Credit, Asset Prices and Monetary Policy

A thesis submitted for the Degree of Doctor of Philosophy

by

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Abstract

The developments in asset markets have influenced researchers to focus on the interaction between monetary policy and the financial system. In Chapter 1 we provide an overview of the role of the financial system for the whole economy. We show the importance of this sector in transmitting the monetary policy actions.

The aim of this research is twofold; firstly we want to investigate how important the amount of credit for the whole economy is. To accomplish this objective, in Chapter 2 we make use of the VAR technique to study the monetary transmission mechanism. In particular we are interested in explaining why previous empirical research has found that prices show an increase after monetary tightening. We investigate how an unanticipated movement in the risk free interest rate affects all those variables responsible for the transmission of a monetary shock. Our results suggest that the immediate increase in prices is not due to some form of econometric misspecification, but rather to the change in the composition of firms' source of finance. Prices rise because the need for external funds increases, thus firms' costs of production increase.

Another important issue that we want to tackle is the contribution of external finance to the 1990 economic recession. In Chapter 3 we show that the increased level of indebtedness was one of the forces at the root of the economic downturn. We argue that the crisis could be explained on the basis of Minsky's financial instability hypothesis.

In the remaining part of this research we tackle the second aim of this research: we focus our attention on the link between asset prices and monetary policy. Asset prices, in fact, can give an indication of future consumers' and firms' decisions on spending and, therefore, might be indicators of future economic activity. Wealth deriving from gains in these markets tends to increase the level of consumption and investment. At the same time, sharp movements in asset prices could signal imbalances in the economy; developments of this kind can threaten financial stability. In Chapter 4 we argue there might be a trade-off between financial stability and monetary stability when these are the main objectives of the monetary authorities. First we explore the possibility that the demand equation is affected positively by changes in asset prices, secondly empirical findings suggest that for the period 1992:10-2003:1 monetary policy in the UK can be better represented by a rule which takes into consideration movements in house prices and stock prices.

The empirical evidence provided in Chapter 4 brings us in Chapter 5 to construct a macroeconomic model where the asset prices enter indirectly into the Central Bank's loss function. We model the aggregate demand of the economy so that output is determined, among other variables, by the wealth effect. The optimal interest rate rule is obtained by optimising intertemporally a loss function that includes inflation and output variance. We find that the optimal policy in the presence of wealth effects not only depends upon inflation and output, but also it depends on financial imbalances, as represented by asset price misalignments from fundamentals. The response to asset price deviations from fundamentals becomes more aggressive as wealth effects build up, while the reaction to inflation and the output gap becomes less pronounced.

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Introduction

For many years macroeconomic researchers looked at the economy as if the financial sector was not important. This idea was based on the Miller-Modigliani (MM, 1958) irrelevance theory. In a world characterised by perfect capital markets without uncertainty and frictions, financial structure is indeterminate and irrelevant for investment decisions. The MM proposition and the Neoclassical School that developed in the seventies led researchers to the notion that the financial system was "merely a veil", Fama (1980) in Hubbard (1994, p.3)

By the late 1980s, macroeconomists started to develop an interest in the financial system, its key role in the monetary transmission mechanism, and its being a vehicle of financial crisis. Although many differences still exist among researchers, there is a widespread consensus that the understanding of how the banking system and capital markets operate are of fundamental importance in formulating appropriate economic policies. We can identify two reasons for this change in interest. First of all, financial markets and instruments have had an exponential growth; in the developed economies this expansion started during the eighties and saw its full development during the nineties with the complete liberalisation of capital markets. The second reason lies in the fact that empirical analysis has never fully supported the notion of financial irrelevance.

This new interest, however, was just a revival of theories that many classic authors (Smith, 1891 and Bagehot, 1873 among the others) had already pointed out. Indeed economists were not new to the idea that financial markets are responsible for channelling funds from savers to producers and that fully efficient financial intermediaries reduce information cost and reduce the risk associated with each investment.

Although the vast majority of researchers seem to agree that financial markets are important in a capitalist economy, a consensus does not exist in explaining the role of financial markets in determining business cycle fluctuations. We can distinguish four different theories of the monetary transmission mechanism. The first is the so-called "money view": it refers to Keynes's theory that prices are not fully flexible; this implies that a monetary policy tightening increases the long term interest rate and the users' cost of capital; inducing a decrease in investment and consumption. This channel is conventionally incorporated in the traditional IS curve. Some authors (Benanke and Gertler, 1999 and Clarida and Gertler, 1995) have pointed out that macroeconomic fluctuations are much larger than those implied by this channel. This suggests that an alternative channel might be in operation along with the traditional interest rate.

One of these channels is the "credit view" or the "bank-lending" channel. The idea was first developed by Bernanke and Blinder (1988); they argue that banks are the main source of external finance for non-financial companies. A monetary policy tightening contracts the amount of reserves banks have available via a contractionary in demand deposits: this, in turn, causes a decrease in the supply of credit; the capital available to firms is, therefore, limited. The result will be contraction in investment and consequently output.

An alternative explanation is proposed by Bernake and Gertler (1999). They develop a model where capital markets are characterised by asymmetric information; this determines an important distinction between internal and external finance, though no distinction is made between different sources of external finance. A central role in this theory is covered by asset prices: they determine the value of the collateral against which producers and consumers are able to borrow. In an environment which departs from MM framework information costs determine a premium which is a function of the level of interest rate and the level of indebtedness; in the presence of falling collateral value the model predicts an increase in the premium borrowers have to pay. In such a model, monetary policy tightening increases the cost of capital more than proportionally: i.e. when monetary policy tightens, the supply curve becomes steeper. Thus, policy changes are magnified via a financial accelerator effect.

A fourth theory which places great importance on the value of asset price is the "broad money" channel. This model is built on the Modigliani (1963) life-cycle model of consumption and on the Tobin q. They emphasise how an increase in interest rate reduces the value of consumers' and firms wealth, inducing a reduction in the aggregate demand. An important point to stress is that all these channels do not work independently of each other but rather it would be a combination of these that determines the final level of output and inflation.

One important question that arises from the modern theories of the monetary transmission mechanism is whether policy makers should take into consideration asset price swings. Following Bernanke and Gertler (2001), large movements in asset prices are one of the major sources of fluctuations in output and inflation. The reason for this is that monetary policy has an immediate effect on the financial markets, and consequently, a direct impact on the value of the borrowers' collateral. It is well accepted in the literature that positive movements in the risk free interest rate (i.e. discount factor) would produce a negative movement in the value of asset prices. Thus, considering that the value of the collateral is determined by its price, monetary policy affects indirectly both the amount that the financial system is willing to lend, and the firms and consumers ability to borrow. Furthermore, if financial institutions incur losses because the level of collateral against which they lend declines, this could then lead to some degree of financial instability. There is yet another reason why Central Banks should take into consideration asset price inflation. Borio and Lowe (2002) suggest that even if an environment is characterised by monetary stability, this does not guarantee that the system is then immune from financial instability. They stress that the former is not a necessary and sufficient condition to prevent the latter: that what matters is financial imbalances. Typically, tensions in output and inflation first show up in the asset markets. Consequently Borio and Lowe advise central bankers to check the conditions of the financial market before formulating their policies.

Given the recent developments in macroeconomics, the purpose of this work is twofold: the first part empirically investigates the importance of the firms' external borrowing to output and inflation fluctuations in the presence of an unexpected change in the monetary policy instrument (Chapter 2[1]); and to study the impact of the credit on the 1990-92 UK recession (Chapter 3[2]). Secondly part of the research analyses the link between monetary policy setting and asset prices. It tackles the problem from two perspectives: first we investigate if UK monetary policy has reacted to asset prices movements in the last ten years (Chapter 4[3]), secondly, we build a structural macroeconomic model to explore how monetary policy should react in the presence of the wealth effect (Chapter5[4]).

In order to investigate how monetary policy shocks are transmitted to the real economy one of the most common econometric techniques is the Vector Autoregressive analysis (VAR). The usefulness of this technique relies on the possibility of distinguishing between a fundamental and a non-fundamental component. In practice, identifying the exogenous component of monetary policy is relatively straightforward. We can model the response of any macroeconomic variable to the identified shock by adding them to a VAR containing a set of core macroeconomic variables and a policy instrument. When VAR methods are employed, economic theory is used to choose both the block of non-policy variables

[1] Part of this chapter has benefited from comments at a seminar organized by the Department of Economics and Social Sciences at the University Federico II in Naples.

[2] I would like to thank Prof. Sheila Dow for the most valuable discussion about Minsky economic theory.

[3] This chapter has benefited from comments of the participants at the 6th International Conference on Macroeconomic Analysis and International Finance- Crete, Greece. Part of this is "Has Monetary Policy Reacted to Asset Price Movements? Evidence from the UK" (with A. Kontonikas), May 2002. This work is forthcoming in Ekonomia.

[4] Part of this chapter has been presented at 2nd European Conference in International Economics and Finance, Bologna, Italy with the paper entitled "Optimal Monetary Policy with Wealth Effect" (with A. Kontonikas) and at the 7th International Conference on Macroeconomic Analysis and International Finance- Crete, Greece with the paper entitled "Optimal Monetary Policy and Asset Prices Misalignment" (with A. Kontonikas). The paper is currently under review at The Manchester School I would like to thank Prof. Charles Goodhart for his most valuable comments.

and the appropriate policy instrument, and to choose the ordering of the variables[5]. Typically monetary policy shocks are identified as an unexpected change in the risk free interest rate. Chapter 2 suggests that many VAR analyses are frequently economically misspecified since the vector of non policy variables to which the Central Bank reacts is usually not correctly defined. Using variables in their levels rather than as a deviation from their target (when they exist) and from their natural levels generates *false* monetary policy innovations. We will specify our macroeconomic model as a Phillips curve, a demand equation and a Taylor rule.

Usually estimated VAR suggest the presence of a price puzzle: a persistent increase in the price level following a monetary policy tightening. Chapter 2 illustrates the increase in the price level is not the result of some form of misspecification: instead, a simple economic explanation can be found. The chapter will explore the responses of different variables that describe the monetary transmission mechanism to a policy shock. The results suggest that the so-called puzzle is the result of a change in a firms portfolio composition. This is equivalent to the consideration of monetary policy shocks as a source of cost-push inflation.

Another important issue arising from the modern theories which incorporate asymmetric information to explain output fluctuations is that they generate business cycle dynamics that are intrinsically non linear (Bernake and Gertler, 1999). The authors stress that the financial accelerator model propagates monetary shocks to the real economy. However, there is a further issue that is not fully addressed: accepting the notion that the economy is dominated by asymmetric information should conclude that the financial system can be itself a generator of instability of the system. This concept was first modelled by Minsky who stressed the pro-cyclicality of expectations. Chapter 3 links the new credit view with the notion of Minsky's Financial Instability Hypothesis. We test the possibility that the 1990-92 recession was the result of speculative dominated investment for the period preceding the crisis.

[5] There is an alternative way to investigate the problem. Romer and Romer (1989) propose a narrative approach; unfortunately it has little information, "it delivers few episodes of large policy actions, with no indication of their relative intensity" (Christiano, Eichenbaun, Evans, 1994 p.5).

The aim of chapter 4 is to explore if the Bank of England has reacted to price movements. We will estimate monetary policy reaction functions augmented by the nominal stock return and house price inflation. The evidence presented shows that since the introduction of the inflation target, the Central Bank has reacted to asset inflation. We find that greater weight has been placed on house prices than stock prices. We believe this reflects the British economic condition: a greater portion of wealth is locked into housing than stocks.

Previously highlighted was the point that modern theories of the monetary transmission mechanism place a great importance on the role of asset prices. Furthermore we observe that these prices are taken into consideration by the Bank of England, nevertheless one of the major areas of debate in the recent literature is how the Central Bank should react to asset price movements. We recall three different positions: 1) Bernake and Gertler (1999) stress that policy makers should ignore asset price movements if they do not effect inflation targets. 2) Goodhart (1999) emphasises how asset price inflation is as harmful as goods and services inflation, which brings him to the conclusion that Central Bank should use a broader measure of inflation; 3) Cecchetti *et al.* (2001) advocate a more systematic response to asset prices. They argue that a complex monetary policy rule is always superior, in terms of output and inflation volatility, to a simple one. Recently the debate has shifted towards a middle common ground: economists argue that monetary policy should not aggressively respond to asset prices and it should not try to burst a bubble. Rather, it should take account of asset prices fluctuations to the extent that they can provide information about the shocks affecting the economy, or have possible implications for output and inflation in the medium term, beyond the usual inflation targeting horizon.

Given the results obtained in Chapter 4 and the recent developments in the literature linking asset prices and monetary policy, in Chapter 5 we develop a structural macro model where asset prices enter directly the Aggregate Demand (AD) equation and indirectly the Central Bank loss function. One interesting aspect of this model is that we allow the asset prices to follow a partial adjustment, we account for momentum trading and revision toward the fundamentals to affect asset prices. Monetary authorities preferences are modelled exclusively in terms of inflation and output volatility. This allows for a monetary policy impulse to be transmitted to the real economy not only via the traditional interest rate channel but also via changes in asset prices: thus, monetary policy has a double effect on the level of output.

The derived result suggests that the monetary policy instrument does not only depend on inflation and demand pressures, as standard in the Taylor rule literature, but also on financial imbalances, as represented by asset price misalignments from fundamentals. The magnitude of the policy reaction to this misalignment is conditional to the importance of the wealth effect on the Aggregate Demand. Thus, monetary policy becomes more aggressive towards the deviations from fundamentals in the financial markets when the wealth effects build up. It is important to stress, however, that our result does not necessarily imply a tighter monetary policy, since when asset prices misalignments enter into the optimal interest rate, the weights attached to output and inflation decrease. Instead, the result calls for an independent assessment of financial instability (i.e. systemic risk) within the interest rate setting process. In the end we recognize that monetary authorities face a high level of uncertainty about the existence of bubbles and asset prices true fundamental value, so the final monetary policy would necessarily be a matter of judgement; in some cases activist policies are necessary, and in others, such a response would be counter productive.

In concluding, this thesis intends to provide an in depth understanding of the monetary transmission mechanism with particular emphasis on the notion that financial factors may cause or reinforce real fluctuations. Furthermore this thesis intends to shed some light on monetary policy setting in an environment where economic agents' decisions are strongly affected by financial markets behaviour.

Chapter 1

Financial markets, the monetary transmission mechanism and the real economy

1.1 Introduction

The importance of bank credit as a central factor in the monetary transmission mechanism has always been recognised because monetary policy operates through banking sector. However, in the last decades we have observed an increased importance of this topic within monetary economics. There are several factors that can explain why economic researchers have been focusing on financial markets. In recent economic crises, bank credit appeared as the main reason for economic instability. Japan, Latin America, Asia: all have experienced major problems in their banking sector that coincided with severe recession. Secondly following the financial deregulation and the increased globalization of capital markets since the early eighties, all major economies have registered an increase in asset prices and in the amount of external finance available to firms and households.

The problem that we are going to analyse is perfectly described by Walsh (1998, p.314):

> "If the credit channels are important for the monetary transmission process, then evolution in financial markets, whether due to changes in regulations or to financial innovations, may change the manner in which monetary policy affects the real economy. It also implies that the level of real interest rate may not provide a sufficient indicator of the stance of the monetary policy. And credit shocks may have played an independent role in creating economic fluctuations"

Further, according to Gray and Stone (1999) there is a close link between macroeconomic development –stability- and corporate sector. If corporations are highly leveraged an increase in interest rate might raise the risk premium in such a way as to magnify economic downturn, rapidly moving the economy into deep recession. Moreover, the increasing rate of corporate failure might push the government to divert funds toward bank recapitalization. The broad credit channel suggests that the higher the level of indebtedness and the higher the level of interest rate the greater the risk of asymmetric information, and therefore, the cost of capital would be higher, which illustrates the possibility that a tight monetary policy could

result in credit rationing. According to the asset price channel what we should look at is the relative price of financial and real assets.
Both, the broad credit channel and the asset prices channel, underline that movements in assets prices are likely to have a real effect on the economy since they directly affect the capacity of households and firms to borrow.

This said, monetary policy should be thought of not only as a promoter of monetary stability (stability in the general price level), but also as a promoter of financial stability, where the latter is refers to stability in the financial system (markets and institutions); thus, financial stability is a public good, and monetary authorities should consider it as an important goal of their policies (Mishkin, 1996 and Crockett, 1997).

The reminder of this chapter is organised as follows. In the next section we present the role of the financial system in capitalist economies. In the second part we move to a detailed discussion of the monetary transmission mechanism confronting different views, namely money view, bank lending channel and broad credit (asset price) channel. We highlight how the monetary policy propagates through the financial system before affecting real variables. In section 1.5 we will discuss the link between monetary policy and asset prices, highlighting the reason why Central Banks might wish to respond to asset prices movements. We run some correlation tests and we estimate an augmented Phillips curve equation in order to test whether current inflation is affected by past asset prices. Section 6 presents the conclusion.

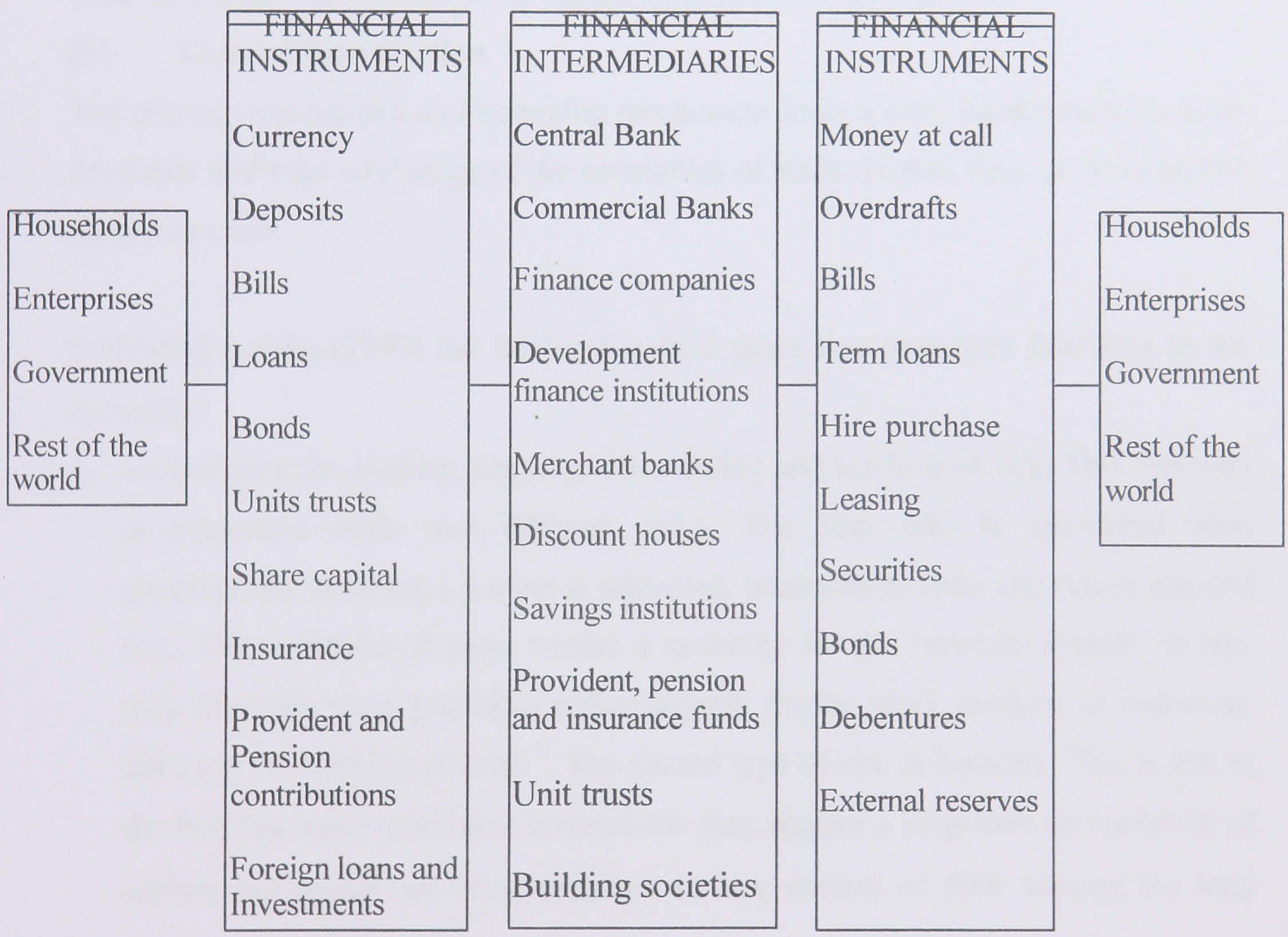
1.2 The financial system and the economy

The role of financial intermediaries is to channel funds (savings) from savers to investors. The figure below illustrates the flow of funds in an economy with a relatively developed financial system. With the term 'financial intermediaries', we identify all those institutions which collect savings. They transfer funds from units (mainly households, enterprises) which present surplus of funds to those units that require funds for their investments. This intermediary position gives them a key role in economic growth. Indeed, the more developed this sector, the more efficiently the funds are channelled into more productive and less risky projects. Figure 1 gives a representation of the interaction between surplus and deficit units.

