance for LVOLUME

Horizon	Std.Err.	DLRGDP	DLPRICE	DFRATE	LVOLUME
1	0.25392	0.24241	0.042561	0.053115	99.66192
2	0.31641	0.85143	3.69497	1.06027	94.39333
3	0.34827	0.71392	5.95161	1.39056	91.94392
4	0.36681	0.64377	7.53938	1.52430	90.29256
5	0.37799	0.60647	8.57891	1.56399	89.25063
6	0.38486	0.58517	9.23909	1.56729	88.60845
7	0.38911	0.57384	9.65066	1.55938	88.21612
8	0.39176	0.56881	9.90463	1.55002	87.97654
9	0.39340	0.56733	10.06056	1.54227	87.82984
10	0.39443	0.56754	10.15613	1.53663	87.73971
11	0.39508	0.56835	10.21471	1.53276	87.68418
12	0.39548	0.56924	10.25067	1.53021	87.64988

6.5 Impulse Response Analysis

Following the variance decomposition, the next analysis relates to the impulse response function analysis, as it is the second tool of innovating accounting analysis. Again as explained in Chapter 5, the impulse response function (IRF), shows how one variable responds over time to a single innovation in itself or in another variable. In a VAR system consisting of four endogenous variables (RDGP, Lvolume, Funds rate, Price) a reaction/ response of one variable to an exogenous shock may involve a number of other variables as well. An exogenous shock in a variable has effects on other variables if there is a casual relationship between the "shocked" and the remaining variables. Therefore, from the estimated model the effect of an exogenous shock or innovation in one of the variables on all other variables can be measured. This process is called the impulse response analysis or the multiplier analysis.

Under the assumption that shocks in different variables are independent, we can say that shocks occur in only one variable at a time. In the contemporaneous correlation test, we could not reject the null hypothesis that the system covariance matrix of the errors in the VAR model is diagonal (that is, the autocorrelation co variances $\delta_{ij}=0$, $i \neq j$, in the system are expected to be zero):

$$Y_t = \begin{bmatrix} RGDP_t \\ P_t \\ FR_t \\ V_t \end{bmatrix} = A_0 X + A_1 \begin{bmatrix} RGDP_{t-1} \\ P_{t-1} \\ FR_{t-1} \\ V_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{RGDP,t} \\ \varepsilon_{P,t} \\ \varepsilon_{FR,t} \\ \varepsilon_{V,t} \end{bmatrix} \quad (6.2)$$

Where:

RGDP = Real GDP,

P = Price level,

FR = Federal Funds Rate,

V = Derivatives trading volume.

Therefore, the error terms in the VAR system are independent, and the shock occurs only in one system at a time. To isolate such an effect between the variables in the system consider the following VAR system.

Where A_1 is a 4x 4 matrix of coefficients and A_0 is a parameter matrix. We assume that the mean of three (P, FR, V) variables prior to time period t is zero. With A_0=0, to trace a unit shock in time period t =0 in the system we obtain:

$$Y_0 = A_0 Y_{-t} + \varepsilon_0 = \varepsilon_0 = \begin{bmatrix} \varepsilon_{RGDP,0} \\ \varepsilon_{P,0} \\ \varepsilon_{FR,0} \\ \varepsilon_{V,0} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} , \qquad (6.3)$$

$$Y_1 = A_1 Y_{0,}$$

$$Y_2 = A_1 Y_1 = A_1^2 Y_0,....$$

$$Y_t = A_1^t Y_0,$$

$$A_1 = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} . \qquad (6.4)$$

By computing vector V_t, we can trace out the responses of variables (P, FR, V) to a one unit shock from RGDP as well as responses to RGDP to shocks from P, FR and V at various time periods (t= 1,2,3...). One standard deviation is used as a unit shock to measure the response of variable j to a unit shock in variable k in the VAR system.

As explained in Chapter 5 a graphical illustration of an impulse response function can provide an intuitive insight into the dynamic relationship between two variables, as it portrays the response of one variable to an unanticipated shock in the other variable over a certain time horizon.

Impulse responses of variables are depicted in Figures 6.2 to 6.17. The first set of impulse responses deal with the response of Real GDP to shocks in price level, Funds rate and derivatives turnover volume Beginning with Figure 6.1, the X-axis of the graph represents the duration (quarters) of the response of one variable to one unit shock from another variable, while the Y-axis measures the level or the degree of the response. The maximum horizon period t = 12 quarters, and the measure of response is one standard deviation. The next section deals with the impulse responses for each shock in turn.

Figures 6.2 to 6.5 plot the response of RGDP to a one unit unexpected shock in price. The response is generally negative and the values return to equilibrium after a lag of 12 quarters. The impact is insignificant, as the values are very small. The response of RGDP to an unexpected innovation in Funds rate is generally positive but again the values are very small. In other words a temporary change in Funds rate leads to an Increase in RGDP for two quarters before it falls back to zero. An unexpected innovation in derivatives trading volume leads to an initial decline in RGDP but a rapid increase later on, before moving towards equilibrium. The response is negative for only two quarters before finally turning positive for the remainder of the time frame. However, the positive increase is more than offset by the initial negative values. The important thing to note is the values are very small, further supporting the conclusion in the previous section regarding a weak relationship between economic growth and the derivatives markets.

Figures 6.6 to 6.9 illustrate the response of derivatives volume due to shocks in Price, RGDP and Funds rate. An unexpected innovation in price leads to a fall in derivatives volume of around 6%. Thus the relationship between price and derivatives trading is relatively strong as compared to other real variables. Shocks in RGDP have an immediate negative impact on volume with the response showing positive values after four quarters before moving towards equilibrium. Impulse response for derivatives volume is positive due to an unanticipated shock in Funds rate. However, the nature of the response is sharp (3%) and instantaneous before gradually declining to zero.

Figures 6.10 to 6.13 portray the response of price to a one-unit shock in derivatives volume, Funds rate and RGDP. Any unanticipated shock in derivatives volume traces out a negative relationship with price. Though the values are very small, the impact is instantaneous. The impulse response of Price to shocks in Funds rate is positive. The response again is instantaneous. There is a sharp increase in the first quarter before gradually lagging off towards zero. Shocks to RGDP leads to an initial negative response followed by a sharp increase by quarter two. It more or less stays stagnant for two to three quarters before gradually declining.

Figures 6.14 to 6.17, illustrate the response of Funds rate to shocks in the other three variables. Innovations in RGDP lead to an increase of 2.5% in the first two quarters before lagging off gradually. While innovations in price cause Funds rate to fall from 8% to zero by four quarters before becoming negative 1% for the remaining time frame. The response of Fund rate to derivatives volume is the most significant (a change of 16%) before becoming positive around the ninth quarter.

The important findings from the above empirical model are as follows:

- The funds rates in the economy is very responsive to derivatives trading.
- The responses of macro economic variables to unanticipated shocks are instantaneous, supporting the theoretical claim that the presence of derivatives markets has speeded up the transmission mechanism in the US economy.
- The impact by the derivatives sector is rather small on the real sector, but it does affect the financial markets (as interest rates respond faster).
- The fact that derivatives markets do not have any definitive impact on the macro economy means that derivatives should not be seen as a threat to macroeconomic

stability or systemic stability. Hence, policy makers should not view derivatives as a source of any potential systemic failures.

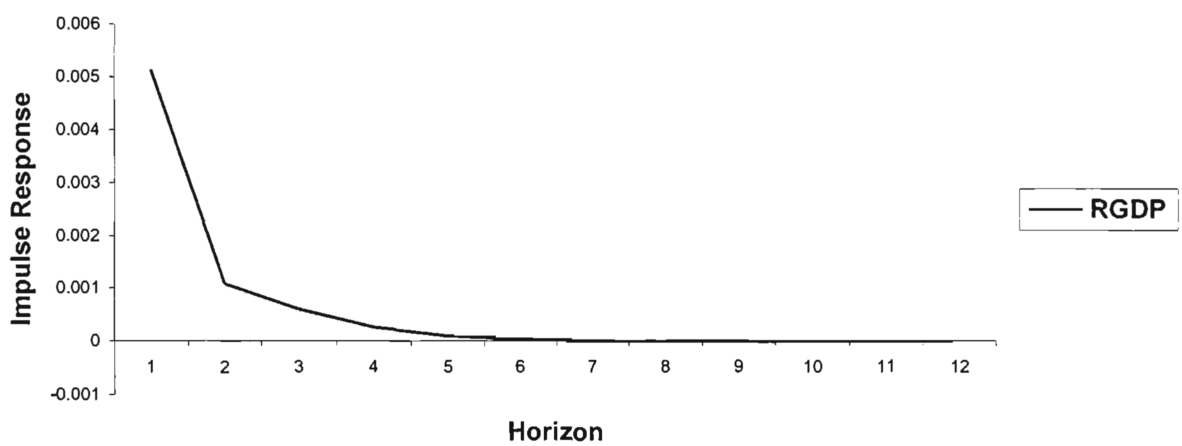


Figure 6.2: Impulse Response of RGDP to Shocks in Itself

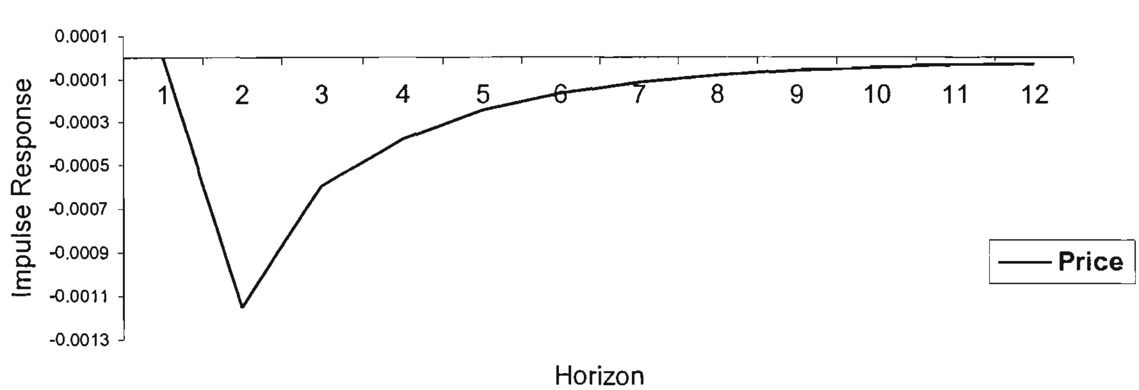


Figure 6.3: Impulse Response of RGDP to Shocks in Price

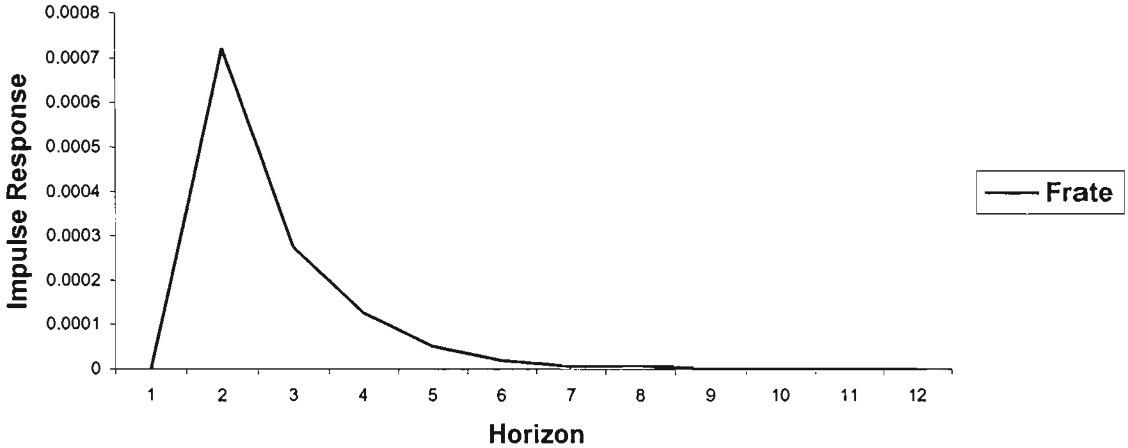


Figure 6.4: Impulse Response of RGDP to Shocks in Funds Rate

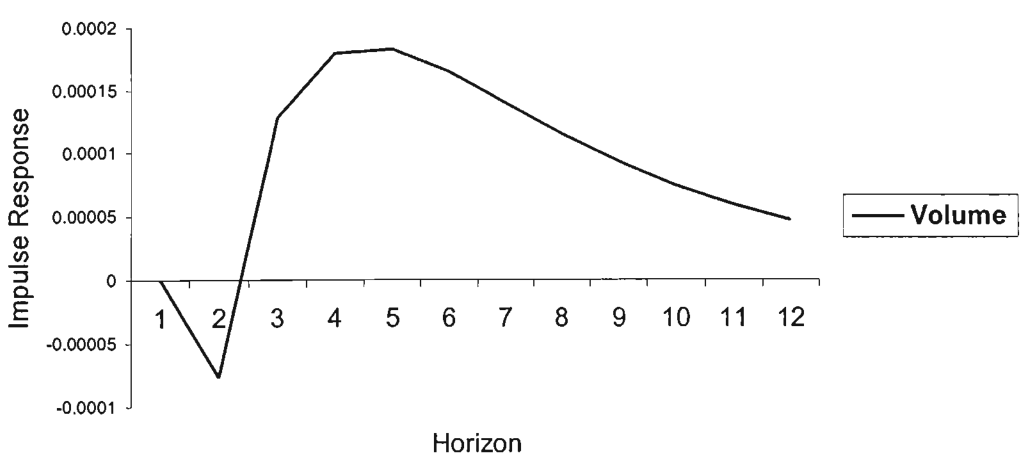


Figure 6.5: Impulse Responses of RGDP to Shocks in Volume

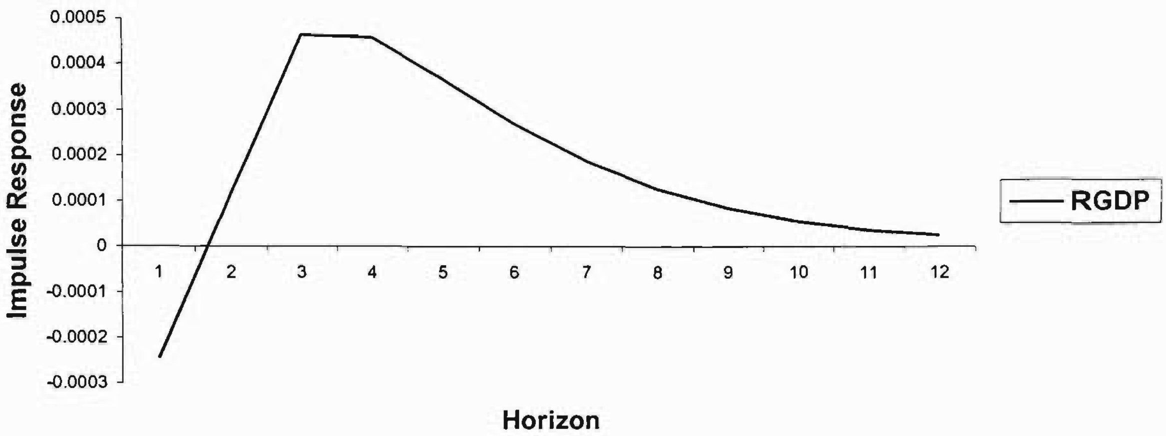


Figure 6.6:Impulse Response of Price to Shocks in Real GDP

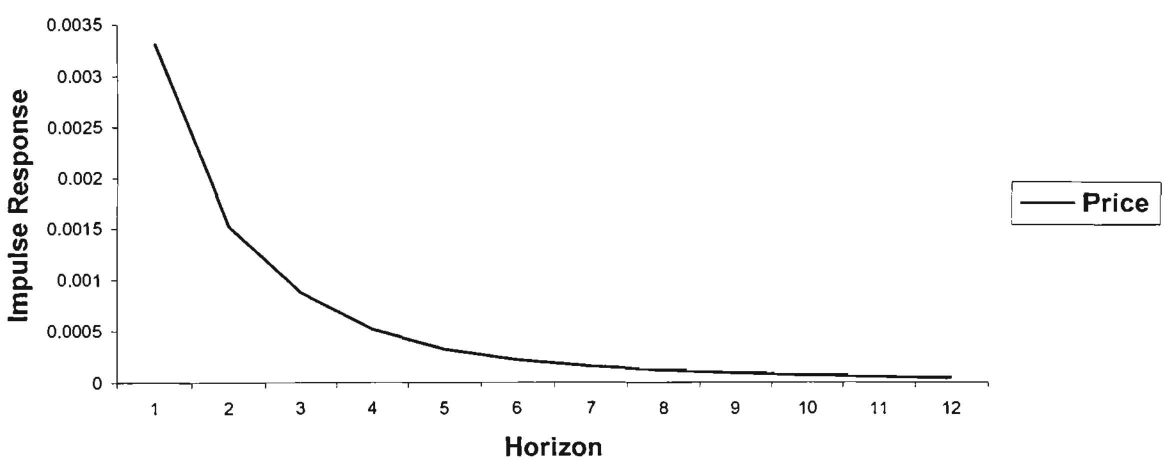


Figure 6.7: Impulse Response of Price to Shocks in Itself

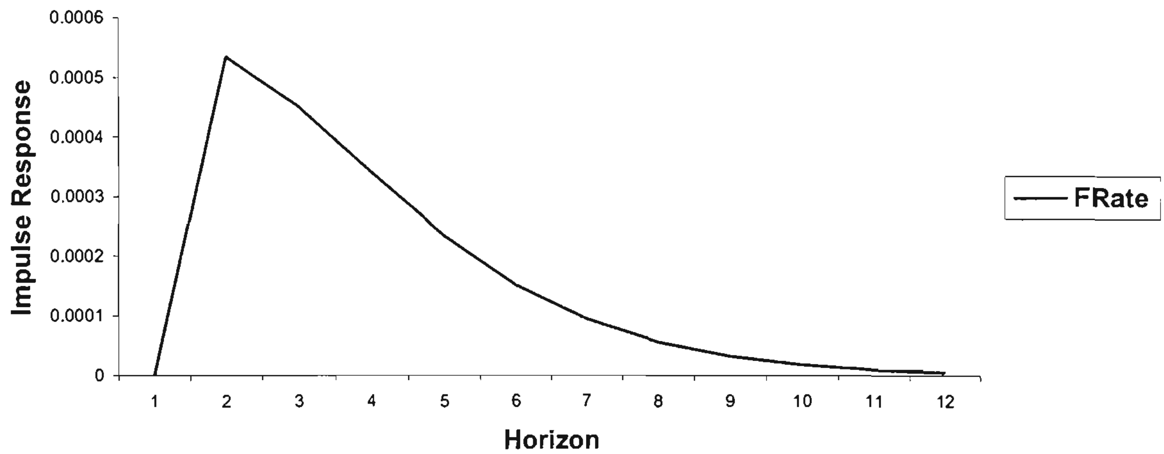


Figure 6.8: Impulse Response of Price to Shocks in Funds Rate

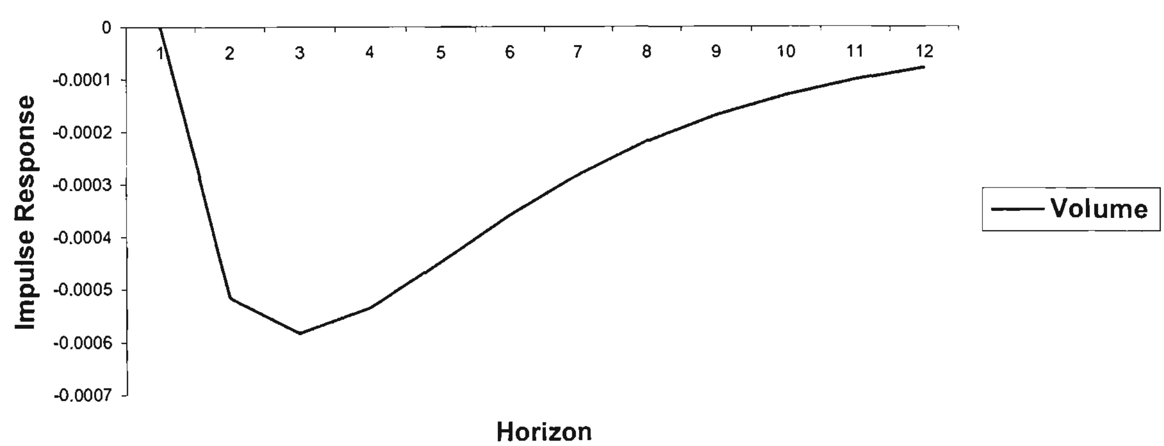


Figure 6.9: Impulse Response of Price to Shocks in Volume

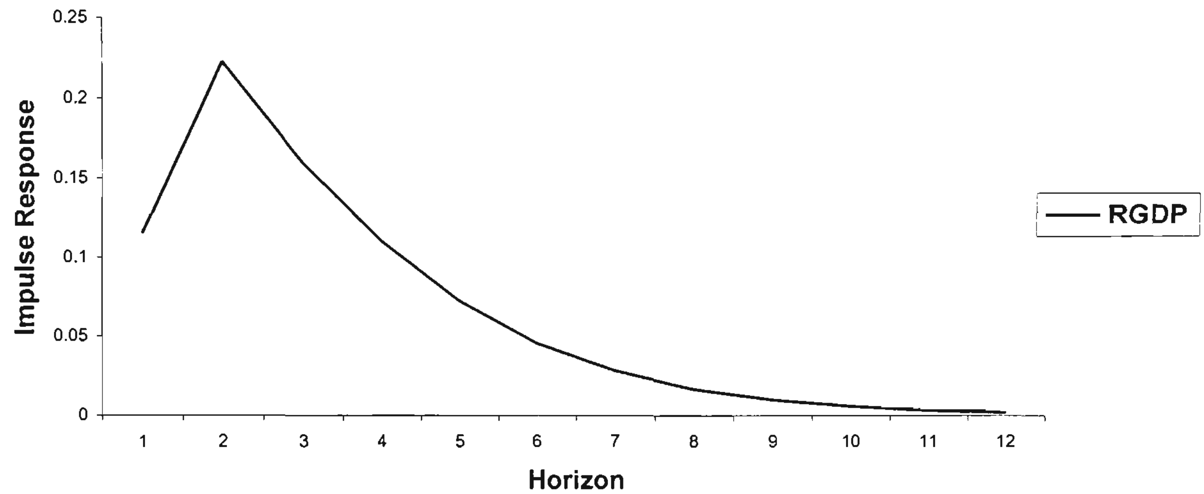


Figure 6.10: Impulse Response of Funds Rate to Shocks in Real GDP

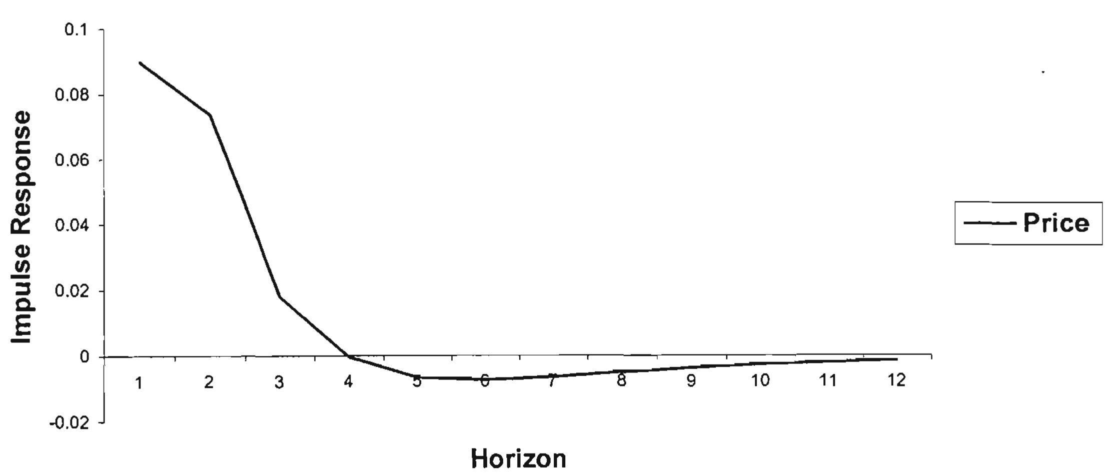


Figure 6.11: Impulse Response of Funds Rate to Shocks in Price

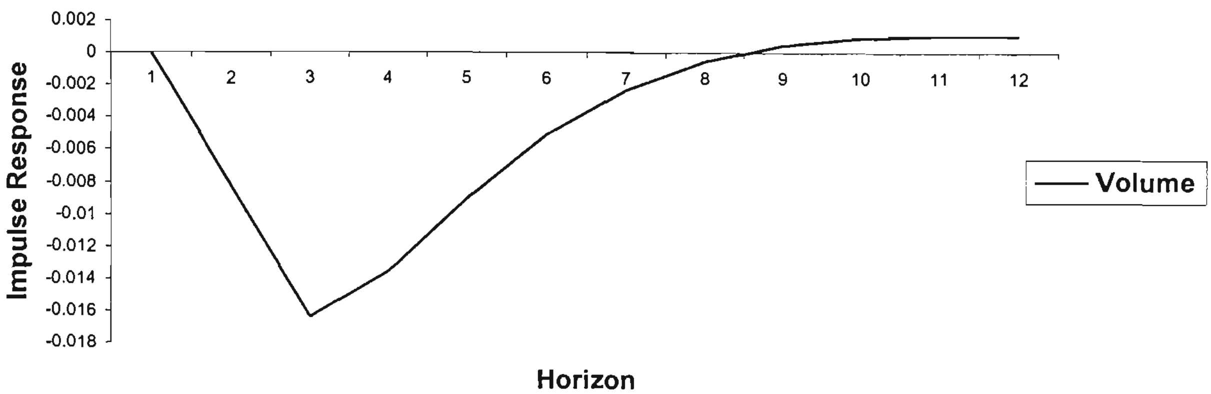


Figure 6.12: Impulse Response of Funds Rate to Shocks in Volume

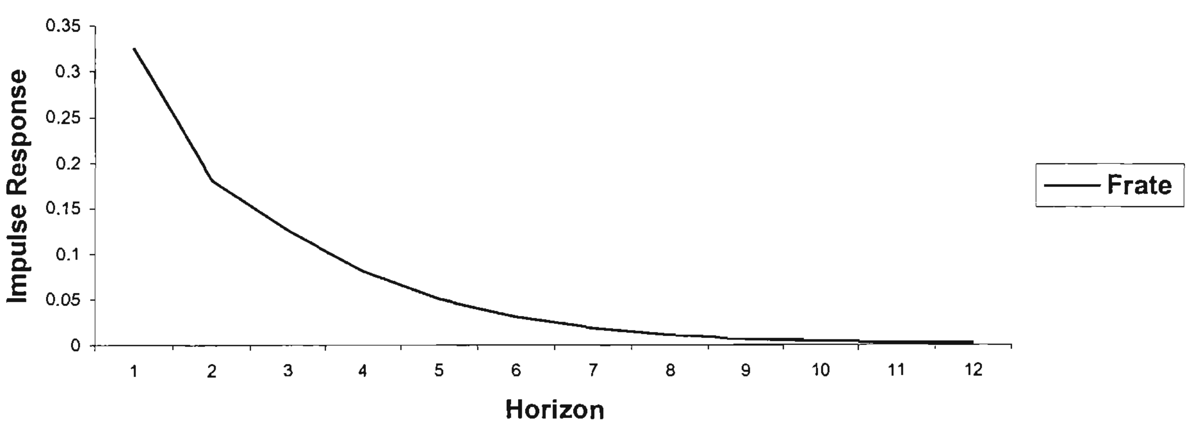


Figure 6.13: Impulse Response of Funds Rate to Shocks in Itself

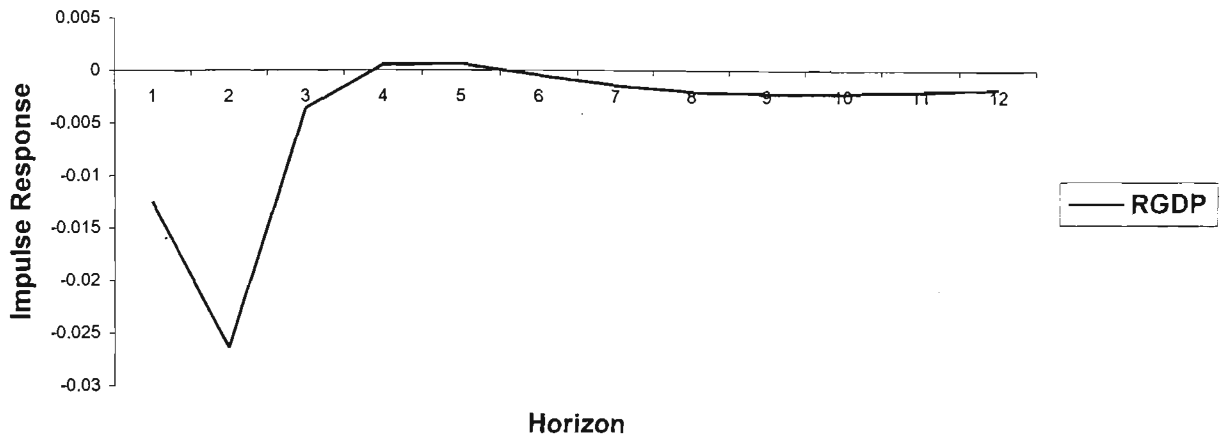


Figure 6.14: Impulse Response of Volume to Shocks in Real GDP

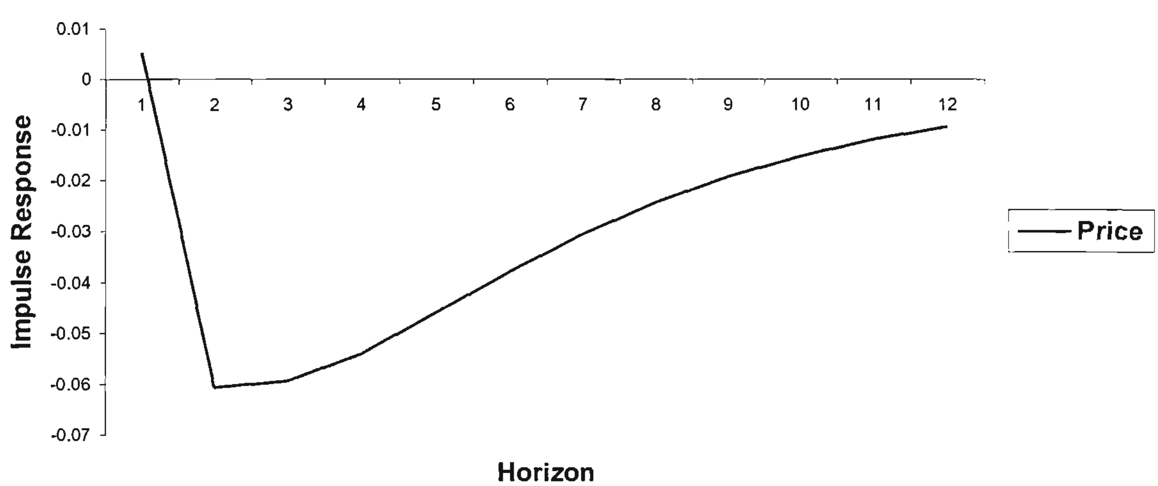