Figure 1.1: Funds in an economy with a relatively developed financial system.

SOURCE OF FUNDS **USES OF FUNDS**

Savings from surplus Units *Investments/Expenditures deficit units*



Sourse: Bank Negara (1995 p.86).

Financial intermediaries transform savings into investments by repackaging wealth and transferring capital and information. As shall be illustrated, information is the central word when we speak about the capital market. Indeed these kinds of markets are different from that of commodity because they involve "delivery in the future and the future is always uncertain" (Fry, 1995 p.62). A central point, which has to be focused on, is that financial intermediaries do not grow in an Arrow-Debreu environment[6]. In fact markets are dominated by two kinds of frictions (i.e. high costs):

(i) Asymmetric Information

When there is a channelling of funds from savers (lenders) to investors (borrowers), adverse selection and moral hazard problems arise. This is because lenders and borrowers have different information regarding the nature and the practicability of the financed project. This refers to the asymmetric information problem.

(ii) Transactions friction

The pooling-mechanism and screening mechanism have a cost. Banks exercise these functions and take advantage of the economies of scale. Hence, they grow to reduce these two costs.

Following Levine (1997) the financial system plays five important functions in the economy:

1. To facilitate the trading, hedging, diversifying and pooling of risk. This function is associated with two different risks. The first risk is associated with uncertainties to which a project is subjected: productivity risks and future demand risk. The existence of these creates a necessity for the financial system. Savers may diversify their portfolios either directly (in the stock market) or indirectly (through the banking system)[7]. The second type of risk is liquidity. This is due to the fact that many profitable investments may require a long-term commitment of capital, but agents are often reluctant to lose control of their savings for long

[6] In an Arrow-Debreu environment all the states of nature are covered by the pay-off of the securities available.

[7] Obsfeild (1994) points out financial markets can diversify the risk at an international level.

periods of time. The existence of financial markets, which allow agents to avoid liquidity shocks, can have a positive impact on the level of savings[8].

2. To allocate resources. This function is linked with the ability of financial institutions to gather information among different available projects. This allows the channelling of savings into the most profitable investments adjusted for the level of risk.
3. To monitor managers and exert corporate control. This function suggests to us that the financial system can reduce the risk of moral hazard. Banking and other intermediary institutions monitor the project during the life of the loan in order to prevent a bad utilisation of the funds. This function is also referred to as the 'screening-mechanism'.
4. To mobilise savings. The presence of efficient financial institutions may improve the willingness of the savers to transfer their surplus into deficit units. Usually, the existence of an insurance mechanism at a government level facilitates this function[9].
5. To facilitate the exchange of goods and services. This basic function refers to the payment system. In fact, a necessary condition for economic growth is the exchange mechanism. Hence, the monetisation of the economies needs an efficient financial system.

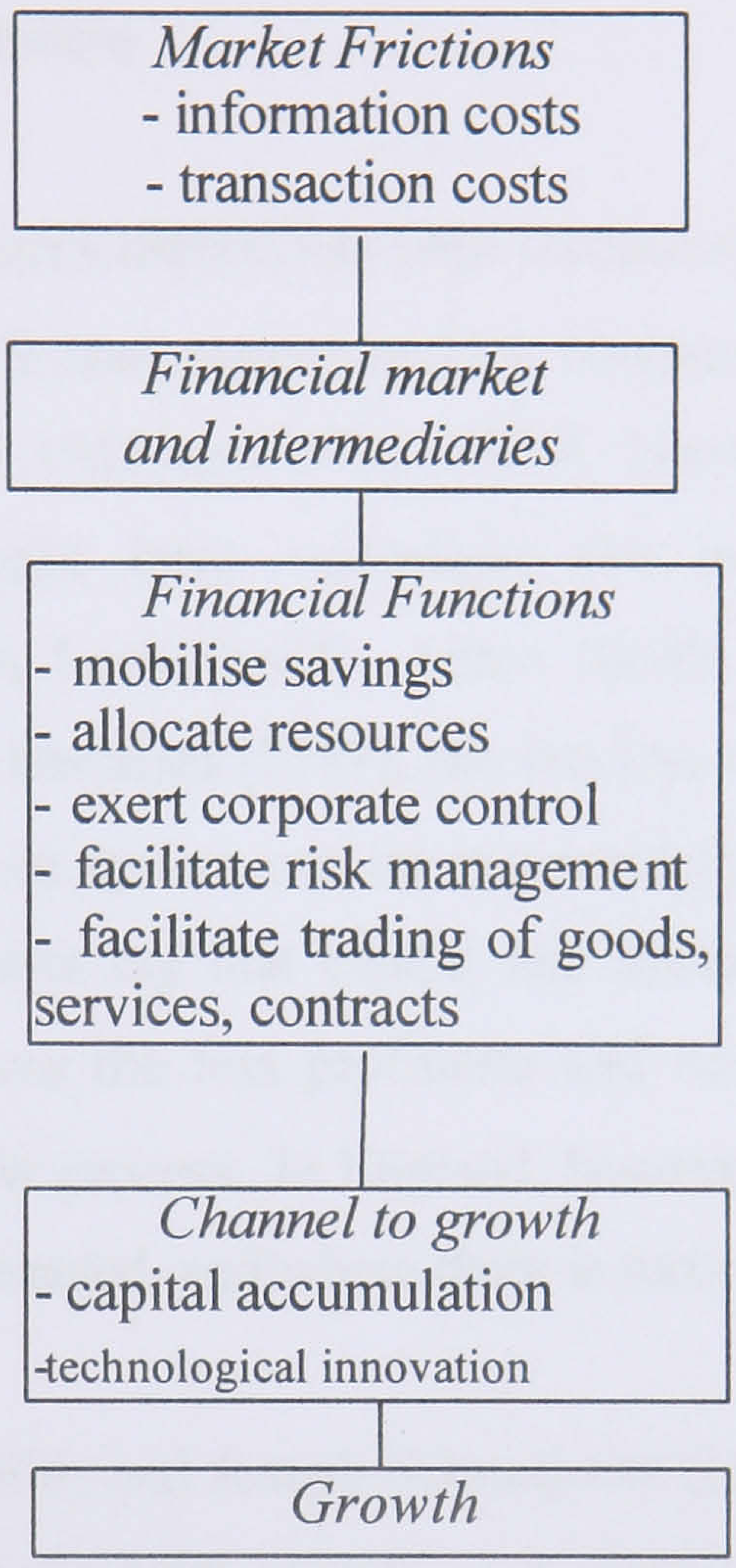
These five functions point out how important the role of the financial sector is. Uncertainty and instability in this sector of the economy would have a negative impact on the productive units and on the level of saving.

Figure 2 shows how financial markets can be the vehicle to promote economic growth.

[8] An example ofhow this institutions work can be found in the stock market crash in the October 1987. Investors feared a credit squeeze on broker-dealer in the credit market. Before the stock market opened for trading the following day the FED announced that it was ready to provide liquidity in support of the economic and financial system.

[9] An example is the Central Banks as Lender of Last Resort to prevent 'bank runs'.

Figure 1.2: A Theoretical Approach to Finance and Growth.



Source: Levine (1997, p. 691)

Again following Levine (1997) we can recognize two channels through which the financial system exercises its influence on economic activity:

a) Capital accumulation. The financial system can modify the level of savings in the economy or it can reallocate savings among different users, choosing the more profitable investment among the different levels of risk[10].

b) Technological change. The intermediary system may alter the steady-state growth by modifying the rate of technological innovation[11]. Capital markets allow the reduction of profitability shocks. This facilitates investments into more productive and specialised technologies even if such investments more risky.

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[10] In reality, as we will present later in the chapter, under particular circumstances financial institutions may ration the credit and prevent a Pareto-efficient allocation of resources.
[11] Pagano (1993).

1.2.1 A brief historical overview

The importance of financial intermediation has been recognised since the last century. It has its root in the Banking School represented by Thomas Tooke, John Fullarton and John Stuart Mill (Cramp, 1962 and Wray, 1990). Nevertheless, other authors outside this school of thought have underlined the importance of financial intermediation. They are John Looke(1665), Adam Smith (1776, IV book of his "Wealth of Nations"), Jeremy Bentham (1787), Bhohm-Baweark (1891). What these authors think about the financial system can be expressed through Bagehot ([1873] 1991, p.6): "Political economists say that capital sets towards the most profitable trade, and that it rapidly leaves the less profitable and non-paying trades. But in ordinary countries this is a slow process...In England, however, capital runs as surely and instantly where it is most wanted, and where there is most to be made of it"

More recently, John Hicks (1969) and Joseph Schumpeter ([1912] 1936) pointed out that the development of the financial system is a necessary condition to boost economic growth. Studying the English industrial revolution, the former concludes that "the industrial revolution has to wait for the financial revolution" to convert ideas into marketable goods. The latter wrote: "The banker...stands between those who wish to form new combinations and the possessors of productive means...He makes possible the carrying out of new combinations, authorises people, in the name of society as it were, to form them"(p.74). And then, "the essential function of credit...consists in enabling the entrepreneur to withdraw the producers' goods which he needs from their previous employment, by exercising a demand for them, and thereby to force the economic system into new channels" (p.106).

Three other authors who present a deep analysis of the correlation between financial and economic development are Goldsmith (1969), McKinnon (1973) and Shaw (1973). These researchers present a different view on how finance effects economic growth. The first found a relationship between financial development and the efficiency of investment; the other two authors focus their attention on the credit supply process as opposed to the money supply process. Gurley and Shaw (1973) argue that what matters is the economy overall financial capacity. This is the borrower's ability to absorb debt without having to reduce the level of spending commitment; in this framework financial intermediaries are important because they extend the borrower's financial capacity. In their view, financial liberalisation plays a key role in increasing savings, investment and hence, growth.

In the same period, Minsky (1975) and Kindleberg (1978) explained how business cycles could be driven by financial factors. Minsky's analysis stresses the relationship between credit market and firms behaviour at a micro level. In his Financial Instability Hypothesis, he suggests that money and finance have a real significance; their significance is not limited to determining the price level, as in the monetarist account, but they can cause unemployment.

Despite all these studies for a long time a broad part of the literature has ignored the importance of financial systems in the macroeconomic environment[12]. According to Gertler (1988) we can identify four different reasons for this:

1. For a long part of this century, macroeconomic analysis has been represented by the Hickesian IS/LM model. This model is indeed constructed by considering a world with two assets: money and bonds. Clearly the credit and its market are omitted in this framework (Blinder and Stiglitz, 1983, Bernake and Blinder, 1988 and 1992). The natural consequence is that the model does not capture the force of economic intermediaries in fostering the economic activity. In Keynes 's "General Theory" the focus is on the link between money and real activity, considering the equilibrium in the money market as the result of a fixed money supply that could not adjust to changes in money demand. Besides, the importance of money was emphasised by Friedman and Shwartz (1963) in their

[12] In Lucas, for example, the importance of the financial system is over-stressed (Lucas, 1988).

monetary history of the United States. This work marked an important step for the macroeconomists who followed. What distinguishes the Gurley and Shaw viewpoint from these interpretations is that they underline the importance of "financial capacity" rather than the quantity of money[13].

2. During 1958, Miller and Modigliani (MM) proposed a theorem where real economic decisions did not depend upon the financial structure[14]. The elegant mathematical framework appeared more rigorous than the Gurley and Shaw approach. However, the environment in which MM developed their theorem was completely different from that of GS.

   The latter formed their theorem on the assumptions that there are no perfect capital markets. Moreover, the irrelevance of the MM theorem in modern finance can be see in the words of Robinson and Wrigthsman (1980)[15]: "The main lessons learned by the survivors of the 1970s bankruptcy wave are (1) to go easy on debt financing when operating earnings are unstable, (2) to go easy on short-term borrowing when operating assets are illiquid, and (3) to pay more attention to expected cash flow and bank balances than to reported earnings and assets".

3. The introduction of VAR (Vector Autoregressive) moved researchers interests to the quantity of money as the central factor of economic activity. These studies were supposed to find empirical evidence to support the monetarist propositions. First the interest was in finding a causal relationship between money and output *á la* Friedman and Schwartz (1963). They investigated the historical relationship between money and output; their investigation focused the attention on the role of money, this was found to be highly correlated with output. This work became the

[13] This interpretation of Keynes is misleading and incomplete. According to post-Keynesian school, in his articles in the Economic Journal (1937-39) Keynes recognises the credit-money dichotomy as central factor to the modern capitalism. Rochon (1999, p.11) states that those articles are "a whole new book with insight and approaches for a theory of a capitalist economy of production, and for a money theory [...] the finance motive which Keynes developed in the *Economic Journal* articles invalidates the *General Theory* in many respects."

[14] Fama (1980) applied this theorem to bank portfolios. His finding was that "the financial system is merely a veil" Hubbard (1994, p.3).

[15] Quoted in Davies (1992, p.30).

cornerstone of the monetarist analysis. Then, following Barro (1977, 1978), the analysis focused on the distinction between anticipated and unanticipated money and its causality with output. There are two critiques of this type of investigation:

i) As suggested in many studies[16] "interest rate tends to absorb the power of money" Bernanke and Blinder (1992). Therefore, studies conducted using monetary aggregates as an instrument of monetary policy might be seen as inconclusive.

ii) Analysing monetary aggregates the distinction between credit and money falls[17]. Indeed, broad measures of money include money and credit, but a perfect understanding and distinction between the two is essential in order to understand a capitalist economy. Money and credit are not equal. "Credit is not a component of the demand for money" Rochon (1999, p.53). As emphasised by Palley (1996) money is a medium of transaction, while credit must be thought of as a medium of production. Rochon (1999) speaks of credit as an *ex ante* variable that drives the entire economic system. Credit is important because it determines the level of production and activity[18]. On the other hand money is an *ex post* variable. It exists because credit has been used and destroyed during the stages of production.

4. Following the work of Kydland and Prescott (1982) and Long and Plosser (1983) mainstream economics became neoclassical macroeconomics. This led economists to build a series of real business cycle models where output was entirely driven by changes in preferences and supply shocks. Neither the monetary nor the fiscal forces were assumed to play a central role in the analysis[19]. Of those models which modelled explicitly the monetary sector, none was able to obtain real effects from monetary forces. King and Plosser (1984) presented a formal treatment of the analysis. They reached the conclusion that outside money –the liabilities of the

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[16] Sims (1980), Bernanke and Blinder (1992), McCallum (1983), Svenson (1997), Taylor (1999)

[17] This notion follows the Post Keynesian theory, where the distinction between money and credit is essential to explain the endogenous money theory.

[18] There is a lively debate among the money supply. For the New Keynesian school the money supply is determined by the supply of credit while for the Post Keynesian it is determined by the demand for credit.

[19] Kydland and Plosser (1982).

Federal Reserve Bank, the monetary base- has a high correlation with price level; furthermore, inside money –monetary aggregates, such as M1 and M2, that represent the liabilities of the financial system- where responsible for output fluctuation. Their interpretation was that much of economic process fluctuations were determining (endogenously) the response of the banking system, and therefore of monetary aggregates.

With new theoretical and empirical development, macroeconomists seem to have turned their attention towards the financial system and its key role in the monetary transmission mechanism, and its being a vehicle of financial crisis. On the theoretical side we observe the development in economics of information and incentives where the basic insight is that inefficiencies in trade and in the allocation of capital could be the result of asymmetry of information between the contractual parts. Moreover, the empirical work presented by Sims (1980) start questioning the fact that the business cycle was driven entirely by money; other factor appeared to be important.

Although many differences still exist among researchers, there is a widespread consensus that the understanding of how the banking system and capital markets operate are of fundamental importance in formulating appropriate economic policies.

1.3 The monetary transmission mechanism

In the previous section we gave a general overview of the importance of the financial sector on overall economic activity. In this section we will critically present how capital markets can have a decisive impact in transmitting monetary policy actions.

We start by defining the monetary transmission mechanism as the process through which monetary policy affects the economy; more specifically, income and inflation. Different views have been expressed in the literature. They differ on the emphasis they place on money, credit, interest rates, asset prices or the role of commercial banks and other financial institutions[20]. In the last decades various models have been proposed, but so far none of them has been able to gather all the different channels through: which the monetary policy might operate. Three channels emerge from the literature: namely, Money channel, Credit channel and Asset Price channel. Further empirical evidence does not help in solving this puzzle. As we will show below, the results obtained using micro and macroeconomic data are contrasting.

1.3.1 Money Channel

The money channel is generally accepted as the channel that operates through the interest rate[21]. It asserts that what matters in the monetary transmission mechanism are banks liabilities. More specifically, what matters is a decline in money supply, through a reduction in banks reserves or issues of bonds which will cause a reduction in the real money balances. Since the demand for money is not changed, this will cause a rise in interest rate in order to restore the equilibrium in the money market. With an increased interest rate (cost of capital) it will follow a decline in investments[22], and consequently of the aggregate demand and output. Using a general IS/LM model a contractionary monetary policy will shift the LM curve up to the left.

More analytically the equilibrium in the money market can be expressed as:

$$\overline{M} = L(y, i) \tag{1.1}$$

where y is real income and i is the domestic rate of interest. The left-hand side of the equation represent a fully exogenous money supply; while the right-hand side is the

[20] Mishkin (1996) and Cecchetti (1995),

[21] Some authors refer to this as the traditional Keynesian channel. However, this is a misinterpretation of Keynes writings. Davidson (1994) presents an extended analysis on this issue. Erturk (2001) proposes a Keynesian model with asset prices and liquidity preference.

[22] It is usually assumed, for simplicity, that only the level of firms investments decline; however, this increase in the level of interest rate causes a reduction in households consumption, particularly for durable goods and housing.

demand for money which is positive with respect to output and negative related to the level of interest rate.