Figure 6.15: Impulse Response of Volume to Shocks in Price

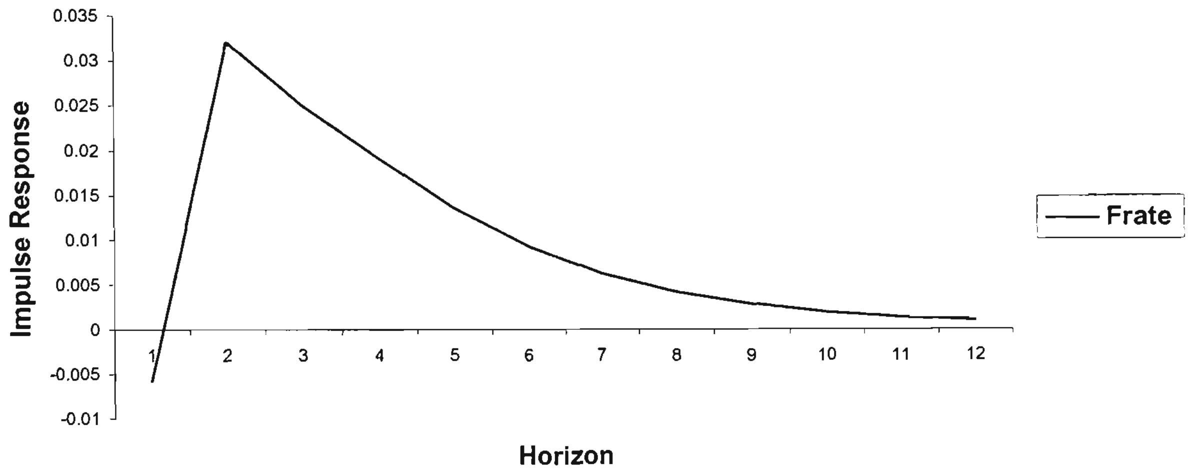


Figure 6.16: Impulse Response of Volume to Shocks in Funds Rate

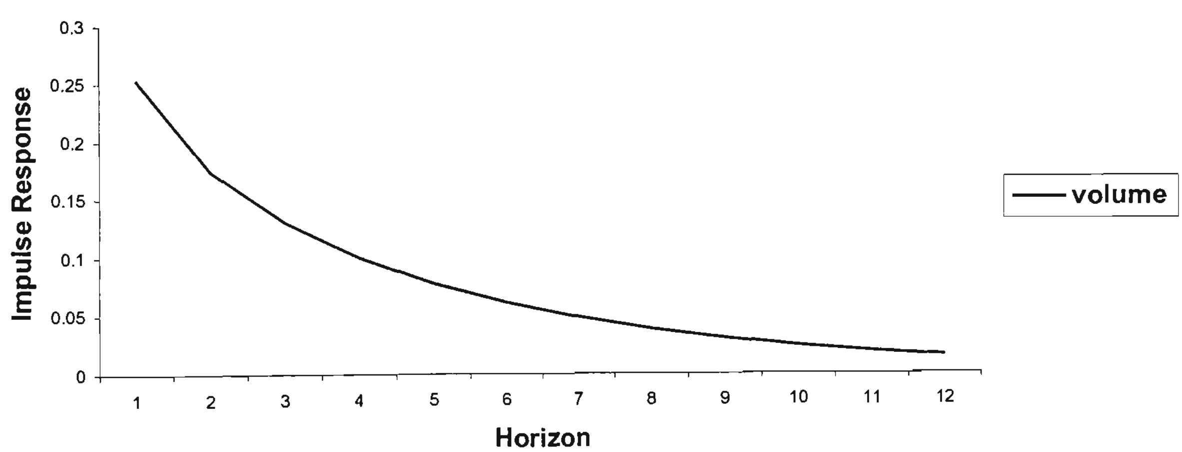


Figure 6.17: Impulse Response of Volume to Shocks in Itself

6.6 Empirical Results of the VAR Model

The main aim of this chapter is to estimate the VAR system to analyze the macroeconomic relationship between the four main variables: real GDP, Price level, Federal funds rate, and derivatives trading volume as measured by the turnover in the futures markets on the Chicago Board of Trade for the U.S economy and whether there have been changes in the monetary policy transmission in the presence of derivatives markets. The rational behind the empirical study of the U.S economy stems from the fact that the U.S is the major financial center of the world and derivatives markets are well developed and have been in use for over two decades in the U.S economy; thus providing sufficient time series data to conduct the analysis. Theoretical analysis suggests that the presence of derivatives markets speed up the transmission process of monetary policy, by making markets more complete. This has been supported by the impulse response analysis. The impact of any unexpected shock to any one variable leads to a contemporaneous response in other variables.