The equilibrium in the goods market requires that savings (*S*) is equal to Investment (*I*). We can write the saving and the investment functions as:

Saving: $S = a_0 + a_1 y + a_2 i$ $\quad a_0 < 0,\ 0 < a_1 < 1,\ a_2 > 0$ (1.2)

Investment: $I = b_0 + b_1 i$ $\quad b_0 > 0,\ b_1 < 0$ (1.3)

Equating (1.2) and (1.3) so that $I = S$, and solving for *i*, we obtain the level of interest rate as required in the goods market.

$$i = \lambda_0 + \lambda_1 y \tag{1.4}$$

Where $\lambda_0 = \frac{a_0 - b_0}{b_1 - a_2}$, and $\lambda_1 = \frac{a_1}{b_1 - a_2}$

The equilibrium in the whole system is then determined by the interaction of the two functions:

$$y = \frac{l_2 a_1 + (b_1 - a_2) l_1}{l_2 (b_1 - a_2)} + \frac{1}{l_1 + \left(\frac{a_1 f_2}{b_1 - a_2}\right)} M \tag{1.5}$$

From Eq. (1.5) it is clear that every change in the money supply affects the level of economic activity through the slopes of the IS-LM curves. We can represent the money channel is the following way:

$$\Delta M \Rightarrow \Delta i \Rightarrow \Delta I \Rightarrow \Delta y \tag{1.6}$$

There are some important assumptions underlying this model. First of all prices are assumed to be sticky, i.e. they do not adjust immediately. Secondly, the supply of money is exogenously determined; as expressed in Eq (1.1), monetary authorities are in full control of the amount of money in the economy. Thirdly, bank loans and bonds are perfect substitutes. Using the Walrasian Law the bond market is in equilibrium, implying that the credit is ignored in this standard framework. There are three important implications: i) financial intermediaries offer no special services on the asset side (credits), ii) it makes no difference which type of assets banks hold, iii) it makes no difference whether firms borrow from banks or from an auction market (corporate bonds market). This last implication is strictly linked with the third assumption of the model: borrowers are treated as homogenous; lenders do not distinguish between net-worthy customer and the heavily indebted ones.

Empirical test for the interest rate channel are usually made regressing the changing output gap (y), against the change in the high-employment budget surplus (n) and a short term interest rate.

$$y_t = \beta_1 + \beta_2 y_{t-i} + \beta_3 n_{t-i} + \beta_4 i_{t-i} \tag{1.7}$$

where the parameters on n and on i are assumed to be negative. Using quarterly data, Perry and Schultze (1992), find that movements of output are significantly explained by change in the short term interest rate. However Morgan (1993) highlights how output might respond asymmetrically to an increase or a decrease in short term interest rate. In fact they obtain large negative errors during recessions.

One key point of the interest channel is that a movement in short-term interest rate, i.e. a change in the monetary policy instrument, is assumed to affect directly[23] the real long-term interest rate used for investment and saving decisions. Testing for the money view is, therefore, a joint test for the term structure of interest rate. Model and empirical studies on this part of literature are highly debated. There is no obvious a priori explanation of movements in long-term interest rates. Estrella and Hardouvelis

[23] The implicit assumption is that monetary policy operates in an environment dominated by rational expectation and sticky prices.

(1990) find a positive relationship between the Federal Fund Rate and the ten years Treasury Bills[24].

Another problem with the interest rate channel is the *timing* between the change in monetary policy and its effect on the real activity. According to Bernanke and Gertler (1995) the effect of a monetary policy shock on interest rate is transitory, while some components of GDP do not change until after the interest rate returns to its trend value, eight to nine months after the shock occurred. Moreover, they find that inventories rise in the first quarter following a monetary contraction, while business fixed investment has a pronounced decline between six and twenty four months after the monetary tightening. Again, following Bernanke and Gertler (1995, p.34), the money view has a further problem "in the *composition* of the spending effect. Because monetary policy has its most direct effect on short-term rates, it would seem that is should have its most significant impact on spending on assets with shorter lives [...] yet the most rapid effect of monetary policy is on residential investment [...] (that) are typically very long-lived and thus (according to the conventional view) should be more sensitive to long-term rates most directly influenced by the FED". Other studies[25] have found that initially inventories seem to increase after an increase in interest rates.

Concluding, this view seems to be incomplete rather than incorrect since it does not capture the "distributional, or cross-sectional, responses to policy actions, nor of aggregate implications of this heterogeneity" (Hubbard 1994, p.6)

1.3.2 Credit View

This channel of the monetary policy has been developed since the observation that persistent and large reductions in aggregate demand follow an increase in the short

[24] Ioannidis and Peel (2003) state that the predictive power of interest rate changes accordingly with the monetary regime adopted by the monetary authorities
[25] Blinder and Mancini (1991).

'term interest rate. As underlined by Bernarke and Gertler (1995, p.27) "empirical studies of supposedly 'interest-sensitive' components of aggregate spending have in fact had great difficulty in identifying a quantitatively important effect of the neoclassical cost-of-capital variable".

The credit view emphasises how 'frictions', such as asymmetric information and costly enforcement of contracts, create agency problems in financial markets. In such an economic environment a wedge between the perceived cost of credit for the firm and the market interest rate arises, and some projects that would earn the market rate of return are not realised. As we will illustrate later, great emphasis is on the role of firms' net worth and on the role of the collateral. The credit view thus implies that the effect of monetary policy could be inefficient by foregoing valuable investment opportunities and moreover, could have distributional consequences by affecting predominantly firms that are subject to asymmetric information problems. In this framework we can recognise two important assumptions:

A) Prices do not adjust instantaneously to offset changes in the (nominal) quantity of money. In this view prices must be considered as downward sticky, otherwise an increase/reduction in nominal banks reserves can be entirely compensated by a reduction/increase in prices[26].
B) The supply of money is credit-driven. High-powered money and bank deposits determine the supply of loanable funds. In other words the supply of money is exogenous.

In the literature[27] the credit channel is split in two sections. For both of them the starting point is an exogenous fall in money supply. From this point the two channels diverge. The narrow credit channel focuses on what happen to banks assets (loans), and their importance because of the imperfect sustainability between bank credit and other form of financing. On the other hand, the analysis carried on by the broad credit channel has a wider spectrum. It highlights the firms' costs of external financing.

[26]The New Keynesian view accepts the notion of money neutrality, although in the long run.
[27] This literature is referred as the New Keynesian School.

Given imperfect capital markets, financial institutions sustain a cost in monitoring and evaluating the creditor. This raises an external finance premium.

- *Bank lending channel (narrow credit channel)*[28]. In most economies, banks are essential providers of liquidity and external investment finance for households and entrepreneurs: "If the supply of bank loans is disrupted for some reason, bank dependent borrowers [...] may not be literally shut off from credit, but they are virtually certain to incur costs associated with finding a new lender, establishing a new credit relationship, and so on" (Bernanke and Gertler, 1995 p.40). Therefore a contractionary monetary policy, which decreases bank reserves causing a drastic reduction in the availability of credit, is bound to increase the cost of external finance. It will have an impact through its effect on the overall economic activity, but especially on small firms. The key point to understand is that the bank-lending channel operates given the assumption that there is a lack of close substitutes for deposit on the liabilities side of banking sector's balance sheet and the lack of close substitutes for bank credit for the productive sector (firms) and for consumers. Producers and households are assumed to be financially constrained; they cannot substitute bank loans with other form of credit. In such a world of imperfect capital market, banks play a special role in the credit intermediation. Traditionally banks have specialised in information-gathering activities. Such institutions, over time, have developed knowledge specific to their own borrowers. Particularly of those borrowers that are their own customers, they have been able to observe the borrowers deposit flow (Fama, 1980). This allows banks to reduce the asymmetric problem and offer lower premia on interest rates.

There are two key assumptions regarding the bank lending view:

1. The Central Bank can directly influence the volume of credit by adjusting bank reserves. As stated before the money supply is entirely supply determined. 2a) Banks cannot shield their loan portfolio from changes in monetary policy; 2b) Borrowers

[28] This strand of literature starts with Bernanke (1983), who analyses the impact of banking on the Great Depression. He argues that because banks have the crucial role of gathering information and channelling funds, banks failures played a major role in magnifying the output changes in the early 1930s in the United States.

cannot fully insulate their real spending from changes in the availability of bank credit.

2. Bank loans and securities are imperfect substitutes both for borrowers and for banks.

The 'stepping stone' macroeconomic model which formally explains the effect of bank credit in the economy was presented by Bernanke and Blinder (BB, 1988). The base model is an extension of the traditional IS/LM model. The main feature is that the ecormy is composed of three asset: money, bonds and loans; where bond and money are not perfect substitutes. The loan demand is determined by[29]: $L^d\left(r_{B_+}; r_{L_-}; y_t\right)$, where: r_B is the interest rate on bonds; r_L is the interest rate on bank loans; y is the household income. It will increase when the interest rate on bonds will increase and *vice versa* for the interest rate on loans. The level of income enters this function to explain that part of loans that is required for "working capital or liquidity considerations" (BB 1988 p.435). The bank balance sheet is now composed of three assets: Reserves (R), Bonds (B^b) and Loans (L^b); while liabilities are determined by the level of Deposit (D) as follows:

$$R + B^b + L^b = D \tag{1.8}$$

The level of reserves is given by required reserves (ρD, where ρ is the reserve rate), plus excess reserves (E). Rearranging Eq. (1.8) we obtain:

$$B^b + L^b + E = D\left(1-\rho\right) \tag{1.9}$$

With the excess reserves assumed to be zero (they do not affect the portfolio decision of the bank), it is easily shown that the supply of loans (L^s) will be determined by the return on bonds and on the return on loans after the reserve requirements are satisfied.

[29] The subscripts + and - refer to the postulated signs of the partial derivatives.

$$L^s = \eta(r_{B_-}; r_{L_+}) D(1-\rho) \quad (1.10)$$

The equilibrium in the credit market is reached when loan demand is equal to the supply of loans, therefore:

$$L^d\left(r_{B_-}; r_{L_+}; y_+\right) = \eta\left(r_B; r_L\right) D(1-\rho) \quad (1.11)$$

The equilibrium in the money market is given by the traditional IS/LM model[30]. What is modified in the BB model is the IS curve. In an economy with three assets the firms have two forms of financing. They can either use the bond market or alternatively they can borrow from banks. The investment decision is not taken considering only one interest rate, but considering the two interest rates (the prices of the two source of financing). Following BB the IS curve is determined by the intersection of the following two equations:

The equilibrium in the good market: $I\left(r_{B_-}; r_{L_-}\right) = s\left(y_+; r_{L_+}\right)$ (1.12)

The equilibrium in the credit market: $L^d\left(r_{B_+}; r_{L_-}; y_+\right) = \eta\left(r_{B_-}; r_{L_+}\right) D(1-\rho)$ (1.13)

Using the signs of the partial derivatives, from the two *equilibria* it is possible to obtain the level of the interest rate on loans as function or r_B, y and R: $r_L = \vartheta\left(r_{B_+}, R_-\right)$. Thus substituting the defined level of interest rate in the goods market equilibrium, we get:

$$I\left(r_B; \beta\left(r_B; R\right)\right) = S\left(y; r_B\right) \quad (1.14)$$

which can be solved to obtain the Commodities and Credit curve (CC) described by Barnanke and Blinder.

---

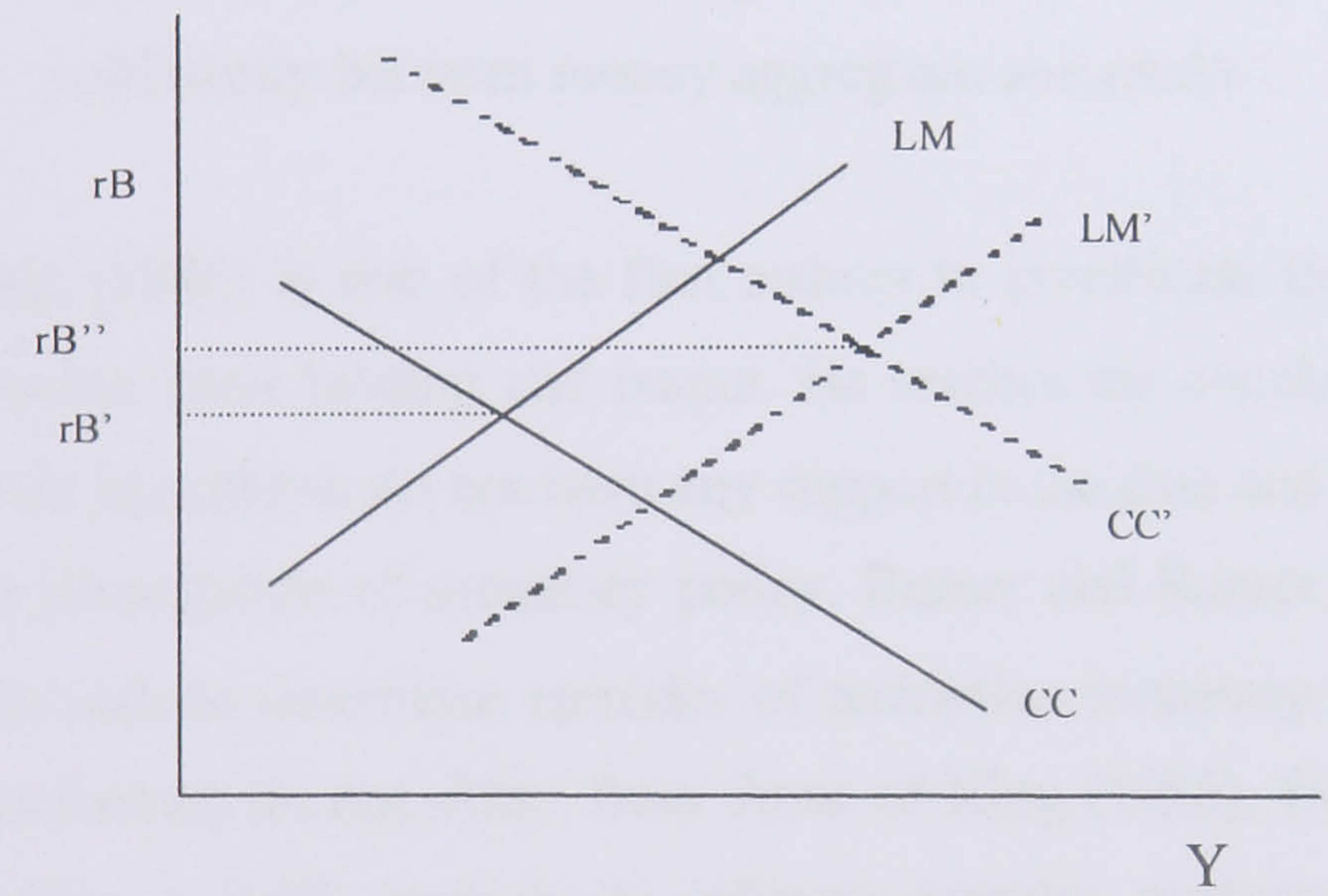
[30] As in Eq. (1.1), money supply is assumed to be exogenous in the system.

$$y = Y(r_B, \beta(r_B; y; R)) \quad (1.15)$$

As discussed by BB, the CC curve is negatively sloped like the traditional IS curve, but it can be shifted by a change in monetary policy (*R*), by a shock in the credit market which affects either the demand or the supply for loans.

The figure below illustrates an expansion in the supply of reserves. As previously stated, not only does this have an impact on the LM curve, as it does in the traditional IS/LM model, but it also causes a outward movement in the CC curve.

Figure 1.3: The Bank Lending Channel



This result has some important implications:

1) Monetary policy matters. The level of the bank reserves enters directly in the goods market equilibrium. This means that a less tight monetary policy (low level or reserves requirement) increases the credit supply. The LM curve and the CC curve shifts to the right, given that more credit is available to the economy. This has the effect of increasing the level of output but, at the same time, raises the interest rate. This increase in interest rate is the first significant difference

from the traditional analysis.

2) The CC curve captures the credit-market shocks, either on the demand side, $L^d(.)$, or in the supply side, $L^s(.)$. A decrease in the risk of loans may represent a shock in the supply side. The interest rate on loans will decrease and this effect will be reflected entirely on the CC curve. The level of output and interest rate will increase. A shock on the demand side will ha ve exactly the opposite effect.

3) In the credit view, the Central Bank should monitor carefully the level of credit in the economy. Money, the rate of interest and credit should be the financial variables that the Central Bank must observe in order to predict future economic developments. It is on this third point that researchers have differing opinions because monitoring credit is not an easy task: in fact, there is high collinearity between money aggregates and credit.

King (1986) is one of the first authors to investigate the correlation and causation between bank lending and output. He reaches the conclusion that theories based on credit hypothesis do not have any support in the data and they do not play any role in the propagation of monetary policy. Romer and Romer (1990) propose a narrative approach to determine episodes of restrictive monetary policy in the US, but their conclusions do not differ from those of King (1986). Bernanke and Blinder (1992) employ a VAR analysis to estimate impulse response functions; they find that monetary policy works both through bank loans and bank deposits. Loans seem to respond slowly to monetary policy innovations. They argue that over time banks respond to a tighter monetary policy, terminating old loans and restricting new ones; the authors carry on saying that since some borrowers are limited to bank credit, this reduction in supply of credit has a negative impact on the economy. Ramsey (1993) uses a Johansen cointegration test in his analysis; the results do not support the credit view. No significant role has been found for bank loan velocity and banks portfolios do not have any significant impact on output. In another study, Walsh and Wilcox (1995) find support for the credit view. They use a VAR model analysis where the price of bank loans is determined by the prime rate; the results are consistent with the credit view: in the US, the supply of bank loans had less effect on bank lending than output. Loan shock was a factor in the boom in the late 1980s and the recession of 1990-91. For the UK economy, Matthews and Ioannidis (1997), using a structural VAR model with unadjusted data, find that both credit growth and M0 growth plays an important role in the determination of inflation and output. Moreover, credit market shocks affects the variance of inflation, but not its mean. The latter is entirely determined by the rate of growth of M0.

Kayshap, *et all.* (1993) tackle the problem from a different perspective. Their starting argument is that a monetary tightening should force firms to find alternative forms of financing, since their desire of investment is unchanged and since bank loans are now more expensive. This should induce a change in the composition of firms external finance. Using U.S. time series data for the period 1963:1-1989:4, they find strong support for the lending view theory. After a monetary contraction leads to a shift in firms mix of external financing, bank loans fall while commercial papers rise. This suggests that contractionary policy reduce loan supply, thus affect investment, interest rates and output. This result is questioned by Oliner and Rudebusch (1993), and Gertler and Gilchrist (1993); they suggest that the decline in the aggregate bank loan to commercial paper ratio is not conclusive evidence of a bank credit channel. Using aggregate data for the US economy, they find that bank loans to small businesses fall (as well as loans to consumers and loans for real estate), while loans to large firms actually increase, so that total bank loans to businesses are left unchanged after a monetary contraction. They argue that one possible explanation why the overall bank share in external finance declines is that large firms have a wider range of financing options, so they rely less heavily on bank debt than do small firms. Once firm size is taken into account the mix of financing is left unaffected. So while small firms use less credit and large firms use more credit, the macroeconomic effect of this change in distribution is unclear.

Morgan (1991, 1992a/b) explores the problem from a different perspective. His starting point is that "a bank loan commitment may also relax financial constraints by providing information" (Morgan 1991b, p.41). His results tend to support this statement. Financial constraints emerge as the main cause of decline in aggregate investment spending when firms do not have a bank loan commitment. He also provides an explanation for the dichotomy between small and big firms. In the majority of the sample that he investigates, small firms do not have a bank loan commitment.

The empirical evidence does not seem to shed light on the main question: how relevant is the role played by the banking system in the monetary transmission mechanism? Moreover, some theoretical objections have been presented. Firstly, not all the firms are bank dependent. This can be assumed for small countries or for economic systems with less developed financial markets. To this critique, the advocates of the credit view reply that even in OECD countries (with advanced payment and credit system) bank loans are the primary source of financing. Indeed in European countries the Commercial Paper market does not exist and the corporate bond market is virtually non-existent[31]. Another critique advanced is that banks are not the only source of external finance for a firm. However, this argument is valid only on a theoretical basis, but lacks of fundament in the 'real world'. Indeed, for a firm, the switch from one bank to another or to non-bank intermediaries is very costly. To concede a 'line of credit' banks need to gather all the information about the borrower and need to know the credit history of the borrower. Therefore there is an advantage for a firm to be in a stable relationship with a bank. This would allow the financial institution to monitor the firm closely. Last but not least, real assets are not included in the analysis. This makes the analysis incomplete. Indeed, if such assets were included, the aggregate demand would have different responses to shocks in the loan (and money) demand and supply. As we will see, this point has been emphasised by the monetaristic school.

[31] Davis (2001).

• *Balance-sheet channel (broad credit channel).* Here the emphasis is on the market frictions and on the imperfect substitutability between internal and external finance[32]. This literature can be traced back to Minshkin (1978), who seeks to explain the General depression through changes in households balance sheets, due to rising liabilities - a consequence of the debt build-up in the 1920s and the price deflation in the early 1930s – and falling assets as the stock market crashed. The 'liquidity hypothesis' argues that households has their demand of durables and residential investment on liquidity of their assts, so that falling households net worth led to lower expenditures and aggregate demand. The reason is that high indebtedness or low financial assets holding make financial distress more likely, "since the buffer of financial assets to tide him over bad times has now diminished" (Minshkin, 1978). The starting point of this channel of monetary transmission is the assumption that firms have to sustain a risk premium if they want to acquire funds in the capital market, and these premia depend decisively upon enterprises balance sheets position. The lower the level of the net worth and cash flow, the higher will be the asymmetric information problems (i.e. moral hazard and agency problems). This will make external finance more expensive by augmenting the risk premium. In such a framework, monetary policy may effect firms balance sheets in several ways:
a) lower share prices, following a monetary tightening, increase the risk of adverse selection and moral hazard, following a reduction on lending;
b) higher interest rate causes a deterioration of the balance sheet because it increases the interest payment for firms, reducing the level of cash flow and the net worth.

This channel is seen as a broader phenomenon and overcomes the problems encountered by the bank-lending channel. It is not restricted to the case where the banks lending ability is limited by a contraction in reserves. As underlined by Morgan (1991a), asymmetric information can effect firms in both equity and debt market. In the credit channel framework there is no distinction between the difference sources of financing. Financial markets are dominated by imperfect information Therefore,

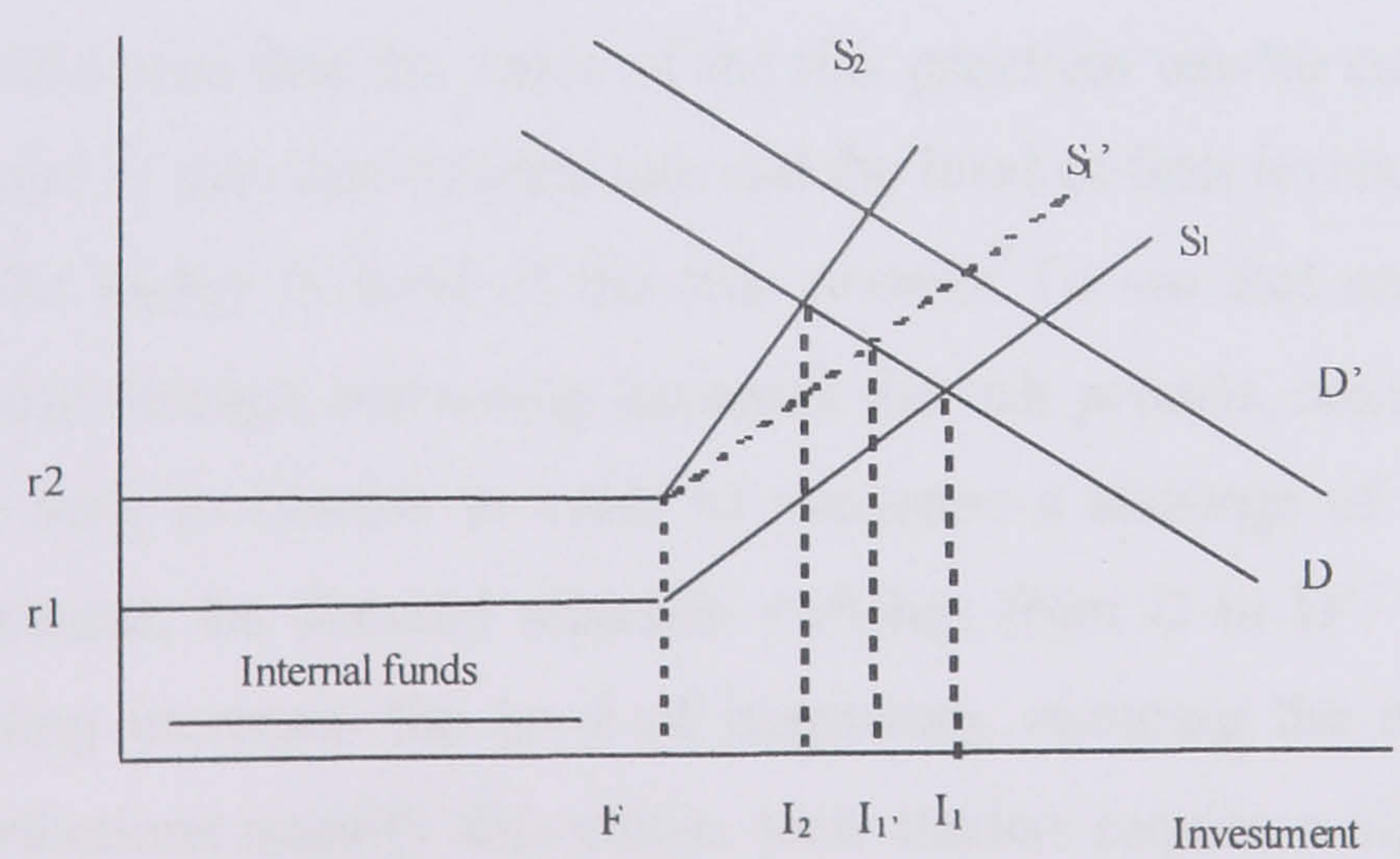
[32] Bernanke and Gertler (1989, 1990), Greenwald and Stiglitz (1993), Calomiris and Hubbard (1990), Kyotaky and Moore (1993), Bernanke, Gertler and Gilchrist (1996), present the financial accelerator in dynamic general equilibrium models.

internal funds are cheaper than external funds. The existence of a narrow credit channel is a necessary but not sufficient condition for the existence of the financial accelerator.

To understand this result we have to recall the neo-classical theory of investment. According to the literature, in an environment with perfect capital markets, firms make investment decisions to maximise the Net Present Value of future cash flow.

If the interest rate rises, the Net Present Value of profits fall making investment less attractive. However, the story changes substantially in a world with imperfect capital markets. Here, the risk premium on external funds will be higher when the risk of adverse selection or moral hazard is most severe. Thus the direct effect of monetary policy on interest rates is amplified by endogenous changes in the external finance premium, which is the difference between the cost of funds raised externally (by issuing equity or debt) and funds generated internally (by retaining earnings). The figure below gives an illustration of this effect.

Figure 1.4: Magnification of the interest rate increase



Source: Oline and Rudebusch (1996,)

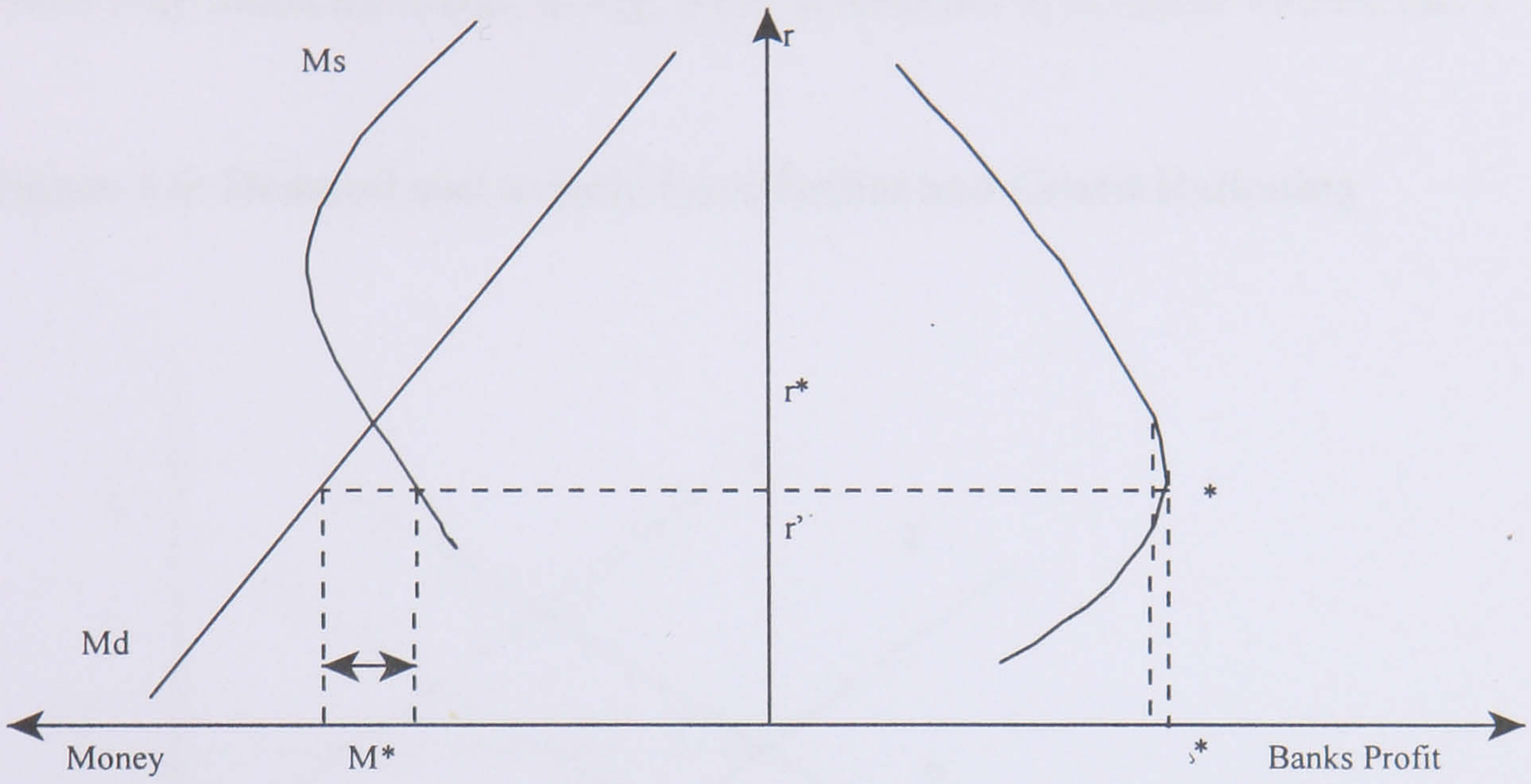
The cost of the internal financing is given by r1 and the amount of internal Funds available is F. In the presence of a perfect capital market, external funds would be available at r1 too, where r1 is given by the sum of the risk free rate (r_f) and the risk adjustment appropriate for the firm (θ). However, with moral hazard and adverse selection problems, or more generally, asymmetric information problems, the cost of financing exceeds r1. It will incorporate a risk financing premium (Ω). The total risk will amount to $\theta+\Omega$. Two important points on Ω need to be highlighted: 1) the higher the level of indebtedness of the firm, the higher Ω will be. This is because of the increased moral hazard problem and this accounts for the slope of the supply of funds S_1. 2) Ω is positively linked with the risk-free rate. With an increase in the risk-free-rate the financial system will offer a lower amount of funds. If the new risk-free rate is r2 the Supply curve will shift upward to position S2. Investment will decline to point I_2. The question now is: why does the S schedule move from position S_1 to S_2 instead of S'_1. The answer is the core of the broad credit channel. Since the risk-financing premium (Ω) is linked with the risk-free rate, credit ma rket imperfections will magnify any monetary shock. In the credit channel literature this is called "the financial accelerator" effect. The slope of S'_2 will be given by $\partial\Omega / \partial r_f$. In the third chapter we will present the results of the financial accelerator model and we will propose some macroeconomic implications.

We have seen that the value of the risk premium can be considered as a function of the level of risk-free interest rate and the level of firm leverage: the higher the interest rate the higher is level of the risk *premia.* To see that an increase in investments financed through borrowing increases the risk *premia*, consider a rise in demand. If firms need to borrow in order to overcome a shortage of cash or to finance other investment, the demand schedule switches from D to D'. This raise in investment spending increases the level of borrowing, reducing the net worth. Credit market imperfections amplify this effect. Now lenders require a higher risk premium, since the firm has increased its default risk and it needs to be monitored more carefully[33]. This would bring the financial system to *"ration the credit"*. Stigliz and Weiss (1981) presented a theory to explain how the presence of credit market imperfections and the consequent asymmetric information problem (moral hazard and adverse selection) results in a situation of credit rationing[34]. The authors give the following descriptions of credit rationing: "a) among loan applicants who appear to be identical, some receive a loan and others do not, and the rejected applicants would not receive a loan even if they offered to pay a higher interest rate; b) there are identifiable groups of individuals in the population who, with a given supply of credit, are unable to obtain loans at any interest rate, even though with a larger supply of credit, they would" Stigliz and Weiss (1981, 249-250). In such a framework, the rate of interest is not determined by the interaction of demand and supply but rather by firms (banks) that behave in such a way to maximise their expected returns. Stiglitz and Weiss refer to this interest rate as the ""bank-optimal rate". Interesting enough, this represents the equilibrium level interest rate even in presence of excess demand. Indeed, with the presence of credit rationing, an excess demand does not push up the interest rate; in fact, for the financial institution, lending at a higher interest rate means increasing the investment risk.

[33] We should notice that this can not be the case if the increase in investment spending is due to an increase in demand and therefore an increase in future profits. In such a situation, the slope of the supply schedule might be reduced.

[34] The underlined concept of this kind of analysis is that the lender (bank, financial institution) cannot fully observe the project-specific risk and that a higher level of interest rate induce the borrower to undertake projects with a higher level of risk (i.e. with higher probability of default).

Figure 1.5: Credit rationing and Money Market Equilibrium



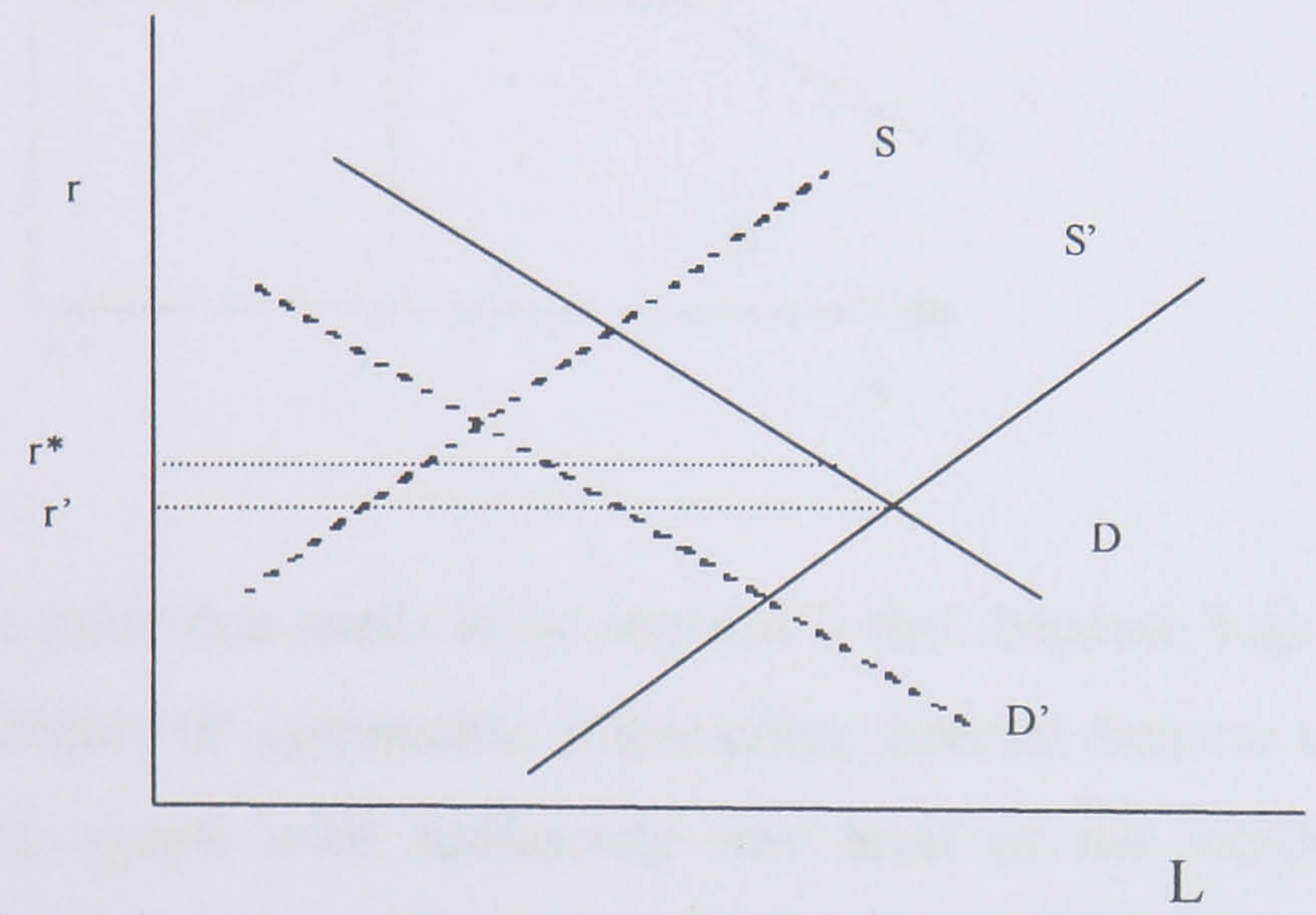
Source: Rochon (1999)

A representation of the credit rationing mechanism is given in Fig. (1.5); on the left side of the chart we have the equilibrium in the money market. When demand and supply can freely interact the optimal level of money in the economy is given by M*. A translation of this position into the banks profits interest rate space, we see that such a point does not maximise the level of banks profits. If financial institutions are rational agents in the market that try to maximise their profits then their optimal point is ð*. At this level the demand of money is not entirely satisfied. The two arrows indicate the excess demand of money. Note that credit rationing arises when the level of market-determined interest rate is above the rate which maximise banks profits.