But there is no definite empirical support for a change in the transmission process itself or that derivatives markets do have a significant impact on the real sector of the economy. Overall the empirical results do not support the hypothesis that the presence of derivatives markets has changed the transmission of monetary policy to the real economy in the U.S. However, there is evidence that derivatives have affected transmission through financial markets (interest rates respond faster) even though there is only a marginal impact on real variables. This result should be treated with some skepticism, as it might be possible that the Federal Reserve already takes into account the derivative market responses and the VAR model is simply picking up the new response in its "normal" response function. Also, it is likely that the open and well developed financial markets of the U.S economy, that enabled the early and fast development of derivatives markets did not make much difference to the monetary policy transmission in the U.S itself, as they would have, if introduced in any emerging economy. For instance, derivatives could play a less important role in completing markets if markets were already complete and less important role in circumventing regulations where regulations were already fairly liberal.

Since the empirical research using the VAR model does not support the proposed hypothesis, it is important to test the same hypotheses using the Structural Vector Autoregressive technique. This enables a test of the validity of the result restrictions, and this analysis is carried out in the following section.

6.7 The SVAR Model

The SVAR model estimated using all the variables takes the following form:

Dlrgdp = a_{10}+ a_{11}.dlrgdp(-1) + a_{12}.dlprice(-1) + a_{13}.dfrate(-1) + a_{14}.lvolume (-1),

Dlprice = a_{20}+ a_{21}.dlrgdp(-1) + a_{22}.dlprice(-1) + a_{23}.dfrate(-1) + a_{24}.lvolume (-1),

Dfrate = a_{30}+ a_{31}.dlrgdp(-1) + a_{32}.dlprice(-1) + a_{33}.dfrate(-1) + a_{34}.lvolume (-1),

Lvolume = a_{40}+ a_{41}.dlrgdp(-1) + a_{42}.dlprice(-1) + a_{43}.dfrate(-1) + a_{44}.lvolume (-1).

The model has been estimated with a lag structure of one as identified in Chapter 5 using SBIC and AIC criteria.

Structural VAR analysis attempts to analyse the dynamic interaction between the variables by imposing identification assumptions about the underlying structural form. Once the structural model is identified, interrelationships between the variables can be investigated via impulse response functions and forecast error variance decomposition, that shows the evolution of economic shocks through the system.

As explained in Chapter 5 forecast error variance decomposition (FEVD) is one of the tools of innovation accounting analysis to trace out the impact of shocks (innovations) in the VAR system. FEVD is used to ascertain the importance of the interactions among the economic variables in the system. The variance decomposition divides the forecast error variance of a given variable according to the causal strength of the innovation effects of the variable on itself, and on other variables in the VAR model (Hakkio and Morris, 1984). As Sims (1980) pointed out, the magnitude of the forecast error variance provides an estimate of the Granger causal strength of the innovating variables on other variables in the VAR model. Variance decompositions for 12 period ahead forecasts were calculated to capture the full dynamics of the impact of Derivatives markets (Lvolume) on real gross domestic product (RGDP) and the results are reported in Tables 6.7 to 6.11. For the purpose of empirical analysis, a causality effect exists when a variable explains 20% and above of the forecast error variance of the other variable. While interpreting the variance decomposition results, one should pay attention to the values of the components of the forecast errors over the entire forecast horizon.

The results reported in Table 6.7 suggest that the most important explanation of innovations in Real GDP is due to its own past values (accounting for around 91%) over different forecast horizons. The next important explanation is in real activity and can be explained by price level (around 6.5%) and Funds rate (around 2%). The innovations in derivatives trade accounts for a very small proportion (around only half of one percent). This indicates that derivatives markets trading does not play an important role in the real growth of the US economy.

Table 6.8 explains the amount of innovation in price level due to other variables in the VAR system over the 12 period forecast horizon. As expected the most important explanation in variations in price level are explained by its own past values (83%). The next important variable explaining the innovations in price level is derivatives trading volume (8%). Finally real GDP and funds rate account for 4% of the variations in the level of prices in the US economy.

Table 6.9 provides explanations for innovation in the funds rates because of other variables like real GDP, price level and derivatives trading volume. Once again the most important explanation of innovations in funds rate are explained by the past values of the variable itself (funds rate) over the different time horizons (around 57%). The second most important variable is real GDP accounting for around 38% of the any innovations in the funds rate, which takes into account the fact that Federal Reserve changes in policy stance are governed or explained by the level of economic activity in the economy. Around 5% of the innovations are explained by the price level and a negligible amount of the innovations are explained by derivatives trading volume (.0034).

The results reported in Table 6.10 further provide evidence of the causal relationship between derivatives turnover and other real variables in the economy. As expected the most important explanation of innovations in derivative volume is its own past values (accounting for about 87%) over different forecast horizons. Again the relationship between derivatives volume and real GDP is very small (.5%) further providing support for the proposition that derivatives markets do not have an important impact on real economic activity. Economic theory suggests an innovation in price level explains over 10% of the forecast error variance of derivatives turnover volume. While the fund rate accounts for only 1.5% of the forecast error variance of derivatives volume. Thus, the relationship between funds rate and derivatives trading is not very high, suggesting that interest rate exposure is not the only factor encouraging derivatives trading; it is possible that traders have been using derivatives more for speculative rather than hedging purposes. While interpreting the results from variance decomposition tables it is important to pay attention to values of the components of the forecast errors over the entire forecast horizon. Results in Tables 6.7 to 6.10 show that the proportions of each component (of forecast error variance) remain more or less constant.

Table 6.7: Decomposition of Forecast Error Variance for DLRGDP

Horizon	Std. Error	RGDP	Price	Frate	Volume
1	0.005133	100.0	0	0	0
2	0.005420	93.669	4.534	1.77622	0.019984
3	0.005494	92.343	5.605	1.97675	0.073921
4	0.005518	91.767	6.041	2.01174	0.17921
5	0.005527	91.476	6.221	2.01355	0.28808
6	0.005532	91.310	6.302	2.01116	0.37613
7	0.005535	91.211	6.340	2.00911	0.43952
8	0.005537	91.150	6.359	2.00776	0.48233
9	0.005538	91.112	6.370	2.00692	0.51022
10	0.005539	91.089	6.375	2.00640	0.52799
11	0.005540	91.075	6.379	2.00607	0.53918
12	0.005540	91.066	6.381	2.00587	0.54617

Table 6.8: Decomposition of Forecast Error Variance for DLPRICE

Horizon	Std. Error	RGDP	Price	Frate	Volume
1	0.0033269	0.54247	99.457	0	0
2	0.0037351	0.53291	95.515	2.0471	1.904
3	0.0039339	1.86859	91.062	3.1558	3.913
4	0.0040438	3.04987	87.800	3.6930	5.456
5	0.0041047	3.76529	85.837	3.9070	6.490
6	0.0041377	4.12858	84.749	3.9784	7.143
7	0.0041555	4.29549	84.163	3.9954	7.545
8	0.0041652	4.36705	83.849	3.9951	7.788
9	0.0041706	4.39605	83.678	3.9908	7.934
10	0.0041737	4.40716	83.583	3.9868	8.022
11	0.0041755	4.41110	83.529	3.9840	8.075
12	0.0041766	4.41231	83.497	3.9821	8.107

Table 6.9: Decomposition of Forecast Error Variance for DFRATE

Horizon	Std. Error	RGDP	Price	Frate	Volume
1	0.35665	10.4310	6.3401	83.228	0
2	0.46351	29.2193	6.2759	64.472	0.0322
3	0.50635	34.3114	5.3833	60.172	0.1324
4	0.52463	36.3820	5.0147	58.412	0.1908
5	0.53210	37.2102	4.8910	57.683	0.2148
6	0.53501	37.5314	4.8581	57.388	0.2217
7	0.53611	37.6499	4.8536	57.273	0.2227
8	0.53651	37.6913	4.8558	57.230	0.2224
9	0.53665	37.7047	4.0860	57.214	0.2224
10	0.53670	37.7086	4.8605	57.208	0.2226
11	0.53672	37.7095	4.8617	57.205	0.2230
12	0.53673	37.7095	4.8624	57.204	0.0034

Table 6.10: Decomposition of Forecast Error Variance for LVOLUME

Horizon	Std. Error	RGDP	Price	Frate	Volume
1	0.253	0.242	0.042	0.053	99.661
2	0.316	0.851	3.694	1.060	94.393
3	0.348	0.713	5.951	1.390	91.943
4	0.366	0.643	7.539	1.524	90.292
5	0.377	0.606	8.578	1.563	89.250
6	0.384	0.585	9.239	1.567	88.608
7	0.389	0.573	9.650	1.559	88.216
8	0.391	0.568	9.904	1.550	87.976
9	0.393	0.567	10.06	1.542	87.829
10	0.394	0.567	10.15	1.536	87.739
11	0.395	0.568	10.21	1.532	87.684
12	0.395	0.570	10.25	1.530	87.649

Summarizing the decomposition analysis it can be said that derivatives markets do not have a significant impact on the level of real economic activity for the US economy. Interest rate exposure is not the most important factor promoting derivatives trading and there is little empirical evidence derivatives have any significant impact on the effectiveness of monetary policy itself.

Table 6.11 explains the diagnostics of the SVAR system and Table 6.12 states the coefficients of the SVAR model. Table 6.11 and 6.12 together help explain the robustness of the SVAR model. Table 6.13 is the covariance matrix of the SVAR model.

Table 6.11: Diagnostics of the System

Equation 1
Dependent Variable: DLRGDP

Mean of dependent variable = .756617E-02
Std error of regression = .493560E-02
R- Square= .145224
Durbin-Watson Statistic = 2.08228

Equation 2

Dependent Variable: Dlprice

Mean of dependent variable = .761431E-02
Std error of regression = .319842E-02
R- Square= .304193
Durbin-Watson Statistic = 1.87914

Equation 3

Dependent Variable: Dfrate

Mean of dependent variable = -.087727
Std error of regression = .342873
R- Square= .525618
Durbin-Watson Statistic = 1.94059

Equation 4

Dependent Variable: Lvolume

Mean of dependent variable = 17.0835
Std error of regression = .244108
R- Square= .621713
Durbin-Watson Statistic = 2.43417

Table 6.12: Estimate of SVAR Model

Variable	Coefficient	Error	t-statistic
DLRGDP(-1)	.139997	.132707	1.05493
DLPRICE(-1)	-.407342	.190309	-2.14043
DFRATE(-1)	.221470E-02	.151123E-02	1.46549
LVOLUME(-1)	-.302269E-03	.163077E-02	-.185354
C	.015016	.028360	.529490
DLRGDP(-1)	.228910E-02	.085998	.026618
DLPRICE(-1)	.418538	.123326	3.39376
DFRATE(-1)	.160594E-02	.979323E-03	1.63984
LVOLUME(-1)	-.203367E-02	.105678E-02	-1.92440
C	.039137	.018378	2.12958
DLRGDP(-1)	31.1580	9.21902	3.37975
DLPRICE(-1)	7.22354	13.2206	.546385
DFRATE(-1)	.554734	.104984	5.28398
LVOLUME(-1)	-.032848	.113288	-.289949
C	.220478	1.97012	.111911
DLRGDP(-1)	-7.02206	6.56347	-1.06987
DLPRICE(-1)	-22.3467	9.41239	-2.37418
DFRATE(-1)	.110846	.074743	1.48302
LVOLUME(-1)	.686106	.080655	8.50664
C	5.61399	1.40262	4.00250

Dependent variable: DLRGDP

Mean of dependent variable	.756617E-02
Std. dev. of dependent var.	.537935E-02
Sum of squared residuals	.160777E-02
Variance of residuals	.263569E-04
Std. error of regression	.513390E-02
R-squared	.145224
Adjusted R-squared	.089173
Durbin-Watson statistic	2.08228
F-stat. (block exogeneity)	1.85617

Table 6.13: Residual Covariance Matrix

	Dlrgdp	Dlprice	Dfrate	Lvolume
DlRgdp	0.000026357			
Dlprice	-1.25799D-06	0.000011068		
Dfrate	0.00059136	0.00026973	0.12720	
Lvolume	-0.000064181	0.000020443	-0.0028736	0.064473

6.8 Impulse Response Analysis of the SVAR Model

Again as explained in Chapter 5, impulse response function (IRF), shows how one variable responds over time to a single innovation in itself or in another variable. A graphical illustration of an impulse response function can provide an intuitive insight into the dynamic relationship between two variables, as it portrays the response of one variable to an unanticipated shock in the other variable over a certain time horizon.

Impulse responses of variables are depicted in Figures 6.18 to 6.33. The first set of impulse responses portrays the response of Real GDP to shocks in price level, Funds rate and derivatives turnover volume. The X-axis of the graph represents the duration (quarters) of the response of one variable to one unit shock from another variable, while the Y-axis measures the level or the degree of the response. The maximum horizon period t = 20 quarters and the measure of response is one standard deviation. The observations from the figures are as follows and the impulse responses for each shock are considered in turn.

Figure 6.18 traces the response path of RGDP to a one unit shock in itself. The response is positive and the decline is sharp. The values return to equilibrium in around 5 quarters. Figure 6.19 plots the response of RGDP to a one unit unexpected shock in price. The response is generally negative and the values return to equilibrium after a lag of 9 quarters. The impact is insignificant, as the values are very small. The response of RGDP to an unexpected innovation in Funds rate is generally positive, but again the values are very small (see Figure 6.20). In other words a temporary change in Funds rate leads to an increase in RGDP for two quarters before it falls back to zero. An unexpected innovation in derivatives trading volume leads to an initial decline in RGDP, but a rapid increase later on, before moving towards equilibrium (see Figure 6.21). The response is negative for only two quarters before finally turning positive for the remainder of the time frame. However, the positive increase is more than offset by the initial negative values. The important thing to note is the values are very small, further supporting the conclusion in the previous section regarding a weak relationship between economic growth and derivatives markets.

Figures 6.22 to 6.25, portray the response of price to a one-unit shock in RGDP, funds rate and derivatives volume. Any unanticipated shock in derivatives volume traces out a negative relationship with price. Though the values are very small, but the impact is instantaneous. The impulse response of Price to shocks in Funds rate is positive. The response again is instantaneous. There is a sharp increase in the first quarter itself followed by a sharp decrease before gradually lagging off towards zero. Shocks to RGDP lead to an initial negative response followed by a sharp positive increase by quarter two. Thus, it more or less stays stagnant for two to three quarters before gradually declining.

Figures 6.26 to 6.29, illustrate the response of Funds rate to shocks in real GDP, price, and derivatives volume. Innovations in RGDP lead to an increase of 2.5% in the first two quarters before lagging off gradually. While innovations in price cause the Funds rate to fall from 8% to zero by four quarters before becoming a negative 1% for the remaining time frame. The response of the Funds rate to derivatives volume is the most significant (a change of 16%) before becoming positive around the ninth quarter.

Figures 6.30 to 6.33 illustrate the response of derivatives volume due to shocks in Price, RGDP and Funds rate. An unexpected innovation in price leads to a fall in derivatives volume of around 6%. Thus the relationship between price and derivatives trading is relatively strong as compared to other real variables. Shocks in RGDP have an immediate negative impact on volume and the response shows positive values after four quarters before moving towards equilibrium. The impulse response for derivatives volume is positive due to an unanticipated shock in Funds rate. However, the nature of the response is sharp (3%) and instantaneous before gradually declining to zero.

A comparison of VAR and SVAR methodology results reveals no major differences. The impulse responses are very much similar reiterating the fact that there is no significant relationship between derivatives markets and real economic activity. At the same time the results do validate the hypothesis that derivatives have significantly increased the speed of monetary policy transmission.