In the model what matters is the balance sheet position of each firm rather than the productivity of the entire economy. An interesting consequence emerges from the analysis of this model. To show this effect we make use of the demand and supply of loanable funds in an interest rate-loan space, Fig. 1.6. If the economy goes into a recession the demand for credit, D in Fig. 1.6, shifts to the left, lowering the level of the real interest rate. At the same time, lenders face a higher risk and they become more unwilling to lend. This determines a sharp decrease of the supply of funds from

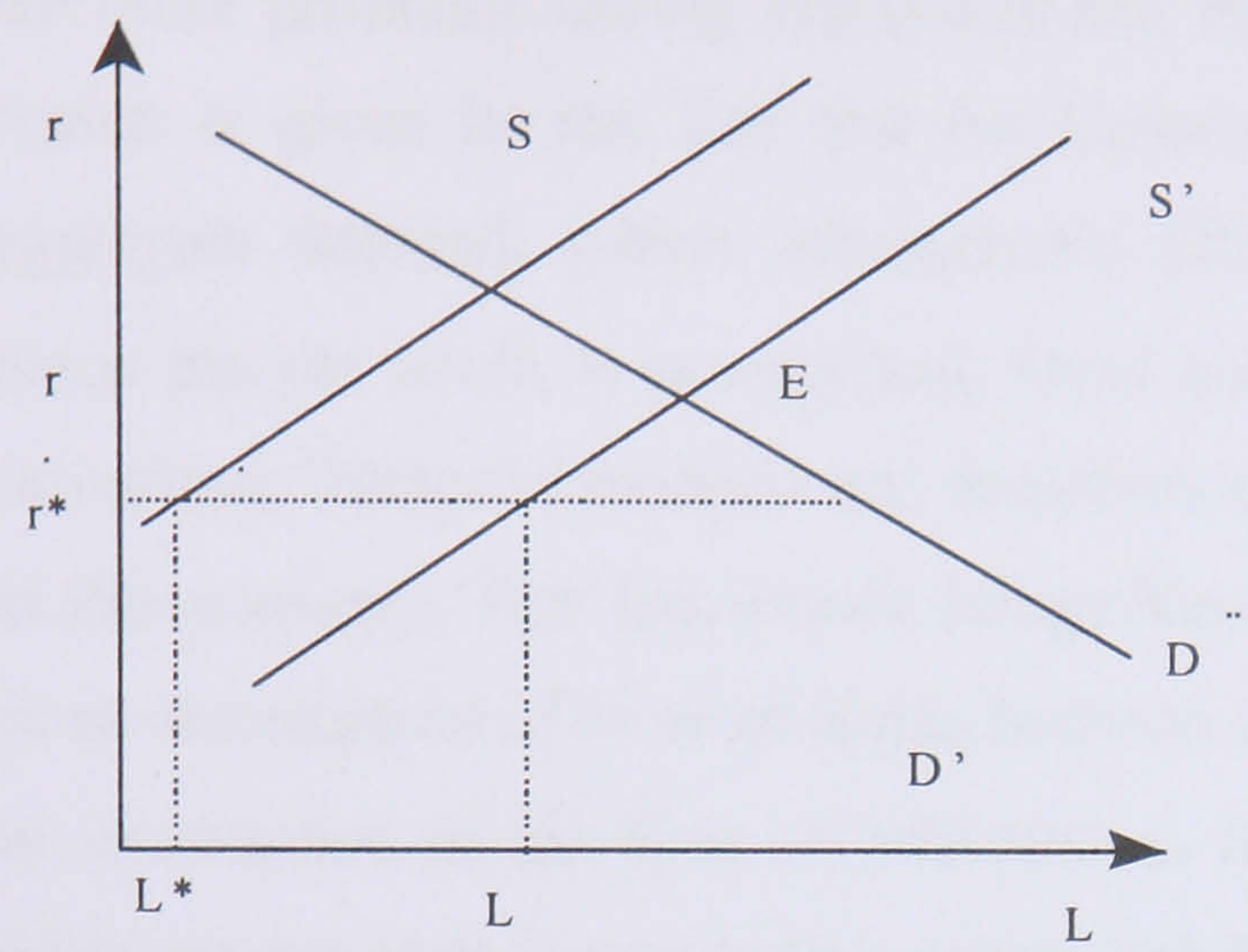
S to S'. The market clearing rate is now *r'*. However, Stiglitz (1999) argues that if new level of interest rate falls below the level at which banks profits are maximised, banks may ration the credit; in Fig. 6 this is reflected by a higher interest rate *r**.

Figure 1.6: Demand and Supply Equilibrium and Credit Rationing



Another interesting case resulting from the credit rationing literature is given by the analysis of market for loanable funds during a monetary loosening. When monetary authorities adopt a less tight policy (i.e. a decrease in interest rate or a reserve requirement), the supply of loans increase, *S* moves to *S**, and the market equilibrium is given by E^*. However, paraphrasing Stiglitz (1999), if banks are extremely risk-adverse, the supply of loans can remain unchanged or it can be expanded but less then the point suggested by the Demand and Supply equilibrium determination. In Fig. 7 banks lend and amount equal to *L*.

Figure 1.7: Credit rationing and Loose Monetary policy



One point that needs to be stressed is that, because high levels of net worth reduces problems of asymmetric information, internal finance is crucial in many respects. First, agents with sufficiently low level of net worth have incentives to select themselves adversely in the credit market (Calomiris and Hubbard, 1990). This implies that agency costs are negatively related to borrowers net worth, and the accumulation of internal finance makes debt cheaper and easier to obtain. Second, agents with higher level of collateral are less likely to take excessive risks; the principal-agent problem is alleviated because they have more on the line, and their incentives are aligned with those of the lenders. Third, net worth can be used as collateral in the case of bankruptcy, reducing the lenders exposure. Fourth, the possibility of future credit market constraints is less threatening for firms with ample internal funds and changes in the terms of credits (i.e. a higher interest rate) have less impact on the output of stronger firms. In the 'ideal' neoclassical world with perfect capital markets, firms would smooth changes in inventories by turning to equity markets or borrowing.

From the New Keynesian perspective, asymmetric information makes equity finance more expensive and/or less available; furthermore, because credit availability depends on the level of net worth, a temporary shock causes a fall in output and investment that is more persistent than that which neoclassical models predict. The conclusion that New Keynesians reach is that business sector profits and banks profits are more profitable during expansion and they fall during recessionary period. The reason is given by the fact that the business cycles affect aggregate income, via aggregate demand, which subsequently affects lenders and borrowers net worth. Since the net worth is pro-cyclical, firms and households balance sheets *accelerate* recessions. Financial markets are, therefore, seen as propagators of shocks occurring in the economy. This framework brings New Keynesians to define a financial crisis as an interruption of flow of funds between deficit units and surplus units caused by an interruption of the flow of information. It follows that New Keynesian financial crisis are not endogenous to the system, but they are just the result of external *events* (negative shocks) in a world dominated by weak balance sheets positions. Such *events* can be an increase in interest rate, as in Stigliz and Weiss (1981, 1983), but also unexpected drops in price levels or stock market crashes, and problems arising in the banking sector, such as maturity mismatch (assets of longer maturity than liabilities). When banks suffer capital shortfalls, their efforts to restore capital adequacy often involve credit crunches. Because the non-financial sectors of the economy depends on the banking sector for funding, banking crises cause distress to the rest of the economy. A crisis is therefore the result of increased uncertainty, because the lender no longer knows borrowers real balance sheets position.

It is a natural consequence of this representation that Central Bank actions can create financial instability. Monetary authority, therefore, should control the economy financial position before implementing its policies. As we will see later, New Keynesians seem to suggest that Central Banks should have a reaction function augmented by a metric which captures the degree of financial instability. This particular issue will be matter of discussion in the last two chapters; Chapter 4 and 5 provide respectively an econometric and theoretical prospective.

Empirical investigations, conducted using micro data, seem to support to the broad credit channel theory. Oliner and Rudebusch (1996), using quarterly data for the US manufacturing sector investigate the relationship between internal funds and business investment. They find evidence that a monetary policy tightening affects small firms more than large firms; in contrast, after a monetary loosening the relationship is little changed for all firms. Fazzari, Hubbard and Petersen (1988) use a panel of 421 US manufacturing firms for the period 1970-1984. Their result suggests that new and small firms investment is more sensitive to the level of the cash flow than predicted by the neoclassical model[35]. They interpret this result as evidence that investment decisions are not independent from financial constraints which firms face. In the literature, the interpretation of financial variables like cash flow as indicating financial constraints have been discussed by Hubbard (1997). If cash flow is a proxy for expected profits, a significant sensitivity of investment to cash flow does not necessarily mean that the firm is financially constrained. Though the possibility exists that the cash-flow coefficient may capture other effects, it can be assumed that the results in fact reflect the existence of financial constraints on investment.

Using a panel of 16,000 UK firms, Yalcin, Bougheas and Mizen (2002) suggest that indeed small and young firms are more affected by a monetary policy tightening than large firms; this implies that the former group is more financially constrained than the latter.

All the empirical evidence points in the direction of the existence of a dichotomy between small and big firms: financial constraints have a more pronounced impact for the former while for the latter the results give strength to the neoclassical theory with no financing constraints. In other words the investments of small and young firms respond much more to change in monetary policy than investment of large firms, *i.e.* the risk-financing premium is larger for the former. Gertler and Gilchrist (1994) find that large firms are actually able to increase bank lending after a monetary contraction. The implication is that in an economy with a mix of small and big firms the net effect is not clear.

[35] Hubbard, Kashyap and Whited (1995) find similar results.

Approaching the issue from the assumption that financial development could proxy the degree of asymmetric information, Denizer *et al.* (2000) provide evidence that suggests that the less developed is the financial system, the higher is the volatility of real per capita output, investment and consumption growth. Further, they find that the banking system "may be particularly important in reducing the volatility of real per capita output, investment and consumption growth". They also find that the banking system "may be particularly important in reducing consumption and investment volatility, while the simple availability of credit to the private sector helps to smooth the consumption and growth" (p.17). This finding seems to give force and support to the Bernanke and Gertler (1994, p.44) view. Indeed, their conclusion was that "credit demand appears to contain a significant counter-cyclical component, which rises from the desire of households and firms to smooth the impact of cyclical variation in income on spending or production".

1.3.3 Asset Prices Channel

Both channels presented above have been strongly criticised by monetarist economists. This has induced some authors (Brainard, 1995 p.160) to catalogue a third channel: the broad money view. We prefer to identify this, more generally, as the assets prices channel, as highlighted by Mishkin (1995, p.7). This is the main difference with the traditional money view: there is a wide spectrum of measures of cost of capital (Brunner and Meltzer, 1993). With respect to this, monetarist researchers emphasize how the monetary policy changes relative asset prices and real wealth. Meltzer (1995, p.52) specifies: "the key point is to look at the way how the monetary policy affects the relative prices of the different assets. A monetary impulse changes[36] the stock of money relative to the stocks of other and foreign assets, and changes the marginal utility of the money relative to the marginal utility of these other assets and the marginal utility of consumption. Money holders attempt to restore equilibrium by equating the ratios of the marginal utilities to the relative

[36] Typically associated with an unanticipated movement in the monetary policy instrument.

prices of all assets and current production and consumption. This involves changes in many relative prices, in spending and in asset portfolio."

We can distinguish two categories of asset prices through which the monetary policy has it effects: stock market prices and house (real estate) prices. Fluctuations in both channels can have an important impact on firm and household spending decisions, and therefore, on the aggregate demand and ultimately on the level of inflation.

We start by considering the influence of the stock market on firms. This mechanism of transmission of monetary policy is given by the Tobin (1969) q theory of investment. In this framework, the variable q is the market value of firms divided by the replacement cost of capital. The main idea is that there is a link between stock prices and investment. If q is low the investment spending will be low; the reason being that firms need a big issue of capital stock to finance the purchase of new investment goods. When monetary policy tightens, bonds become more attractive compared to shares. This determines a decrease in the demand for shares. The lower the value of q, the lower the level of investment, and consequently, output. In addition to this when stock prices rise, firms would find it cheaper to issue shares rather that bonds; in other words a rise in share prices determine a lower cost of capital.

As we mentioned earlier, asset prices also have an effect on households. The wealth effect, as it has been frequently labelled, is linked to the Modigliani life cycle model. Consumers' wealth directly affects their spending, since it is determined by human capital, real capital and financial wealth. A major part of financial wealth is common stock; therefore a fall in share prices decreases the amount of wealth available to the consumers. Output falls as a consequence of a reduced level in consumption. Thus, expansionary monetary policy which raises stock and house prices raises the value of household wealth, thereby increasing the lifetime resources of consumers which causes consumption, output and inflation to rise.

Monetarists doubt that monetary policy shifts the banks supply of loans relative to other types of credit. According to the monetarist the principal problem for the lending view is to show that autonomous shifts in bank offers to lend contribute significantly to cyclical changes in bank loans. The alternative view is that changes in requests to borrow, induced by monetary impulses, best explain cyclical changes in lending. The critics note that banks can borrow on the Euro-dollar market, issue certificates of deposits, sell securities and, in other ways, finance lending if it is profitable. Why do they prefer to reduce loans more than proportionally to their loss of reserves? Why do other intermediaries fail to satisfy the excess demand? As we saw in Section 3.2, in order to explain why loans decline relative to reserves, the lending view suggests that recessions reduce banks net worth and have disproportionate effects on small borrowers. The attention to net worth reflects the restricted range of substitutions permitted by the lending view. With the combination of bonds and real capital in a single composite asset, the lending view buries asset price changes within the composite. Following Meltzer, the monetarist hypothesises that the composition of the change matters, increases in government debt and real capital have opposite effects on market interest rates. What monetarists firmly oppose is the existence of independent credit market effects. The example that they cite in the discussion is Bernanke's analysis of the Great Depression[37]. According to Bruner and Meltzer (1988, 1993) and Meltzer (1995) the theories suggested by the credit channel fail to explain the U.S. banks crises in the 1929. In fact, if it is true that small firms cannot diversify their external financing, but they rely heavily on bank loans, then we should have verified a faster decrease in this type of financing than in alternative sources such as commercial papers. The data does not support this interpretation.

What Meltzer fails to capture is that the credit view reserves an implicit, though important, role to asset prices. They are essential to the borrowers and the lenders because an increase/decrease in the value of real and financial assets increase/decrease the value of the collateral that the borrower can offer to *secure* his/her loans. An increase in assets prices, therefore, reduces the asymmetric

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[37] Bernanke (1983)

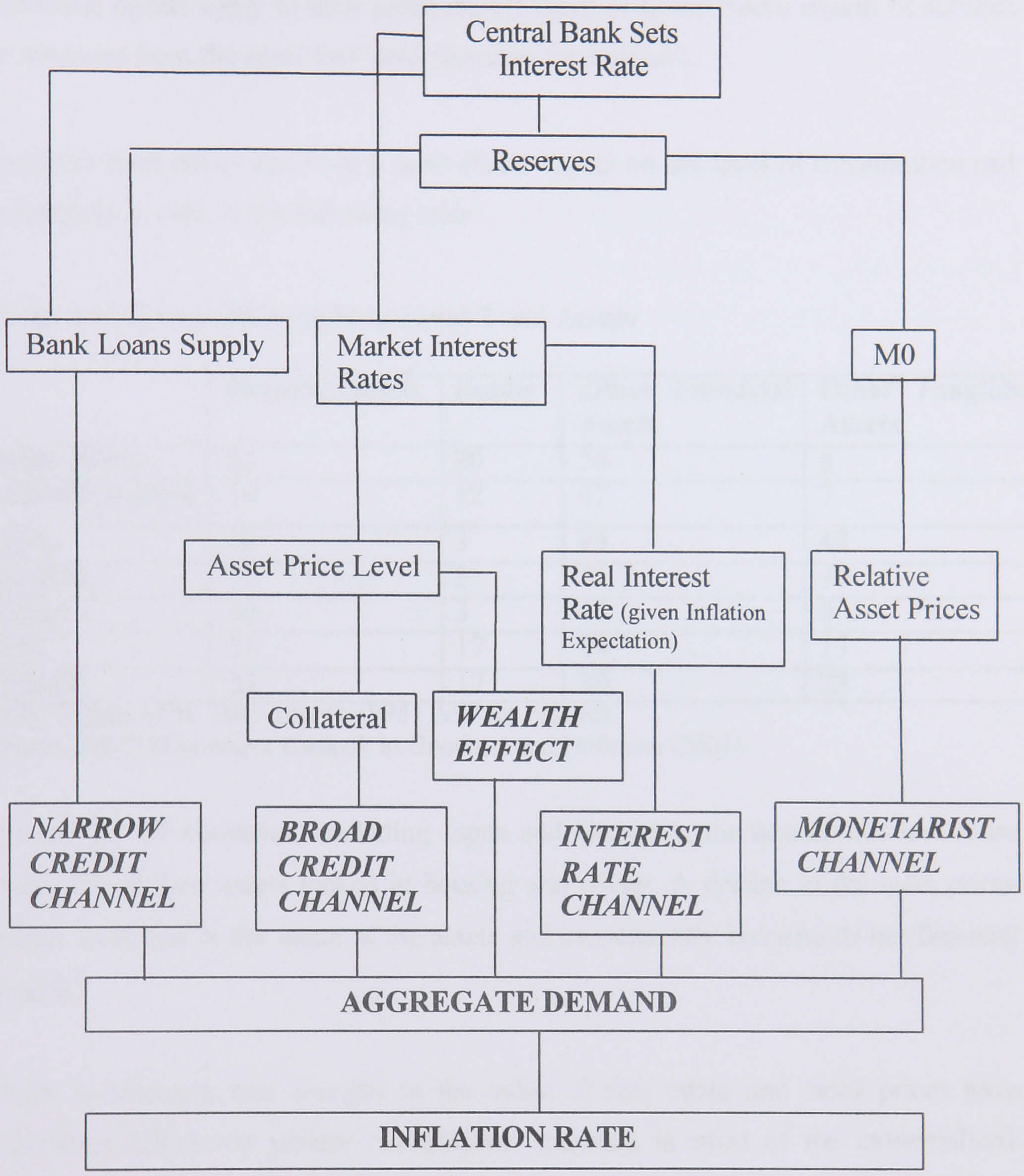
information problem, increasing the borrowing capacity of firms and households by increasing the value of the collateral. We therefore believe that asset price channel and credit view, at least in its broadest meaning, are closely related.[38]

1.4. Evidence on the role of asset prices and some implications for monetary policy settings

In the previous section we presented the main different theories of the monetary transmission mechanism. In figure 1.8 we schematize the complex process through which monetary policy actions can have a direct impact on the real economy. We feel it is important to stress some points of the monetary transmission mechanism; first, the different channels are not mutually exclusive. They work together to determine the final level of aggregate demand and inflation. Second, the existence of the broad credit channel in its broadest definition implies that even a small change in interest rate can have a powerful impact on the final level of income.

[38] See Minshkin (1999a) for a comprehensive review of how asset prices play a role in the credit channel.

Figure 1.8: Monetary transmission channels and inflation



Source: Adapted from Kuttner and Mosser (2002)

An important aspect emerging from the above diagram is the important role played by asset prices during the monetary transmission mechanism. They, in fact, may contain important information regarding the current and future state of the economy. A change in interest rate modifies people's expectations about future economic growth, and thus their profit expectations. This may change the set of discount factors economic agents apply to their profit expectations or to the future stream of services or revenues from the asset they hold (housing for instance).

However asset prices can have a more direct impact on the level of consumption and investment as seen in the following table.

Table 1.1: Composition oh Household Total Assets

	Housing Assets	Equity	Other Financial Assets	Other Tangible Assets
Unites States	21	20	50	8
United Kingdom	34	12	47	7
Japan	10	3	44	43
Germany	32	3	35	30
France	40	3	47	9
Italy	31	17	39	13
Canada	21	17	39	23

Note: Values in %. Data refer to 1998 (1997 for France)
Source: OECD Economic Outlook in Goodhart and Hofmann (2001).

For all the G7 countries, excluding Japan and Germany, the households have more than 40% of their assets locked in housing and equity. A decline in the asset prices means a decline in the value of the assets and consequently households net financial wealth.