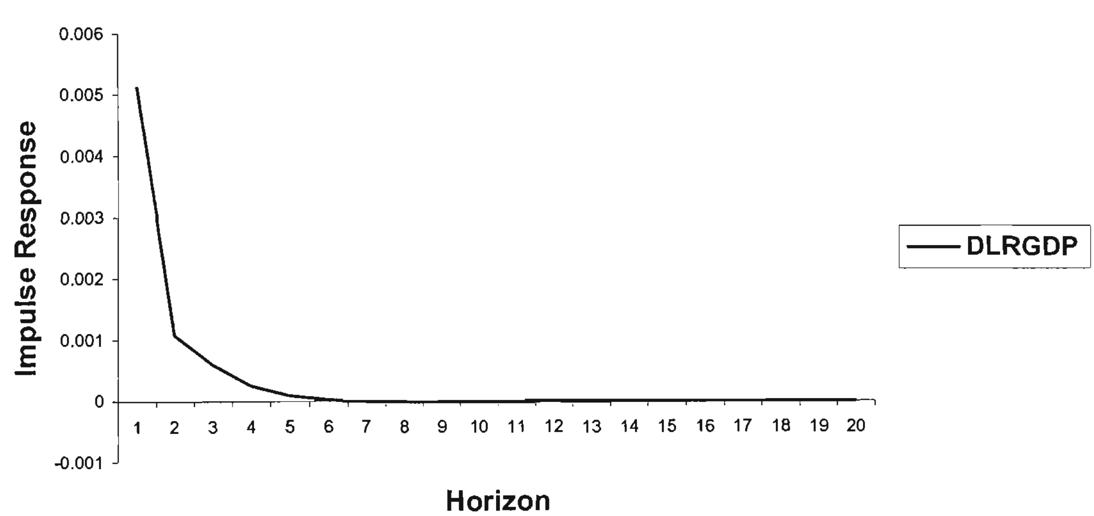


Figure 6.18: Impulse Response of Real GDP to Shocks in Itself

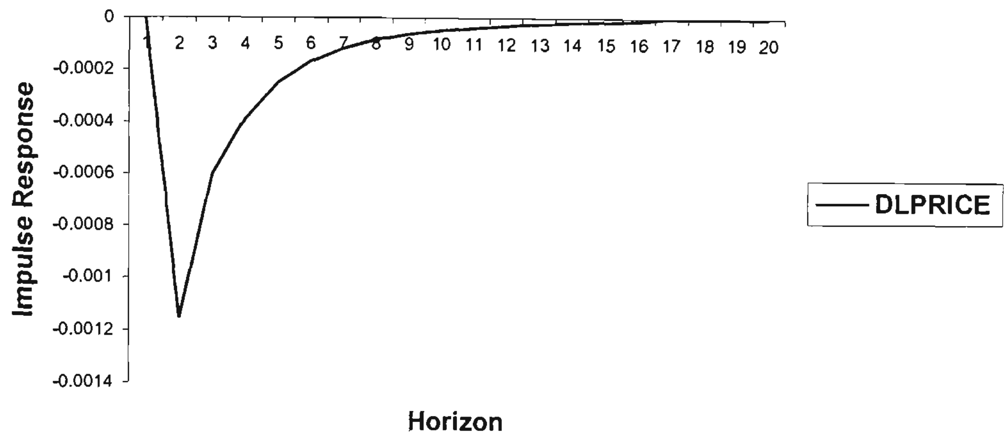


Figure 6.19: Impulse Response of Real GDP to Shocks in Price

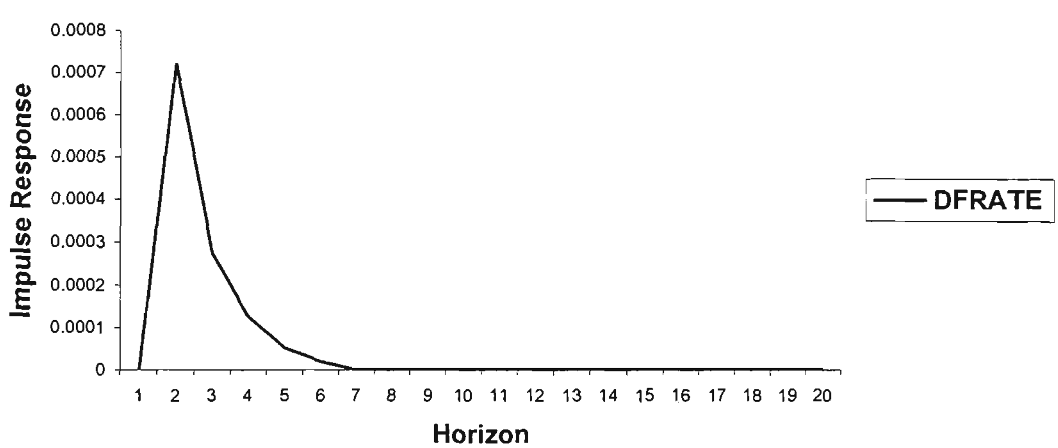


Figure 6.20: Impulse Response of Real GDP to Shocks in Funds Rate

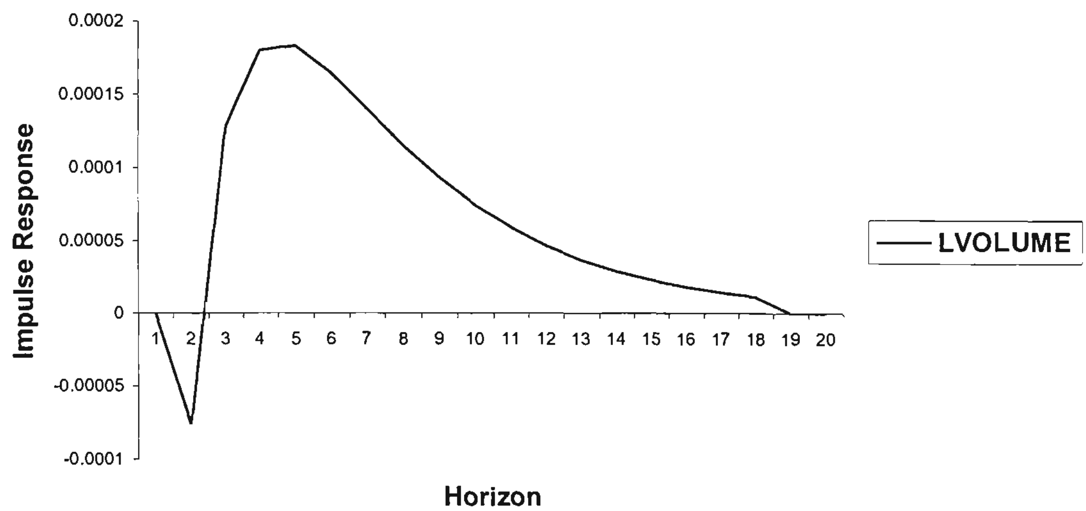


Figure 6.21: Impulse Response of Real GDP to Shocks in Volume

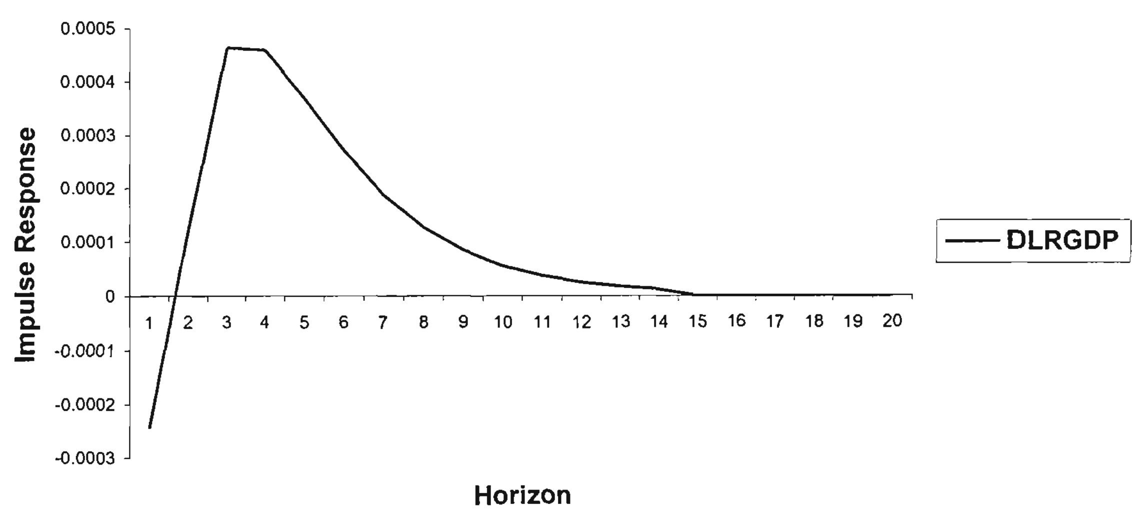


Figure 6.22: Impulse Response of Price to Shocks in RGDP

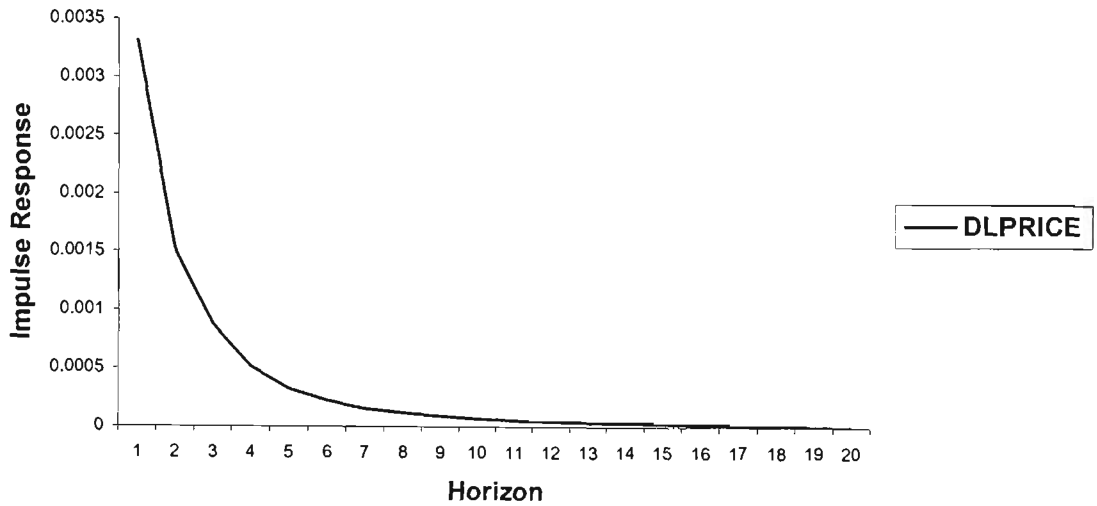


Figure 6.23: Impulse Response of Price to Shocks in Price

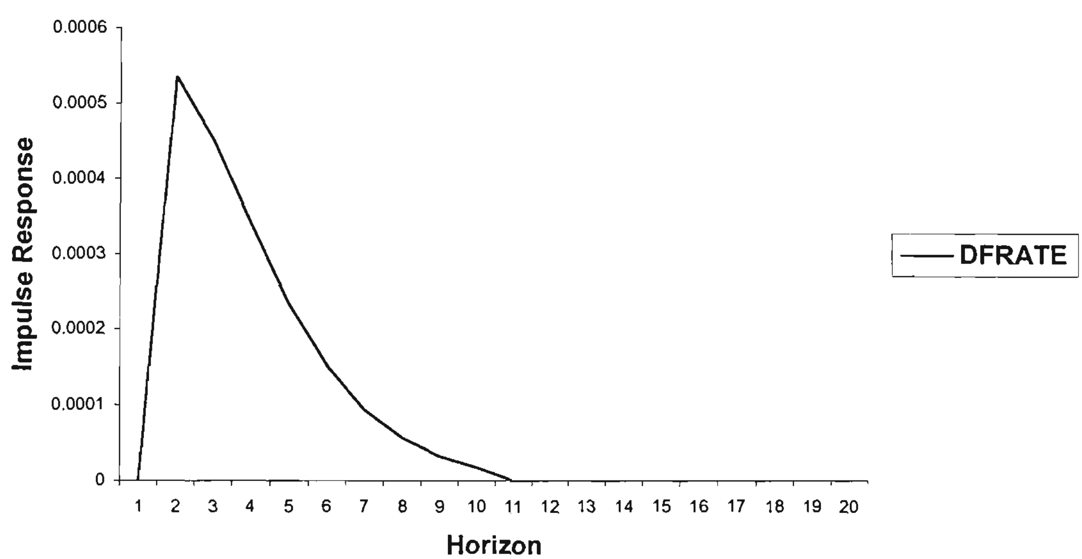


Figure 6.24: Impulse Response of Price to Shocks in Funds Rate

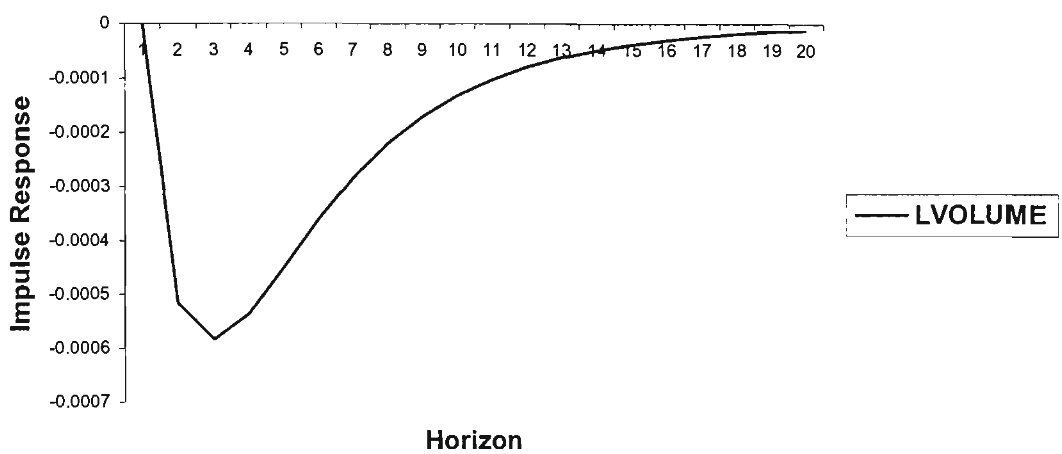


Figure 6.25: Impulse Response of Price to Shocks in Volume

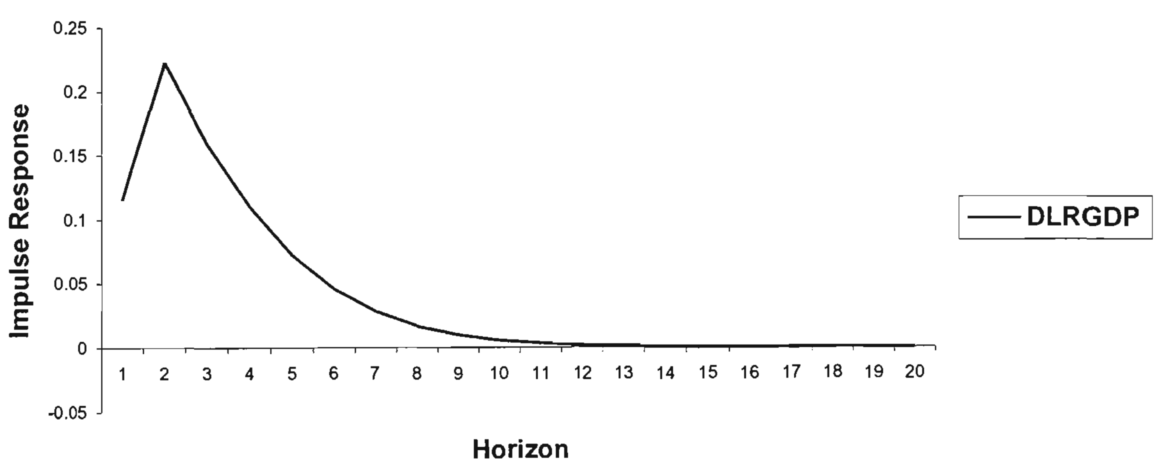


Figure 6.26: Impulse Response of Funds Rate to Shocks in Real GDP

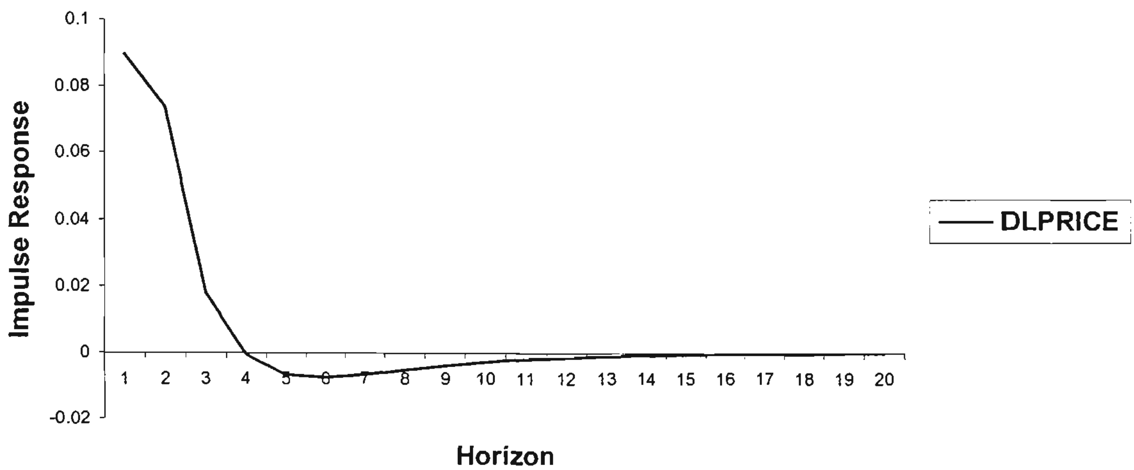


Figure 6.27: Impulse Response of Funds Rate to Shocks in Price

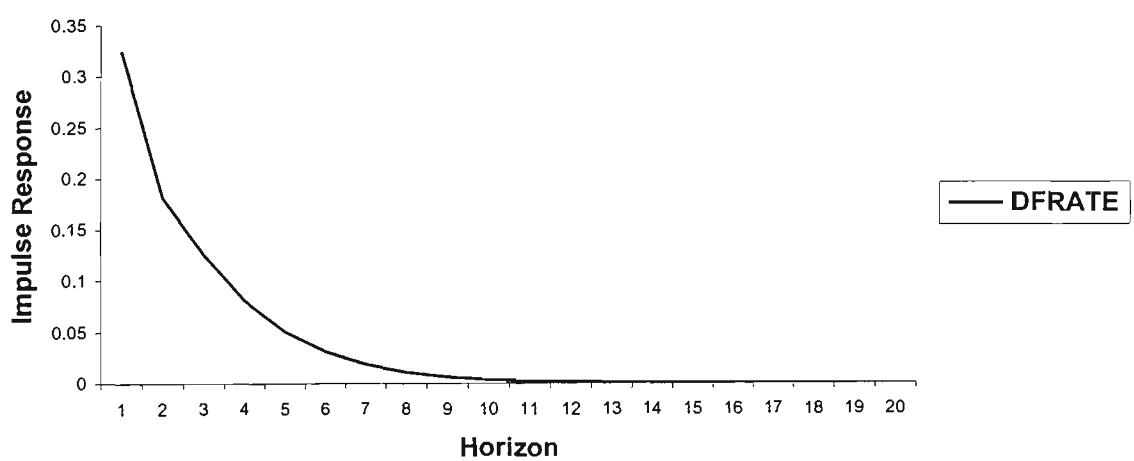


Figure 6.28: Impulse Response of Funds Rate to Shocks in Itself

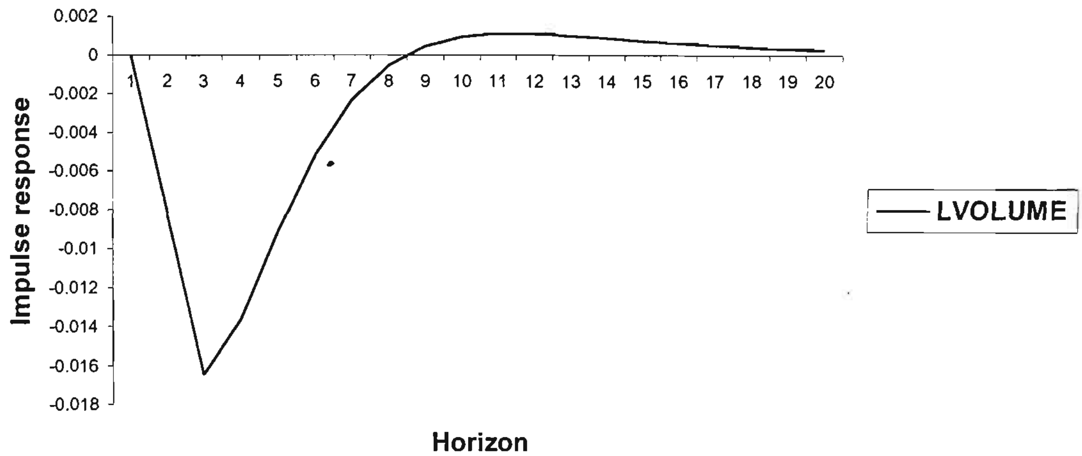


Figure 6.29: Impulse Response of Funds Rate to Shocks in Volume

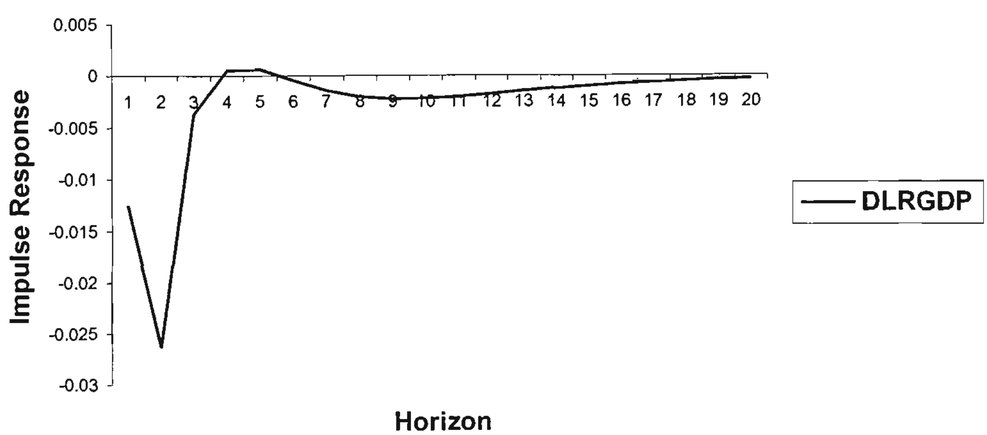


Figure 6.30: Impulse Response of Volume to Shocks in Real GDP

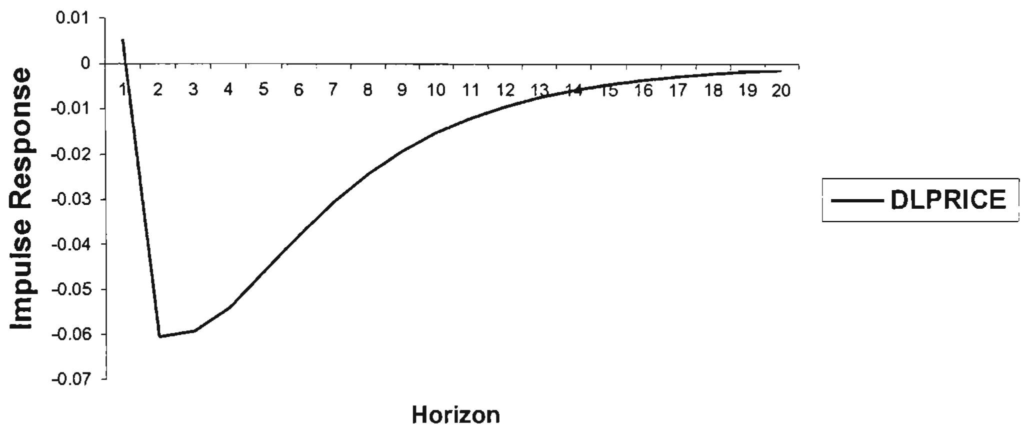


Figure 6.31: Impulse Response of Volume to Shocks in Price

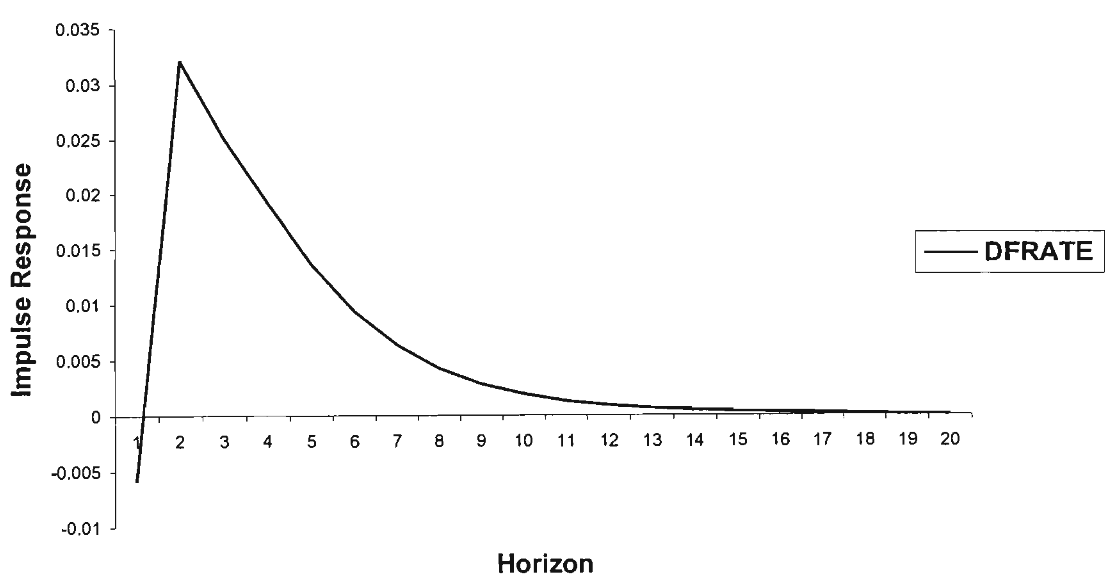


Figure 6.32: Impulse Response of Volume to Shocks in Funds Rate

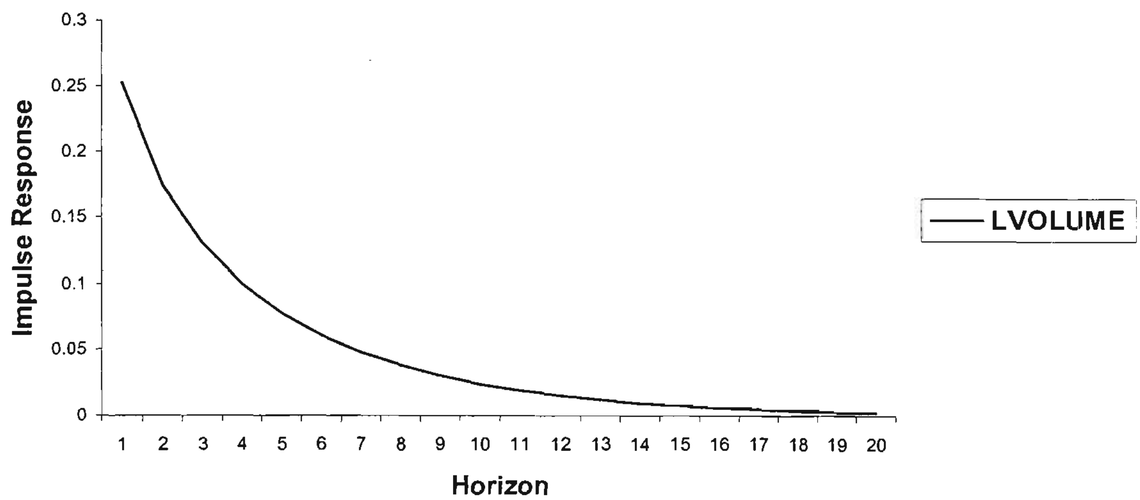


Figure 6.33: Impulse Response of Volume to Shocks in Itself

6.9 Summary and Conclusions

The main aim of this chapter is to estimate the VAR and The SVAR system to analyze the macroeconomic relationship between the four main variables: real GDP, Price level, Federal funds rate, and derivatives trading volume as measured by the turnover in the futures markets on the Chicago Board of Trade for the U.S economy and whether there have been changes in the monetary policy transmission in the presence of derivatives markets. The rational behind the empirical study of the U.S economy stems from the fact that the U.S is the major financial center of the world and derivatives markets are well developed and have been in use for over two decades in the U.S economy thus providing sufficient time series data to conduct the analysis. Theoretical analysis suggests that the presence of derivatives markets speed up the transmission process of monetary policy, by making markets more complete. This has been supported by the impulse response analysis. The impact of any unexpected shock to any one variable leads to a contemporaneous response in other variables.

But there is no definite empirical support for a change in the transmission process itself or that derivatives markets do have a significant impact on the real sector of the economy. Overall the empirical results do not support the hypothesis that the presence of derivatives markets has changed the transmission of monetary policy to the real economy in the U.S. However, there is evidence that derivatives have affected transmission through financial markets (interest rates respond faster) even though there is only a marginal impact on real variables. This result should be treated with some skepticism, as it might be possible that the Federal Reserve already takes into account the derivative market responses and the VAR model is simply picking up the new response in its "normal" response function. Also, it is likely that the open and well-developed financial markets of the U.S economy, which enabled the early and fast development of derivatives markets did not make much difference to the monetary policy transmission in the U.S itself, as they would have, if introduced in any emerging economy. For instance, derivatives could play a less important role in completing markets if markets were already complete and less important role in circumventing regulations where regulations were already fairly liberal.

Since the empirical research using the VAR model does not support the proposed hypothesis, it is important to test the same hypothesis using the Structural Vector Autoregressive technique. This chapter further developed the SVAR model to test the twin hypothesis whether derivatives markets do have an impact on macroeconomic variables measuring the macro economy for the U.S economy, and whether derivatives markets have an impact on the monetary policy transmission policy for the U.S economy. The rational for the use of SVAR stems from the fact that it overcomes some of the criticisms of VAR models in being purely atheoretical. By imposing meaningful economic restrictions SVAR provides a more structural approach to traditional econometric models.

An identical set of variables and identical time span for the series has been used for the SVAR model as used in the VAR. The results obtained from the SVAR model do not support the claim that derivatives markets does have an impact on the real sector of the US economy. The results are ambiguous as far as the impact on the real sector is concerned. This further supports the view that increased volumes of trading in derivatives instruments does not hinder real economic growth, rather they can be looked upon as a separate sector promoting economic growth.

For the second hypothesis, results obtained strongly support the claim that derivatives markets have impacted on the transmission mechanism of monetary policy by speeding up the process. The results from this study tend to support the proposition that the impact of any interest rate shock on the overall economy, starts earlier than would other wise occur in the absence of derivatives markets. This implies that derivatives markets affect the real economy indirectly rather than directly. Derivatives markets can indirectly reinforce fluctuations on the real economy through the broader financial markets. The following chapter summarises the thesis and explains the implications of the findings of this research on the wider macro economy, on derivatives markets and on monetary policy.

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1 Implications

As mentioned in the first chapter this thesis provides a deeper understanding of the nexus between the derivatives market, monetary policy transmission effects and its impact on the real economy. Figures1.1 and 1.2 in Chapter 1.2 explained the direct traditional relationship between the real sector and the monetary sector. Reflected here they are Figures 7.1 and 7.2.