There is evidence that changes in the value of real estate and stock prices have significant effects on private consumption spending in most of the industrialized world. However, estimates of the magnitude of this effect vary considerably across countries and are highly dependent on the type of asset in question. The effect of stock prices on consumption appears to be strongest in the U.S., where most estimates point to an elasticity of consumption spending relative to net stock market wealth in the range of 0.03 to 0.07. This implies that for instance seven cents on the dollar of an increase in stock market wealth is spent on consumer goods with the effect taking one to three years to materialise[39]. Case *et al* (2003) using survey data find that swings in house prices have a substantial impact on the households' wealth. The implication for the US (and the UK) is that if a substantial fall in house price were to occur, growth in private consumption (which accounts for roughly 60 per cent of GDP) would slow sharply. In contrast, studies for Italy and France have not found any significant effect of stock prices on private consumption, whereas for Canada, Germany, Japan, the Netherlands and the U.K. the effects are significant but smaller than in the U.S.[40]. This appears to reflect the smaller share of stock ownership relative to other financial assets in these countries, as well as the more concentrated distribution of stock ownership across households in continental Europe when compared with the United States.

Table 1.2: Household equity holdings as a percent of net wealth

	1980-84	1985-89	1990-94	1995	1996	1997
U.S.A	10.6	11	15.1	19.5	20.9	24.4
Japan	4.5	7.6	5.8	5.4	4.9	3.7
France	1.3	3.1	2.9	2.6	2.9	3.2
Italy	0.8	2.1	3.6	3.8	3.6	4.7
U.K.	5.5	6.3	9.4	11.3	11.3	12.4
Canada	13.7	13.9	14.2	15.6	16.5	18.3

Source : Boone et al (1998)

The IMF (2000) report states that real estate prices have been closely related to the business cycle in the industrialized world. For some countries like Japan the correlation is found to be even stronger. Recessions in Japan since the early 1980s have been accompanied with falling property prices. Conversely, the strong upswings in economic activity in Australia and smaller EU countries since the mid-1990s have been associated with robust growth in property prices. Real estate prices can affect aggregate demand through three channels: direct effects on housing expenditure, household wealth

[39] See Boone *et al.* (1998).
[40] See Boone *et al* (1998), Capel and Houben (1998), Jaillet and Sicsic (1999)

The effects of changes in real estate prices on consumption appear to be stronger in European Union countries. Rising property prices can affect consumption not only through higher realised home values but also by the household's ability to refinance a mortgage or take out (or expand) home equity loans of credit based on higher property values. The two latter channels, in particular, have become increasingly important in European Union countries in recent years, thus bolstering the sensitivity of consumption to property price cycles. Boone *et al* (1998) estimated that the elasticity of consumption to property prices is about 10 percent per year and in the Netherlands to be 7 percent over two years. There is also evidence that property price cycles have been a major determinant of consumption growth – being far more important than stock prices - in Australia and in some other European countries operating through the credit channel[41]. Goodhart and Hofmann (2001), estimating an augmented backward looking IS equation, find that asset prices have a significant effect on future excess demand conditions in the G7 countries. In particular their results suggest that share prices have a smaller impact on output than property prices. Asset prices have a positive link with the level of the future aggregate demand via their impact on the private sector wealth and borrowing capacity of households and firms[42].

Filardo (2000) takes a different direction; he argues that asset price inflation should enter directly into the estimation of the Phillips Curve. We carry on an experiment to explore this hypothesis. We employ monthly data on short-term interest rates, retail sales volume, consumer prices, stock prices and house prices for the United Kingdom from October 1992 to August 2001. Our sample period does not include changes in the monetary policy regime as from October 8 1992 the UK has adopted explicit inflation targeting as a new framework for monetary policy outside the ERM. An inflation target of 1-4 % was initially set and on June 1995 the target was reset at 2.5% or less. All our data was obtained from Datastream. The output gap (y_t^*) the difference between actual and potential output, is calculated as the percentage

[41] Kent and Lowe (1998).
[42] In chapter 4 we repeat the experiment for the UK using a forward looking IS curve.

deviation of the natural logarithm of the monthly retail sales volume from a Hodrick-Prescott trend. The 3-month Treasury Bill rate (R_t), is employed as a measure of the stance of the monetary policy. The deviation of the annual inflation rate from the target is calculated as: $\eth_t$- 2.5 where $\eth_t$ is equal to 100*[ln(CPI_t/CPI_{t-12})]. CPI denotes the seasonally adjusted consumer price index. The annual change in stock prices ($\eth_t^{SP}$) and house prices ($\eth_t^{HP}$) is proxied by the 12th difference of the natural logarithm of the monthly FTSE All Shares stock index and the Halifax house price index respectively. We used annual, rather than monthly, changes for retail prices, stock prices and house prices because as Goodhart (2001) argues, year on year changes on these variables are much more relevant for monetary policy decisions. The month-to-month changes are very noisy indicators; by taking the twelve-month differences we are able to filter out a substantial amount of noise in the data.

In Table 1.3 we present a cross correlation matrix relating asset price inflation with concurrent and future consumer price inflation and two things clearly appear. First, there is no evidence of a relation between inflation and nominal returns in the stock market. Second, the correlation between house price inflation, stock price inflation and consumer price inflation seems to have changed over time. For the period 1985:1 – 2001:8 house price inflation and consumer price inflation are positively correlated, while during the inflation targeting period this contemporaneous correlation is reduced. However for both samples under investigation, current house price inflation is positive and has a high correlation with future consumer inflation, while nominal stock returns are negatively correlated but not significant with future consumer inflation for the period 1985:1-2001:8, and almost non-related during the inflation targeting period.

Table 1.3: Cross Correlations

	Sample: 1985:01 2001:08		Sample: 1992:10 2001:08	
lead	Current stock price inflation with leads of consumer price inflation	Current house price inflation with leads of consumer price inflation	Current stock price inflation with leads of consumer price inflation	Current house price inflation with leads of consumer price inflation
0	-0.1084	0.1716**	0.0144	-0.0541
1	-0.1254	0.1615**	0.0144	-0.0542
2	-0.1315	0.2067***	0.0144	0.0525
3	-0.1227	0.2514***	0.0289	0.1529
4	-0.1192	0.2945***	0.0649	0.2405**
5	-0.1255	0.3319***	0.0714	0.2722***
6	-0.1344	0.3665***	0.0746	0.2971***
7	-0.1266	0.4003***	0.0769	0.3105***
8	-0.1111	0.4315***	0.0688	0.2919***
9	-0.1042	0.4629***	0.0664	0.2796***
10	-0.1048	0.4939***	0.0455	0.2463**

*, **, *** indicate level of significance of 10%, 5%, and 1% respectively.

The measures presented so far might be biased for two reasons. Gertler (1998) argues that, after, other business cycles indicators have been taken into consideration, there is little correlation between short-run inflation and asset prices. Furthermore the results might be subject to statistical noise. Therefore, in order to test if asset prices have a direct effect on inflation, we proceed, following Filardo (2000), to some more elaborate regression analysis. Here we examine the possibility that past movements in asset prices help to predict future inflation; we estimate a Philips curve equation for inflation allowing for inflation persistence and for the effect of lagged asset prices:

$$\pi_t = a + b\pi_{t-1} + cy_{t-1} + d_k \pi_{t-k}^{SP,HP} + u_t \tag{1.16}$$

Table 3 presents the estimations. There is strong evidence that lagged house prices affect current consumer price inflation, but not stock prices. This is in line with Alchian and Klein (1973) theory, and similar evidence is provided by Filardo (2000) using U.S. data. Furthermore this is consistent with the fact that in the context of the UK economy a greater part of households' wealth is locked in the house market rather than in the stock market. To gain some better insight to the direction of causality between the variables of interest, we employed standard Granger causality tests[43].

Table 1.4: OLS estimates of lagged asset price changes on current inflation

d_k	Sample: 1985:01 2001:08	Sample: 1992:10 2001:08
Coefficient	**House prices**	
d_1	0.0093***	0.0117**
d_2	0.0092***	0.0143***
d_3	0.0093***	0.0143***
d_4	0.0083***	0.0112**
d_6	0.0084***	0.0084*
d_{12}	0.0103***	-0.0003
	Stock prices	
d_1	0.0010	0.0002
d_2	0.0033	0.0055**
d_3	0.0019	0.0059**
d_4	-0.0002	0.0033
d_6	0.0028	0.0054**
d_{12}	0.0029	0.0012

*, **, *** indicate level of significance of 10%, 5%, and 1% respectively.

Table 1.5: Granger Causality tests

Null Hypothesis:	F-Statistic	
	1984:1-2001:8	1992:10-2001:8
Consumer price inflation does not Granger Cause house price inflation	1.18029	2.77159 ***
House price inflation does not Granger Cause consumer price inflation	2.65818 ***	2.27957 **
Consumer price inflation does not Granger Cause stock price inflation	1.50337	0.2560
Stock price inflation does not Granger Cause consumer price inflation	0.67132	0.56348

*, **, *** indicate level of significance of 10%, 5%, and 1% respectively.

What appears from Table 1.5 is a strong bi-directional link between house price inflation and consumer price inflation. Thus, the empirical evidence presented suggests that there is a strong connection between house price inflation and consumer price inflation, while the relation between stock returns and inflation is much less straightforward. These findings present a case for a link between the Central Bank

[43] Eight lags are considered in the estimation.

main objective of price stability and the level of asset prices, calling for a tight monitoring of the developments in the asset markets. In other words a monetary policy reaction function that does not incorporate asset prices inflation as a state variable loses important information about future price inflation, and therefore it undermines the efficiency of the monetary authority's actions.

The previous analysis put forward the case for a reaction of monetary authorities to asset prices movements. There are several reasons why monetary policy might wish to respond; a first reason is that asset prices misalignments may endanger the stability of the financial system. This case is put forward by Borio and Lowe (2002), they observe that since the 1970 asset prices cycles have been growing in amplitude and size. They argue that even an environment characterised by sound and credible economic policies, financial instability could be a serious threat. According to them, "it is the unwinding of financial imbalances that is the major source of financial instability, not an unanticipated decline in inflation per se". In the third chapter we will analyse the 1990 recession and highlight the important role played by the accumulation of these imbalances (debt); in the forth chapter we will look at this issue in more detail discussing the Borio and Lowe (2002) position. A second potential reason why central banks would like to respond to asset prices is that, as analysed previously, they play an important role in the transmission of monetary policy. Rising asset prices may have direct impact on the aggregate demand and may, therefore, be associated with growing inflationary pressures. They also influence collateral values and banks' willingness to lend. The final reason is that asset prices might contain important information concerning the future state of the economy; they incorporate information about financial market expectation of inflation and macroeconomic conditions.

A strategic question is whether asset prices should represent an independent objective of monetary policy or rather should only be part of the information set used by the central bank.

This issue will be directly addressed in the fourth and in the fifth chapter. In the former we provide an empirical estimate of the wealth effect in the UK and we proceed in estimating the importance of asset prices (namely house prices and nominal stock market prices) in the determination ofthe nominal short term interest rate following the Taylor rule. In the last chapter we build a macroeconomic model where the wealth effect plays a key role in determining the Aggregate Demand.

1.6. Conclusions

In the last twenty years the financial markets have expanded significantly in all industrial countries. This growth has revived interest in the role played by financial markets in the economy and their role in the monetary transmission mechanism. In the first part of this chapter we highlighted the key role played by financial markets; they have the role to facilitate the trading of capital between surplus and deficit units, they are responsible for the resources allocation (savings) and facilitate the exchange of good and services.

One of the main reasons why researchers have studied the functioning of the financial market is because monetary policies have an effect on the real economy via financial institutions. We saw that many theories have been proposed so far, the first that we analysed was the so called “money view”. This refers to the Keynesian idea that a change in the risk free interest rate will affect the demand of money for investment purposes. This theory is based on the assumption that prices have some degree of stickiness, it is the conventional specification of the IS curve both in its traditional Old-Keynesian specification and in the modern New-Keynesian framework. This view does not seem to be able to explain in-depth the large macroeconomic fluctuations which follow a policy-induced interest rate change. Other alternatives have been proposed along the years. One of these is the credit view: it is distinguished in the Bank Lending channel and in the Balance-Sheet channel. The first stresses credit market frictions; here banks play the key role since they are the main source of finance, it is via the banks' reserves that monetary policy can have an effect on the aggregate demand. Bernanke and Blinder (1988) proposed a model where banks rely heavily on reservable demand deposits as source of finance. A contractionary monetary policy will therefore reduce the supply of loans via a reduction in the aggregate volume of bank reserves. Because of the significant number of firms that rely on bank loans, a reduction in the supply of loans reduces households and firms investments and consequently aggregate demand. The balance-sheet effect, on the other hand, does not distinguish between bank finance and other sources of financing, but the main distinction is between internal and external finance. In a market characterised by frictions (asymmetric information) the level of external finance is determined by the level of the borrower's collateral. An important role is played by asset prices: they determine the value of the collateral. This implies that a tightening of monetary policy would reduce collateral value, which in turn increases the premium that the borrower has to face if s/he wants to borrow. The final result would be a lower level of investment and consumption. The last channel that we presented was the monetarist channel or Broad money view. It focuses on the direct effect of changes in the relative quantities of assets, rather then interest rate. This mechanism starts from the assumption that different assets are not perfect substitutes, therefore changes in monetary policy would affect the composition of outstanding assets which would lead to relative price changes; this, in turn can have real effect.

In the last part of the chapter we pointed out how important asset prices are in the monetary transmission mechanism. They are at the centre of the credit view and of the broad money view. They contain important information regarding current and future value of output and inflation. Given the recent capital market expansion a new strand of research has suggested that monetary authorities should target, or at least monitor closely, asset prices movement. This lively debate has not reached an unanimous conclusion; many believe that authorities do not have inside information and therefore do not have the ability to fully interpret the market behaviour (i.e. Central Banks do not know if a movement in asset prices is due to a change in the fundamentals or just a change in agents optimism). Other authors have pointed out that the recent expansion in credit markets has created the necessity for Central Bank interventions; they see financial stability as important as price stability.

To conclude it is important to underline that the monetary transmission channels we presented in this chapter are not mutually exclusive: when monetary policy is set, it is transmitted to the real economy via a variety of channels. Central banks, therefore, would have to consider all these mechanisms in order to better evaluate their effect.

Chapter 2

Monetary Policy Shocks and the Price Puzzle

2.1. Introduction

The credit view emphasises how, in an imperfect capital market environment, *frictions*, such as asymmetric information and costly enforcement of contracts, create agency problems in financial markets. In such an economic context, a wedge between the perceived cost of credit for the firm and the market interest rate arises, and some projects that would earn the market rate of return are not realised. This strand of economic literature states that the main source of external funds is mainly composed of bank loans. Subsequently it derives that the banking system plays a central role in the transmission of monetary policy for the whole economy. It follows that when monetary policy tightens, banks are less willing to lend money due to higher bankruptcy risks as in Bernake and Gertler (1999). Since some firms and households are assumed to be financially constrained, they cannot substitute bank loans with other form of credit. The credit view thus implies that the effect of monetary policy could be non-optimal by foregoing valuable investment opportunities and, moreover, could have distributional consequences by affecting predominantly firms that are subject to asymmetric information problems. Hence, it is important to stress that the credit view should not be interpreted as an alternative explanation of the monetary policy transmission mechanism, but rather as "a set of factors that amplify and propagate conventional interest rate effects": Bernanke and Gertler (1995, p.28).

In the last twenty years there has been a lively debate on the importance of the credit channel. There are two generally accepted conclusions: i) a credit channel, as we have defined in the first chapter, exists for small firms; ii) this channel does not exist by itself, but operates along with the more traditional *money channel*. One important question, however, is still unsolved: how significant are its effects on the overall economy? The answer is crucial from the Central Bank's point of view; in fact, if a credit channel has a significant role in the transmission of monetary policy, then monetary authorities should take it into consideration before setting their policies.

Other authors emphasise how the credit view is strictly related with stability of the economic system. This creates a necessity for the monetary authorities to consider this channel of monetary transmission. Sinclair (2002, p.13) argues that "safeguarding financial stability is a core function of the modern central bank, no less than market operations and the conduct of monetary policy [...]. This is particularly true in circumstances where bank failure would pose systemic risk. [...] Financial stability impinges upon monetary policy and reacts to it." As pointed out by Minshkin (1996) and Borio and Lowe (2000), monetary and financial stability are "mutually reinforcing goals". Therefore, Central Banks "need to always keep in mind that pursuing price stability requires the pursuit of financial stability" Minshkin (1996, p. 92).

In order to test the credit view and more generally the monetary transmission mechanism, we examine the effects of unanticipated monetary policy tightening on different sources of finance. One intriguing reason to analyse the effect of monetary policy shocks is that they seem to have played a major role in movements of the macroeconomic fundamentals. The Gerlach and Smets (1994) estimates suggest that the "fluctuation in GDP growth and inflation since 1988 are [...] essentially entirely due to the monetary policy shocks". Under the traditional-Keynesian money view framework, we expect that an increase in interest rate produces a lower total demand for credit and a lower aggregate demand. Consequently all the sources of finance are expected to decline. On the other, hand following the credit view, a contractionary policy would produce a decrease in the amount of bank credit. Firms, therefore, would search for new forms of finance. Thus, paraphrasing Kashyap *et al.* (1993), we expect that the composition of the external finances should change if the credit view is valid, with bank loans decreasing more than other forms of credit.

One of the major empirical puzzles of the monetary transmission mechanism is the so-called prize puzzle. It is usually referred to as a "price puzzle" when, in a VAR of output, prices, money, interest rates and perhaps some other variables, contractionary shocks to monetary policy lead to a persistent price increase. This is puzzling because economic theory predicts that a tighter monetary policy should reduce the price level.

This frequently seems a sign of misspecification of the model.

In this chapter we build a VAR model of the economy, in order to recover monetary policy shocks. Our aim is twofold: first we want to investigate which financial aggregates are impacted by these policy innovations; second we aim to provide an explanation for the prize puzzle. In other words we want to isolate the effect of monetary policy shocks on the availability of finance, and more specifically on the availability of bank credit. In doing so we use data from the UK flow of funds to Industrial and Commercial Companies (ICCs) and other variables that we regard as important during the monetary policy transmission process. Our results suggest that the portfolio composition of a firms financing source changes after a monetary policy shock. We argue that the price puzzle can be solved if we concede the possibility that monetary policy has a cost push; innovation in the short term interest rates increase firms' short-run marginal costs which in turn are translated in an increase in inflation.

This chapter is organised as follows: in the next section, we present a critical overview of the Vector Autoregressive (VAR) analysis and its application on monetary transmission studies. In section 2.3 we proceed in a VAR model selection; results are presented in section 2.4.

2.2. VAR analysis and the Monetary Transmission Mechanism

There is a long tradition of VAR analysis in macroeconomics. The starting point was the seminal work "Macroeconomics and Reality" by Sims (1980) and its dissatisfaction with the then existing econometric models. The article is a stepping stone of the unrestricted VAR analysis or "atheoretical macroeconomics" (Cooley and LeRoy, 1985). The *Sims critique* was first related to the Coweles Commission practise in estimating large, simultaneous equations models – particularly the economy-scale macroeconometric models enabled by the Keynesian revolution in economics. To overcome the "*incredible*" restrictions, he proposed a model based on unrestricted reduced-form equation, where all the variables can be treated as endogenous. Canova (1995, p. 78-79) summarise Sims's research program in three points:

> *"First, the identifying restrictions employed by model builders were deemed as "incredible" in the sense that economic theory is weak in deciding what variables should enter a reduced form model and exclusion restrictions were routinely imposed with little attention with to the underlying economic structure. [...] Second, many variables were taken to be exogenous with respect to the system by default rather than as a result of solid economic or statistical arguments. Finally, because the outcomes of traditional macroeconometric models are typically amended by their users with judgmental ex post decisions, the results of policy exercises are both non-reproducible and hard to compare with those of other researchers even when they employ the same type of models."*

There is, however, a further point that needs to be stressed. This approach is very useful in monetary policy analysis since it can give the researcher the possibility to isolate the *feedback rule* (response of the monetary policy to a non-monetary variable movement) from the exogenous monetary policy (effects of the policy action per se, i.e. *shock*)[44]. In other words the principal idea underlying the VAR methodology is to decompose movements in some observed time series into the parts that are due to unobserved underlying shocks which are structural, in the sense that they can be given economic interpretation. In the next section we will see this concept in more detail.

Bernanke and Gertler (1995) try to shed light on the US "Black Box", analysing the response to different macroeconomic data. Christiano *et al.* (1994) summarise the major findings for the US[45]. A tightening of monetary policy causes an increase of the short-term interest rate, manufacturing inventories and unemployment. The price level starts decreasing after four quarters. Output, monetary aggregates, profits and retail sales volume decrease after one year. Finally, firms increase their level of

[44] Christiano *et al.* (1996)
[45] Results for the UK are much more uncertain and there is not a unique view.

borrowing for roughly a semester after the shock. Gerlach and Smets (1994) provide evidence of the monetary transmission mechanism in the G-7 countries[46]. Their results suggest that the effect of a monetary contraction has similar effect in all the countries.

For the UK the most influential study using this methodology is undertaken by Dale and Haldane (1993). They use the same identification procedure to test whether monetary policy shocks (intended as unexpected movement in interest rate) have some effects on exchange rates, stock market, bank lending and banks deposits for the personal and the corporate sectors[47]. Three important results are reported: one standard deviation positive shock in interest rate causes 1) a slower downward movement of output and prices for the corporate sector than for the personal sector[48]; 2) bank lending for the personal sector decreases immediately and its level remains constantly below the pre-shock value. The corporate lending evolution follows a different pattern: it increases for the first 18 months, moving rapidly towards the negative area afterwards[49]. The behaviour of banks deposits is reversed. The corporate sector reduces deposits due to a shortage of cash, while the personal sector increases its deposits for roughly two years[50]; 3) the price level increases for more than three years. They justify this result arguing that monetary policy acts first on the level of output and then on the price level, through a non-vertical Phillips curve. This however might be seen as a misspecification of the VAR. This type of result is usually referred as the price puzzle. Sims (1992) examines the possibility that this could be the result of a missing element in the reaction function of the Central Bank.

[46] They use a three variable VAR: real GDP growth, rate of inflation and nominal short term interest rate.
[47] Following Sims's work the interest rate is ordered first in the VAR. He assumes that monetary policy is unaffected by other non-policy variables.
[48] This result is quite surprising. It is in sharp contrast with the major results of the credit view, (see for instance, Gertler and Gilchrist (1991)) where small economic units react more rapidly then big economic units to change in interest rate. Dale and Heldane (1993) justify their result in the following way: "for sectors whom assets/liability substitutability is low, official interest rate changes may be a less good guide to the overall change in monetary faced by agents. Hence the effects of change in interest rates are felt less strongly and/or more slowly by these agents."
[49] Here we should notice that their estimated impulse response function is not significant since the error bands include zeros.
[50] This increase in deposit corresponds to an increase in saving.

He argues that the puzzle can be solved if a commodity price index is included as a leading indicator for domestic inflation. This extra variable could be thought of as a signal of inflation expectations. In this case, Central Bank can promptly react to commodity price raising (signal of inflation expectation), modifying the interest rate.

2.3. The identification of UK monetary policy shocks.

In the last thirty years the UK has exhibited a variety of different monetary policy strategies. Following Nelson (2000) we can identify seven of them[51]:

1. July 1972-June 1976: from the first full month of floating exchange rates to the end of the pre-monetary targeting period.
2. July 1976- April 1979: from the beginning of £M3 of monetary target to the last month prior the election of the Conservative government.
3. May 1979-February 1987: period beginning with the election of the Thatcher government. During this period (1980-1985) was adopted a Medium Term Financial Strategy (MTFS), but this was heavily revisited during 1982.
4. March 1987-September 1990: informal linking of the Pound to the Deutsche Mark.
5. October 1990-1992: membership of the ERM.
6. October 1992-April 1997: period of inflation targeting prior to the Bank of England independence.
7. May 1997 – present: Central Bank independence.

The consequence of the above is that there is a problem of which variables should be included in the VAR: in fact the inclusion or exclusion of one or more variables can result in an incorrect identification of the monetary policy shocks. We acknowledge that the best strategy to identify which variables should be included in the policy set and therefore identifying the optimal monetary policy rule can be obtained observing

[51] Nelson (2000) does not report the last policy regime since its data sample ranges from 1972:6 to 1997:5. We believe that May 1997 can clearly be considered a change in the Bank of England monetary policy procedure.

the objectives of policy[52].

We decided not to include Central Bank intermediate targets (i.e. monetary aggregates) since they are not consistent within the specified periods and their inclusion could violate the *Lucas critique* of parameters instability[53]. This does not misinterpret UK monetary policy since the ultimate target of the Bank of England has always been the control of inflation; although, as presented above, different strategies were adopted along the years, they were implemented to achieve this aim. Martin and Salmon (1999, p.22) state that "intermediate targets were set consistently with the final objective of monetary policy". This implies that the impact of monetary policy should be captured by the policy final objective.

We decide to specify the vector of non-policy and policy variables as follows[54]:

$$X_t = \left[GDPD_t,\ INF_t,\ INT_t\right]' \tag{2.1}$$

The first variable entered in our model is the UK real output. The variable has been detrended with a Hodrick-Prescott Filter. As we explain later this makes the systematic part of the vector consistent with the actual non-policy variables. This is justified by the fact that Central Banks regards output deviation from its trend or, more generally, output gap as undesirable because of the adverse consequences on unemployment and on the stability of the financial system.

The second variable included is the fourth difference of the natural logarithm of the quarter RPI[55]. We use annual, rather than quarterly, changes for retail prices, because

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[52] An alternative strategy would be to divide the sample in six sub-samples. Such an identification scheme is not applicable in our case. The main reason is due to the frequency of our observation: with quarterly data this would result is a loss of efficiency in our estimators.

[53] Later we will review this critique in a context of monetary policy and we will propose some solutions.

[54] Definition of the variables is provided in the appendix.

[55] The RPI was considered instead of the RPIX since the availability of the latter is limited from 1975:Q2. We do not regard this as a misspecification given the extremely high correlation between the two measures of inflation.

as Goodhart and Hofmann (2001) argue, year on year changes on these variables are much more relevant for monetary policy decisions[56]. Inflation is not entered as deviation from the target as in the original Taylor rule specification since there is no evidence that the Bank of England was following an inflation target approach during that period. Some authors (Salmon and Martin 1999) prefer to specify an explicit target. They regress inflation[57] on a time trend for the period 1976:Q2-1992:Q3; the fitted values are then considered as the inflation target. We find this approach weak in two ways:

1) the period under investigation is clearly influenced by the high inflation during the 70s and early 80s, and the overshoot in the 90s. If a longer period of time was considered then a completely different inflation target path would have been found. Fig. 2 gives an example. The negative sloped line is the inflation trend identified by Martin and Salmon (1999), while the line with positive gradient is obtained using the Martin and Salmon specification but considering the period 1970:Q2-1992:Q1.
2) There is a second reason why Martin and Salmon and other authors that follow this approach might be incorrect. For them, in order to be able to identify correctly the monetary policy rules "we have to define the objectives of policy" (p.23). However, as Nelson (2000) illustrates, there is no evidence that the Bank of England had had an explicit inflation target.

Last we order the policy instrument. As in the Taylor rule-type analysis we consider the nominal short term interest rate as the variable directly controlled by the monetary authorities. Ordering the monetary policy last, we assume that the Central Bank reacts to movements (i.e. deviations) in output and inflation within the quarter.

This VAR model has two advantages: 1) it is consistent with the economic theory. The ultimate goals of the monetary authorities have always been those of price and

[56] They analyse the impact of monetary policy shocks on a set of asset prices. The test in conduced on the G-7 countries: the vector employed is ordered in the following way: Detrended output, annual CPI inflation, real house prices, real exchange rate, real interest rate and real share prices. Real exchange rates and interest rate have a reverse order for Non-Continental European countries.
[57] Here we use quarterly inflation rather then annual inflation.

financial stability (identifiable as output volatility). This specification could be interpreted as a small empirical version of a standard macroeconomic model. comprising IS-schedule, a Phillips curve and a monetary policy reaction function specified as a Taylor rule. 2) It satisfies the criteria of parsimony. Following Thomas (1997, p.363) "[...] a simple explanation of the data should always be preferred to a more complicate explanation".

2.3.1 The econometric approach

We are interested in studying the dynamic behaviour of an nx1 vector of economic variables, X_t. Our modelling strategy is to estimate a structural VAR(p) model of X_t:

$$A_0 X_t = \mu + A(L) X_{t-1} + \eta_t \tag{2.2}$$

where η_t is a $nx1$ vector of i.i.d (0,Ù) structural shocks; μ is a vector containing all the deterministic components (if any); and $A(L)$ is a nxn matrix polynomial in the lag operator L.

The estimation of a structural VAR requires 2 steps. The first step consists of estimating by OLS the reduced-form representation of X_t, where X_t is regressed on lags of itself:

$$X_t = \mu' + B(L) X_{t-1} + u_t \tag{2.3}$$

where $B(L) = B_1 + B_2 L + \ldots + B_p L^{p-1}$ and B_i is a nxn matrix, u_t is a reduced form VAR innovation vector and μ' is a $nx1$ vector of deterministic components.

In the second step, the VAR innovations (u_t) are used to estimate the A_0 matrix and to recover the structural shocks. Equating equations (2.2) and (2.3) imply the following relationship between the reduced-form innovations (u_t) and the structural shocks (η_t):

$$A_0 u_t = \eta_t \tag{2.4}$$

In order for A_0 and η_t to be identified, A_0 must contain at least n(n-1)/2 zero restrictions. A_0 is the key matrix, since it tells us how the endogenous variables are contemporaneously linked to each other and the identification of A_0 allows us to understand the relation between the reduced and the structural form VAR. The problem is that A_0 is unknown and it cannot be derived directly from the estimate B.

The matrix A_0 is modelled so that we can define $\Omega = ADA'$, where Ω is a real symmetric positive definite matrix[58], D is diagonal of unique coefficients and A is a lower triangular matrix. This implies that only the structural shocks are uncorrelated with its past value, and past value of X_t, but also that the reduced forms innovations are uncorrelated with each other. In our model we have:

$$\begin{bmatrix} u_{y,t} & 0 & 0 \\ a_{21}u_{y,t} & u_{\pi,t} & 0 \\ a_{31}u_{y,t} & a_{32}u_{\pi,t} & u_{i,t} \end{bmatrix} = \begin{bmatrix} \eta_y \\ \eta_\pi \\ \eta_i \end{bmatrix} \tag{2.5}$$

As the structure of the restrictions implies the last shock (η_i) is given by the composition of $a_{31}u_{y,t} + a_{32}u_{\pi,t} + u_{i,t}$. This is an important assumption since the ordering of the variables determines the magnitude of the shock.

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[58] See Hamilton (1994, p.87-92).

Once A_0 and the $\eta_t s$ have been estimated, the remaining structural parameters are calculated by observing that Eqs. (2.2) and (2.3) also imply $A_i = A_0^{-1} B_i$ (i=1...p). The structural model can then be used to study the time-series properties of the data in a number of ways. An important feature of the VAR analysis is that it allows researchers to study the impact of an unexpected change in one of the variables in the vector X_t. To study such a response we need to invert the VAR, yielding the Vector Moving Average (VMA) representation otherwise known as Wold's decomposition.

$$X_t = [A_0 - A(L)]^{-1} \mu + [A_0 - A(L)]^{-1} \eta_t \tag{2.6}$$

Or in more compact form:

$$X_t = \mu'' + C(L)\eta_t \tag{2.6'}$$

The process to move from Eq. (2.2) to (2.6) is not straight forward since we require that the process is covariance stationary. We require that the eigenvalues (λ) of the C matrix all lie inside the unit circle. In other words we need that the eigenvalues of the C matrix have the following property:

$$\left| I_n \lambda^p - c_1 \lambda^{p-1} ... c_p \right| = 0 \tag{2.7}$$

When $|\lambda| < 0$ the VAR can approximated as a MA model. When this condition is satisfied we can calculate the impulse response function (IRF) of X_t to a particular structural shock. So the response of the $x_{i,t+1}$ variable to $\eta_{j,t}$ shock is the appropriate element of $C(L)$. This can be interpreted as the first derivative of the left-hand side variable (x_i) with respect to the shock:

$$\frac{\partial x_{i,t+1}}{\partial \eta_{j,t}} = c_{ij} \tag{2.8}$$

So the impulse response function is the plot of the sequence of the response of x_{t+s} to a unit shock in $\eta_{j,t}$. Since this valuable tool can be thought as a "dynamic multipli er", the IRF provides a forecast of the value of X_t when new information about the value of u_t is available. Thus in we can write:

$$\frac{\partial E\left(x_{t+s} \mid I_t\right)}{\partial x_{jt}} = \text{IRF} \tag{2.9}$$

where I_t is the information set available at time t. Furthermore from Eq. (6') we can give an interpretation to μ''; it can be thought of like an unconditional mean or long run value toward which the variable has to converge.

Frequently VAR experiments of the monetary transmission mechanism are conducted considering the level of the variables. Bagliano and Favero, for example, (1998, p. 10) write that "some of the variables display a possibly nonstationary behaviour. Nevertheless, we estimate the system with six lags and all variables in level, with no imposition of cointegration relations. In so doing we avoid a long-run identification problem, which may be in principle difficult to solve". The problem with such a statement is that possible trends cause instability in the impulse response function. Indeed stability is a necessary condition for the VAR specification since we are interested in the magnitude of the response to a shock, but when the VAR is unstable its dynamic is meaningless. We illustrated previously that an AR(n) process can be transformed into a moving average (MA) representation, but this requires that the complementary function collapses to zero as the number of iterations goes to infinity. Therefore, entering the variables in levels when a clear trend exists in the data causes instability in the VAR and the impulse response function cannot have a direct interpretation. Furthermore, if the VAR is unstable impulse response standard errors might result invalid.

2.3.2 Some Problems and proposed Solutions to this approach

VAR analyses which describe the monetary transmission mechanism have the advantage of being easy to set up and to interpret. However, such analysis can be subject to some criticism. The first type of critique refers to Lucas (1976) and it is usually referred to as the *policy-noninvariance propositions*. This states that the coefficient estimates are without real interpretation since they would change as policy regimes change (i.e. when the rule of systemic monetary policy changes). Bagliano and Favero (1998) find support to the issue of parameter instability. However, their final conclusion is that the basic results of the VAR literature do not change.

Another problem associated with VAR models is that when the short term nominal interest rate is used as the policy variable the response of certain macroeconomic variables (in particular price level) is difficult to interpret. To overcome this problem many authors have suggested the use of parsimoniously restricted models (see Gordon and Leeper (1994), Christiano, Eichenbaum and Evans (1996), Bernanke and Mihov (1998), Uhlig (1999)). In this literature, the monetary policy shocks are identified imposing exclusion restrictions on the matrix of the contemporaneous impact based on economic models. However, following Canova and Pina (1999, p.24), these models produce impact dynamics which are not consistent with the restrictions imposed by the identification scheme, since they tend to be "econometrically underidentified". They state that "imposing false restrictions implies an omitted variables bias and [...] the non-zero restriction will capture, to a large extent, the effect of omitted variables. [...] Misspecification (both in terms of sign and magnitude) of the impact coefficients may translate into distorted estimates of the dynamics, since the matrix of contemporaneous effects enters the matrices of estimated structural lagged coefficients".

According to some authors, (see Hoover and Jordà, 2001 and Bagliano and Favero, 1998) VAR analysis itself suffers from *the Sims critique*[59]. According to Hoover and

[59] Sims (1980)

Jordà (2001, p. 9) the ordering of the variables might require "as much justification as many other identifying assumptions if it not to be incredible". Bagliano and Favero (1998) explain that this critique relates to how the monetary policy is entered into the analysis, and how it can be bypassed considering restrictions related to the institutional context. Measuring systemic monetary policy with a VAR methodology must consider restrictions on the monetary block in order to reflect operational procedures implemented by the monetary policy makers. In other words, the wrong choice of the policy instrument and the ordering of the VAR can lead the researcher to misleading conclusions. If, as Sims does, we assume that monetary policy variables are unaffected by contemporaneous innovations to the other variables, we will order the monetary instrument first; if, instead, we assume that Central Bank follows a Taylor rule type of policy then the interest rate has to be ordered after inflation and output. This approach generates completely different monetary policy disturbances: in the latter case it will be a composition of three different shocks, having a much bigger magnitude than the former case.

Rudebusch (1998) casts some doubt on the ability of VARs models capturing the real dynamics of monetary policy. The information set is typically too small to validate the results[60]. Furthermore, the data employed are final data and not real time data, while the true reaction function can only include preliminary data. This might lead to inconsistency of the estimator. In fact, we can estimate the reaction function as:

$$m_t = b\pi_t^F + u_t \qquad (2.10)$$

but the true reaction function is:

$$m_t = b\pi_t^P + v_t \qquad (2.11)$$

[60] Canova and Pina (1999) conduct two experiments in order to verify this hypothesis. They conclude that their results do not show any qualitative change.

where m_t is the money stock and $\eth_t$ is the inflation and the superscript F and P denote respectively final and preliminary data. We consider the final data as the sum of the forecasted value plus an error term:

$$\pi_t^F = \pi_t^P + \varepsilon_t \qquad (2.12)$$

Combining the three equations we get:

$$m_t = b\pi_t^P + u_t \qquad \text{where } u_t = b\varepsilon_t + v_t \qquad (2.13)$$

This means that if the forecaster produces inefficient estimates, then u_t and π^P are correlated, making the estimator "b" inconsistent.

There is another point that is hardly emphasised in the prevalent literature. In VAR studies, the focus is primarily on the monetary policy shocks and much less attention is paid to the systematic part of the system. We will refer to this as an *economic misspecification.* According to McCallum (1999, p. 3) "emphasis on the shock component has been overdone", because "qualitatively the unsystematic portion of policy instrument variability is quite small in relation to the variability of the systematic component". This implies that more attention should be placed on the set of non-policy variables ordered before the monetary policy instrument. Consider, for instance, the following equation as in Rotemberg and Woodford (1997), which represents the monetary policy behaviour in its more general form:

$$i_{t+1} = r^* + \sum_{k=0}^{n\pi} \phi_k (\pi_{t+1-k} - \pi^*) + \sum_{k=0}^{ny} \lambda_k y_{t+1-k} + \varepsilon_{t+1} \qquad (2.14)$$

where r^* is the long term nominal interest rate, π^* is the inflation target and y is the output gap; ε_t is the exogenous monetary policy shock (i.e. unsystematic component). Following Christiano *et al.* (1997, p. 8), Eq. (2.14) can be written in the more general form:

$$S_t = f(\Omega_t) + \sigma\varepsilon_{st} \tag{2.15}$$

S is the instrument of monetary policy, Ω is the information set, and $f(.)$ is assumed to be a linear function that relates Ω and S. The monetary policy shock is the error term ε_{st}, which is considered orthogonal to the information set, while $f(\Omega_t)$ is the feedback rule and σ is a positive number.