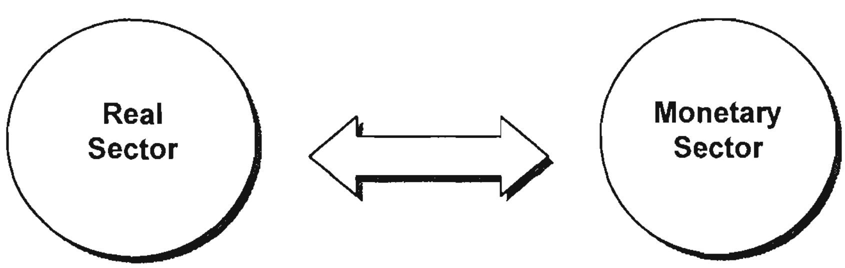


Figure 7.1: Relationship between the Real Sector and the Monetary Sector

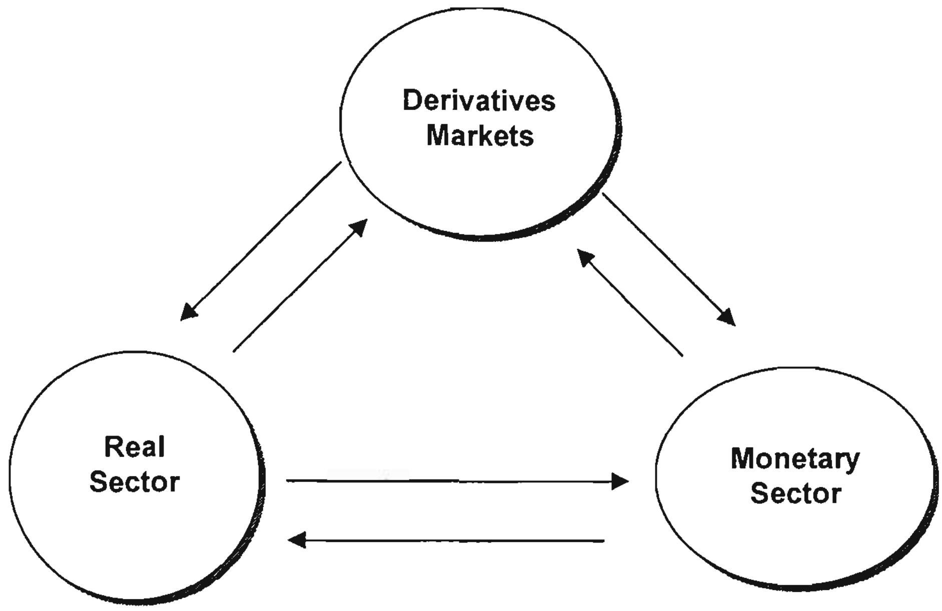


Figure 7.2: New Relationship between the Real Sector and the Monetary Sector

Figure 7.2 explains the probable relationship between the real sector and monetary sector in the presence of a sizeable derivatives market. In academic literature there has always been a debate on whether the transmission mechanism from the monetary sector to the real sector is direct or indirect. The empirical findings from this study state that there is no definitive evidence of derivatives markets impacting upon the real sector, but the results strongly support changes in the transmission mechanism of monetary policy because of the presence of the derivatives market. The speeding up of the transmission mechanism of monetary policy takes place through the financial markets. Therefore it can be said that the monetary sector (represented by the derivatives markets together with the traditional financial sector) reinforce real fluctuations. Therefore, derivatives markets indirectly through the financial/monetary markets have an impact on the real economic activity of the economy. The empirical results of the thesis can be summarized by Figure 7.3 which shows a strong relationship between the real and the monetary sector and a strong relationship between the derivatives markets and the financial/monetary sector which means derivatives markets indirectly influence the real economy through financial markets.

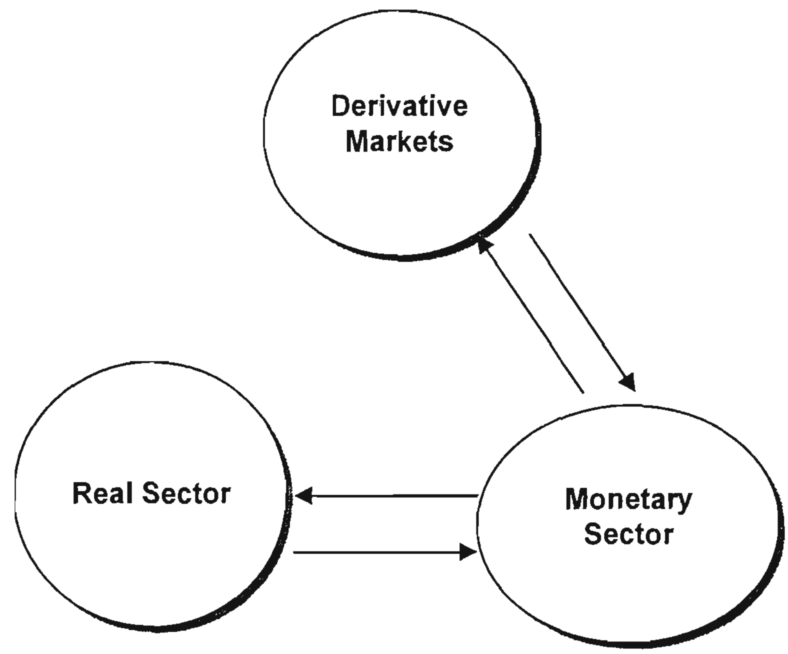


Figure 7.3: Indirect Relationship between Real Sector and the Monetary/Financial Sector

Since derivatives lead to more complete financial markets, by reducing market frictions, and thus act as important vehicle for price risk intermediation, without having any significant directs impacts on the real economy it is important that derivatives markets are not over regulated. For those who have benefited from the appropriate use of derivatives, regulatory restrictions could be costly and counter productive. Thus increased regulation of derivatives markets and products might undercut their ability to reallocate financial risks in the economy, especially when the absence of regulation in the over the counter markets has enabled them to intermediate risks in innovative ways.

7.2 Summary

This thesis investigates questions concerning the dramatic rise in the size and importance of derivative markets and how the emergence of derivatives markets impacted upon the transmission mechanism of monetary policy through reduced demand for money. The reduced impact of monetary aggregates reducing market imperfections ultimately making the real sector less sensitive to monetary sector changes. Derivatives serve as an alternate form of hedging strategy which market participants can use to protect themselves against any unexpected changes in interest rates and exchanges rates. As mentioned in Chapter 3 Derivatives reduce the level of uncertainty existing in the markets by making markets complete. Thus prices of the assets are a true reflection of the nature of monetary shocks in the economy. If agents can successfully hedge themselves from the policy shocks then it is possible that derivatives may have reduced the impact of monetary policy on the real economy.

Chapter 2 starts with an overview of the growth of global derivatives markets and outlines the major reasons that led to the proliferation of derivative instruments over the last two decades. The most notable trends in 2003 have been in terms of substantial growth in gross market values, and an increase in Over the Counter (OTC) derivatives. Some of the reasons explaining the growth can be attributed to factors like increased volatility and uncertainty in the world financial markets. Further, low transaction costs and increased market efficiency make derivatives an attractive tool for hedging interest rate risks. Increased computer technology and less regulatory barriers have also contributed to the growth of these instruments. The second half of Chapter 2 describes the different channels of the monetary policy transmission mechanism. An understanding of the various transmission processes is essential to analyse the impact of derivatives on the implementation of monetary policy. Changes in the financial markets of the economy or changes in the expectations concerning future policy can alter the economic effect of monetary policy. Different channels of monetary policy react differently to the presence of derivatives markets. Channels like inter-temporal effect and wealth effect theoretically show no change in the impact of monetary policy on the economy. Whereas, it is difficult to ascertain the impact on the exchange rate channel of increased derivatives trading. There are two opposing effects which have been identified with respect to the exchange rate channel. First, it can strengthen the exchange rate mechanism, due to increased asset substitutability any change in domestic and foreign interest rate, would produce larger changes in exchange rates because of derivative activity. Second, agents who are sensitive to exchange rate volatility are likely to hedge themselves from such exposure with increased activity in the derivatives markets rendering the channel weaker to any changes in policy stance. Thus, it is difficult to ascertain the impact of derivatives trading on the exchange rate channel. The income effect and the credit effect channels are the ones that show signs of weakening in terms of the impact of monetary policy. The study uses an inter-temporal substitution effect framework to emphasise the changes in income effect of monetary policy in the presence of derivatives markets. Changes in the credit channel have been highlighted with the magnification effect framework as developed by Oliner and Rudebusch (1995). The impact of derivatives may be different on different channels but all channels responded faster in the presence of derivatives markets.

Chapter 3 is an analysis of monetary policy and derivatives that suggests, derivatives have reduced the efficiency of monetary policy by influencing the financial markets. The thesis analyses the impact of derivatives on the real economy from two different viewpoints. The first is from the macroeconomic point of view where the impact of derivatives on the macroeconomy is analysed through changes in the transmissions channels of monetary policy. The second viewpoint is in terms of the impact of derivatives on the financial market itself. The question here is have the derivatives markets speeded up the transmission process of monetary policy just like equity markets?

The theoretical argument stems from the fact that derivatives serve to complete the markets, and provide information through more explicit prices. This makes it difficult to surprise the public, reducing the real policy effects. Some Central banks view this reduction of the real effects of their policies as an erosion of power and influence.

Theoretically, the presence of derivatives reduces the force of monetary policy on real economic activity and vise versa (that is a given amount of monetary stimulus will have a smaller effect) and increases the speed with which monetary policy is transmitted through the economy. So the conclusion is that money is neutral in a friction less economy just like the classical economists claim. But today's economies are exhibiting market imperfections. These imperfections can take the form of increased volatility, high transaction costs and informational asymmetries. The presence of these frictions leads to money playing a non-neutral role in the economy. Therefore, derivatives markets can also be non-neutral in their impact on the real sector. By reducing frictions, derivatives markets can reduce the real effects of monetary policy actions. Monetary policy shocks could be transmitted more rapidly through the economy in the presence of derivatives markets. If this is true empirically that it raises the question as to whether monetary policy will become a weaker tool for counter-cyclical stabilization? Having established the theoretical foundation of the likely impact of derivatives on real economy Chapter 6 develops an empirical model to test the above theoretical claim.

In Chapter 4 is a literature review of the research on monetary policy transmission process, financial innovations and their impact on the real sector. There is a general consensus from the empirical literature that in the long run there is a clear relationship between money, prices and output. Money growth and inflation essentially display a correlation. There is also general agreement on the impact of monetary policy on real economic activity in the short run. Exogenous monetary policy shocks produce hump shaped movements in real economic activity. These effects occur after a time lag and then slowly die out. There is however less consensus on the feedback effects of the monetary policy shocks. Different researchers view in different ways the channels through which monetary policy works. Views diverge even about the monetary transmission process in individual industrialised nations. Financial innovations tend to alter the impact of a given monetary policy measure. One such innovation is the growth of derivatives instruments. Therefore, there is a need to continuously reinterpret the channels of transmission of monetary policy especially in the light of sizeable derivatives market activity. It is important to conduct an empirical analysis of the likely impact of derivatives markets on the monetary policy transmission mechanism and hence its impact on real economic activity.

In order to carry out appropriate econometric testing of hypothesis relating the growth in derivatives markets to the transmission mechanism of monetary policy, Chapter 4 examined relevant econometric approaches suitable to this question. This Chapter also dealt with issues concerning the time series propositions of data relevant to this study. Following a consideration of the range of approaches available, it is clear that the use of a VAR model is the most suitable approach for this study.

Chapter 5 explains the nature of the VAR model and the SVAR method and analyses its various tools such as impulse response analysis and variance decomposition. The chapter introduces the four important variables in the model and establishes the time series properties in order that the results obtained are robust to the system.

In Chapter 6 an empirical testing of the macroeconomic relationship between the macroeconomic variables is conducted. VAR and SVAR systems have been used to measure the impact of derivatives markets on the real economic activity of the U.S. economy. Derivatives trading volume on the Chicago Board of Trade has been used as a proxy to measure the size of the derivatives markets. The impact on the real economy is measured by the real GDP and price level. The aim of this Chapter is to analyse the impact of derivatives markets, if any, on the monetary policy transmission mechanism and thus on the real economy. Theoretical analysis as explained in Chapter 2 does explain that derivatives markets should speed up the transmission mechanism of monetary policy by making markets complete. The empirical results strongly support the above theoretical claim as the impulse responses are less lagged in the sample period thus supporting the claim that monetary policy impacts the real economy faster in the presence of derivatives markets. To confirm the results an SVAR analysis is also conducted which gives identical results to that of the VAR system.

However, with regards to the second hypothesis as to whether derivatives markets change the transmission process of monetary policy and thus significantly impact the real economy, the results are ambiguous. Thus it can be concluded that derivatives markets have definitely affected the transmission of monetary policy in the sense that markets respond faster but the impact of derivatives on the real economy is marginal.

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