The problem emerges when we look at the information set considered in $f(.)$. Christiano *et al.* (1997) and the prominent literature that follows include the VAR variables in their log levels, assuming, consequently, that monetary authorities respond to the level of GPD and CPI[61]. What emerges is that the way in which the variables are entered in the VAR makes the result *economically misspecified.* In order to explain why we believe $f(\Omega_t)$ is not correctly determined, we need to analyse how Eq. (2.15) originates. The monetary policy instrument S (i.e. optimal monetary policy) is derived from a stochastic control problem. The Central Bank chooses an infinite sequence of controls to minimise the expected discounted value of the intertemporal quadratic loss function:

$$\min_{\{\varphi_t\}_{t=0}^{\infty}} \tfrac{1}{2} E_t \sum_{i=1}^{\infty} \beta^i [\pi_{t+i}^2 + \alpha y_{t+i}^2] \tag{2.16}$$

subject to some constrains, typically an Aggregate Demand and an Aggregate Supply equations; where E_t denotes the expectation operator given the set of information available at time t; β^i is a discount factor; y_{t+1}^2 is the deviation of output from the

[61] Angeloni and Kashyap and Mojon and Terlizzese (2002), Peersman and Smets (2001) analyse the impact of monetary shocks in the Euro Area. Their non-policy variables in their vectors are log of CPI and real GDP. They justify this specification allowing for implicit long-run cointegration among the variables.

trend (output of full employment), and π^2_{t+1} is the deviation of inflation from the target. The parameter α is the relative weight attached by the Central Bank on output gap stabilisation[62]. When α tends to infinity the policy-maker cares only about output, and when α tends to zero (s)he cares only about inflation What it is important to notice here is that the *loss function* of the policy-maker (i.e. the function that the authority tries to minimise) is composed of variables expressed as a deviation from a trend or expressed as a variance. In other words, what counts is the volatility of the *gap* of the two variables; the focus of the policymakers is not on the level of the variables. In our view this is a fundamental point that might cast some doubt on the identification exercises which have been undertaken so far. The logical conclusion is, therefore, that $f(\Omega_t)$ in Eq. (2.15) should incorporate the idea that "policy-makers want to minimise squared deviations of output from trend and inflation from the target" (Martin and Salmon, 1999 p.23)[63]. Therefore, failing to consider the true systematic component may result in an incorrect specification of the monetary policy innovations.

Before proceeding to estimate our model, a few more words are required about the use of VAR analysis. We believe that this is a valuable tool since it allows us to distinguish between that part of monetary policy which is fully anticipated by the market agents and the unanticipated component (i.e. shock). One important requirement is that the "systematic component" is correctly specified; otherwise the system would generate false innovations. In such regard, since the true monetary transmission mechanism is in many parts unknown, two aspects need to be underlined: 1) few variables should be preferred to vectors with many variables whose ordering is questionable; 2) structural VARs incur the risk of imposing "false restrictions", making the system overidentified and leading the researcher to generate wrong results and thus reach wrong conclusions. Hence, the VAR that we set up in

[62] The parameter is defined as $\alpha \geq 0$

[63] In the same spirit as Batini and Nelson (2000). McCallum goes a step further. He argues that VAR specifications should include some indicator of financial crisis. This might be a serious issue since excluding some variables changes the fitted residuals and the pattern of the impulse response function. However, the main concern here is that there is no agreement whether the Central Bank should control asset prices.

Eq. (1.1) overcomes the economic critique presented above since it takes into consideration the true Central Bank policy objective function. Furthermore, it is a macroeconomic model based on a system of three equations which does not suffer the possibility of imposing false restrictions.

2.4. Empirical Results

In this section we present the response of output and inflation to unexpected movements in the monetary policy instrument. Furthermore, we highlight how these shocks are transmitted to the monetary policy target variables.

2.4.1 The Response of output and inflation to monetary policy shocks

Eq. (1.1) is estimated for the period 1970:Q1-1992:Q3[64]. The sample period is chosen taking into consideration that from October 1992 the Bank of England adopted an explicit inflation target strategy. This imposes a "policy structural break" in inflation. The objective function of the Central Bank would now be to consider a different specification for inflation. Using the sole inflation level would not be appropriate. Two lag lengths of each of the variables is chosen following the Akaike Information Criterion, the results of which are presented in Table 2.1[65].

It is constructed as $AIC = 2\frac{l}{n} + 2\frac{k}{n}$, where l is the log-likelihood, n is the number of observations and k the number of parameters to be estimated. The log-likelihood is

[64] We include an exogenous constant and time trend to take into consideration a possible inflation trend. We tested for the inclusion of a dummy variable corresponding to the ERM period. It did not appear to be significant so it is not considered in our final specification. Following previous works by Sims(1992) and Christiano *et al* (1994), we estimated a VAR model including a commodity price index and another vector where we included a monetary aggregate and the pound/Dmark exchange rate. All the diagnostic tests indicate a poor specification or a specification that was not sensibly superior to the one employed here. When the commodity price index was included, the estimates did not change the response of inflation to monetary policy shocks.

[65] Tables and Figures are reported in Appendix.

calculated as $l = -\frac{T}{2}\left\{k(1+\log 2\pi) - \log\left|\tilde{\Omega}_l\right|\right\}$, where $|\tilde{\Omega}|$ is the determinant of the residual covariance matrix. It is given by $\det\left(\sum_t \tilde{\varepsilon}_t \tilde{\varepsilon}_t' / n\right)$, $\tilde{\varepsilon}_t$ is the p vectors of residuals.

The Portmanteau Autocorrelation Test and the LM test reported in Table 2.2 and 2.3 respectively, do not detect serial correlation. All the four specifications fail the normality test (not reported here). However, following Hamilton (1994, p.298) this should not pose any serious problems concerning consistency in our estimators. We report the table (Table 2.4) and the graph (Fig.2.1) of the inverse root of the characteristic polynomial as in Lütkepohl (1991). None of the values lie outside the unit circle, implying that the VAR is stable (i.e. stationary) and that the impulse response standard error will not be misspecified.

We compute the impulse response function of Eq. (2.1) using a lower triangular Choleski factorisation as in Eq. (2.4). The pattern of the response is the effect of a one standard deviation orthogonalized shock in the interest rate, holding all other shocks at all dates constant. The restrictions imposed imply that the output and inflation affect monetary policy stance within the quarter, while interest rate has no instantaneous effect on the non-policy variables. The standard errors are computed via a Monte Carlo procedure: at each repetition we draw a random sample from the asymptotic distribution of the VAR coefficients[66], and from the simulated coefficients we compute the impulse response functions. After repeating the process 1000 times, we construct the 95% confidence interval by the percentile method.

In the estimated pattern response in Fig. 2.7, a contraction in monetary policy causes an almost immediate reduction in the level of output. It reaches the lowest point after two years, then it slowly starts to increase, regaining the pre-shock value only at the 14th quarter. This supports the idea that money is neutral in the long-run, and that monetary policy shocks do not have a permanent effect on the level of output. On the

[66] Hamilton (1994).

contrary, inflation is initially positively affected by policy shocks and it declines after the seventh quarter, and taking a longer time (more than twenty quarters) to return to its pre-shock value. This result is consistent with that obtained by Dale and Heldane (1993). The major difference is in the time inflation takes to revert to its pre-shock value. In their analysis, inflation increases for approximately four years, sixteen quarters longer than what we find. The most likely explanation is due to the different VAR specification. They order the policy variable first and prices and real output after a series of monetary transmission indicators. Output shows the same dynamics: it reacts faster than inflation to a monetary policy shock.

It is of great interest that the combination of output and inflation moves in opposite directions for more than a year after a policy shock and that inflation drops below its steady state value only when it has reached its minimum point. This suggests that in the short run inflation is not affected by short run variation in demand. Only when monetary policy has exerted all its effect on output, will it start to fight inflation.

Are these results inconsistent? Does our VAR suffer from the prize puzzle? Why does inflation not decrease immediately with tighter monetary policy? The answer to the first question is no; the results are not inconsistent and the inflation dynamic is not an indication of a misspecification. In fact, "any factor tending to raise the money costs has the potential to cause an increase in the general price level" (Smithin 2003, p.186). At a first glance the response in Fig. 2.6 suggests a cost-push inflation. To see whether this is effectively the case, in the next section we examine the responses of all those intermediate variables that interact to determine the value and response of output and prices.

2.4.2 The monetary transmission mechanism

In the previous section we illustrated that a one standard deviation shock in interest rate causes inflation to increase for more than a year. In this section we try to provide an economic interpretation of this behaviour. To explain this dynamic we need to concede the possibility that monetary policy shocks are transmitted not only via the demand channel (mainly price stickiness), but also via the supply channel (working capital). Both channels call for a decrease in the level of output following a monetary tightening. On the other hand, the effect on the price level is mixed. The demand channel indicates that prices should decrease following a reduction in aggregate demand; on the contrary, the supply channel suggests that unexpected innovation in monetary policy increases the price level due to an increase the firms marginal costs.

In order to investigate if monetary policy shocks are transmitted to the real economy via the supply or the demand channel, we test the impact of policy innovations on different flow of funds of Industrial & Commercial Companies as well as on other variables that are important in describing the monetary transmission mechanism (MTM)[67]. We call these variables $Z_{MTM,j}$.

We proceed by constructing a series of vectors where the policy shock is recovered as in Eq. 2.1, and the MTM variable (Z_{MTMj}) is then added after the short term interest rate; where j indicates the variable of interest. The vector used is given by:

$$[Shock,\ Z_{MTMj}]' \qquad (2.17)$$

Each time the system is estimated replacing Z_{MTMj} with the variable of interest. The fact that Z_{MTMj} is ordered last implies that it reacts within the quarter when the monetary policy shock occurs.

The results are presented in Figs. 2.5 through 2.28. We begin by examining the impact of a monetary policy shock on the long term interest rate (Fig. 2.24), the companies real investment (INVR), Fig 2.8. The estimated impulse response

[67] The ICCs variables included are (in real terms): total income, profits, total funds, internal funds, net borrowing requirement, total external funds, bank borrowing, interest rate payment, coverage ratio and investment. These are collected by DATASTREAM and correspond to Table 10.6 C of the ONS Report. The other monetary transmission mechanism variables are: long term nominal interest rate and return to bank loan.

functions show that there is an immediate increase in the former and a slow decrease in latter. This result is consistent with standard economic theory. The level of investment is a negative function of the interest rate. Only after five years does investment return to its pre-shock level, although the long term interest rate reverts much faster[68]. It takes 3 years to revert to its steady-state value.

The responses of companies total income (Fig.2.9) and profits (Fig.2.10) have quite a different pattern. The immediate response is a positive but not a significant movement; only after six quarters do the responses of the two variables turn negative and significant. The peak is reached by the 8th quarter: just one period after the minimum output level. The fact that companies profits do not react immediately is not surprising and does not contradict economic theory: they are associated with the level of realised sales that are in turn linked with the level of interest rates and output at the previous period or four periods (one year) earlier. Furthermore, it is noticeable that the level of inventories does not have any reaction for the first five quarters. Afterwards, it sharply declines around the fifth quarter after the shock. This supports the idea that their negative level is a strong component in a situation of declining economic activity as suggested by Blinder and Maccini (1991). These results do not seem to support the fact that following a monetary shock firms start to "pile-up" inventories[69].

Looking at the results from the flow of funds impulse response functions we notice that a positive monetary policy shock generates an immediate decrease in total funds available (Fig. 2.11). This decrease seems to be associated with a strong fall in internal funds. This reduction of internally generated finance is evident considering the level and proportion of the total funds available and as a ratio of the GDP (Fig. 2.14). At the same time we register an increase in Net Borrowing Requirements (NBR). This reflects the need for capital from Industrial and Commercial companies. The response of external funds to monetary policy shocks supports the finding that

[68] For each vector we calculate the inverse of the characteristic polynomial (not reported here). There show that the different VAR specification are stable over the estimation period.
[69] Bernake and Gertler (1995).

there is a need for funds and this is fulfilled by contracting debt. The plots tell us, in fact that the majority of NBR is financed using bank loans. The results confirm the findings of Christiano *et al.* (1994). They run a similar experiment and conclude that the business sector in the US responds to a contraction in monetary policy with an increase in net funds which is mainly the result of the contraction of short term debt, namely commercial papers, bank and other loans. Furthermore, this behaviour can be explained recalling the findings of Corbett and Jenkinson (1996, 1997): UK firms rely heavily on internal sources of finance (i.e. internal funds)[70]; during a monetary policy tightening their amount is decreased by a lower level of sales and further, their discounted value decreases, forcing the firm to rely on external capital. There is a significant change in the portfolio composition of firms financial instruments.

At the same time we see that the coverage ratio (Fig. 2.22), which according to Bernanke and Gertler (1995) has the power to measure the financial wealth[71], responds to shocks with a highly significant and persistent increase. It is only at the 12th quarter that it returns to its steady-state value. The response of interest rate payments has the same pattern. The liquidity premium (LIQ), Fig. 2.23, shows a steep increase for the first two quarters, returning to its starting level after one year, roughly one period earlier than the short term interest rate. Considering that LIQ is the extra amount required by banks to provide loans[72], its sharp increase after a monetary policy contraction seems to suggest that the lending channel is at least partially verified. It is evident that the liquidity premium increases when there is an unexpected change in the risk-free interest rate. However, it was observed previously that this does not induce a decrease in bank loans. Rather, it shows that banks increase their provision of loans.

[70] It is indicative that the total internal funds and INVR have the same dynamic. It seems straight forward to derive that the two aggregates are highly correlated. There is a high degree of sensitivity of INVR to cash flow. Although the causality is not addressed here, we believe that the low cash is the cause, rather then the result of, lower investment following a monetary policy contraction.

[71] It is the ratio of interest payment over interest payments plus profits. It can be thought of both as a premium on top of interest rates that firms have to pay and a measure of the availability of cash flow that firms can use to finance their investments.

[72] Davis and Ioannidis (2002)

Given that LIQ is negatively associated with the entrepreneurs demand for bank loans, are the two findings inconsistent? Is this *perverse* increase in loans inconsistent with the bank lending channel? Not necessarily. A first interpretation could be provided by following Bernanke and Blinder (1992, p. 919): "loans are quasi-contractual commitments whose stock is difficult to change quickly", and furthermore "lines of credit" are important determinants of the pattern of the response of bank loans to shocks or, more generally, in changed business conditions[73]. There is not an expectation of an immediate decrease in bank borrowing. The standard bank-credit channel tells us nothing more than that after a monetary contraction, firms borrow less than what they would have done in a *complete market* environment. Furthermore, considering that Profit and Net Income do not seem to be negatively affected by the monetary policy shock for at least one year after monetary policy tightening, this provides a less necessary sudden adjustment in bank loans. It is only afterwards that borrowings start to decrease. The idea is supported by the analysis of firms liquidity ratio (Fig. 2.25), defined as the ratio of assets on liabilities. It shows an immediate decline and it reverts to its pre-shock value after four quarters. Afterwards, it shows a positive trend (although not significant). This dynamic is the combination of increased liabilities and reduced levels of real assets; the latter seems to be more important in term of magnitude in explaining the behaviour of the ICCs liquidity. Looking at ICCs assets and liabilities, Fig. 2.26 and Fig. 2.27 respectively, we see that after a monetary policy shock we have a significant negative response of the liabilities. An interesting point to note is that assets reach the negative peak after six quarters, exactly at the same point when real output reaches its minimum level. This is consistent with the standard theories: a worsening level of economic activity corresponds to a lowering of the level of profits, and a bigger need for external finance in order to face the shortfall in cash flow. Moreover, liabilities increase as the result of the increased level of interest payments and the increased level of borrowing.

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[73] Morgan (1991, 1992b).

We now compare the behaviour of total external finance, the response of bank lending and the behaviour of the response of the ratio of the level of bank borrowing on the total level of funds available. In a situation of no credit market imperfection we would expect that firms can switch from bank loans to other forms of finance, with a resulting decrease in the above ratio. This, however, does not appear to be the case. The ratio follows closely the pattern of the volume of bank loans. Although it is not clear if the shock has a larger effect on the demand or in the supply of loans we can assert with reasonable certainty that the fact that firms lower their level of investment and borrowing supports the idea that they are financially constrained.

All the results presented shows that an increase in the monetary policy instrument has a supply side effect on real variables. This confirms the hypothesis that monetary policy shocks can be considered as *cost shocks*. The importance of such a channel is presented by Barth and Ramey (2000, p.1). They point out that "supply-side channels are powerful collaborators in transmitting the real effect of monetary policy shifts in the short-run". There are some important reasons to consider this channel: first of all "just as interest rates and credit conditions affect firms' long-run ability to produce (by investing in fixed capital), they can also be expected to affect firms' short-run ability to produce (by investing in working capital). The value of investment in working capital is substantial". A second reason for the importance of the supply channel is given by the fact that considering the demand-only view of monetary transmission mechanism does not provide enough explanation of the big impact of shocks to output. Furthermore, we need to stress that investing in working capital is required given important downward rigidities in wages and salaries. If investment can instantaneously decrease following an increase in the cost of capital, the adjustment is quite slow in the labour market. If we think of the inflation generation process in a New-Keynesian framework[74] then it is the rise in the real marginal cost of capital induced by an increase in the cost of capital which causes the firms to raise their

[74] The New-Keynesian Phillips curve incorporate forward looking behaviour by rational agents and profit-maximising firms. It typically assumes the following form:

$$\pi_t = \lambda(\mathrm{rmc}_t) + \alpha E_t\left[\pi_{t+1}\right]$$

where *rmc* is the real marginal cost.

prices. Indeed, rental cost of capital and interest rate (along with wages) are the major components of firms costs.

We believe that the supply channel is not enough to explain the marked decline in output and price response. The credit channel theory provides evidence that the increase in interest rates can have perverse consequences. This theory suggests that monetary shocks that are initially propagated via aggregate demand can, in a second period, be amplified by the supply channel. As our results suggest, we have an immediate decline in firms internal finance, since its opportunity cost increases directly with an increase in the nominal interest rate. This has a positive impact on the marginal financial cost due to the existence of asymmetric information between the borrowers and the lenders. The fact that the response of the variable LIQ offsets the jump in interest rates is an indication that the broad credit channel is in operation.

Our results provide an explanation for Central Bank's adversity to large changes in interest rate. Given that monetary authorities have an important impact on the portfolio composition of firms financing sources, financial stability problems might arise if the movement in the nominal interest rate has not been completely anticipated by the firms and require external capital to carry on their activities. At the same time a sequence of increases in interest rates without any immediate downsize effect on prices could correspond to a weakening of the companies balance sheets. We cannot exclude the possibility that there is a positive relationship between interest rates, moral hazard and financial Ponzi schemes[75]: the consequence being that an increase in the level of the interest rate could undermine the long-term growth and stability of the entire economic system[76].

Finally we would like to point out that long-run money neutrality is not undermined here. There is strong evidence suggesting that the real effect of monetary policy has only a short-run dimension. The explanation of such a channel can be found in the

[75] This expression is borrowed from Minsky.

[76] This point is highlighted by Borio and Lowe (2001) who stress that even monetary stability does not necessarily guarantee financial stability.

short run rigidities in which firms operate. As time evolves, firms have more flexibility to reduce investment and working capital.

5. Conclusions

This chapter examined how monetary policy shocks are transmitted to the UK real economy. We argued that VAR models are a valuable tool in order to decompose the policy into the systematic and unsystematic components. However we have shown that the misspecification of "non-policy" variables which are not part of the Central Bank information set could lead to a incorrect identification of the shocks.

In our VAR, the shocks were identified by allowing the interest rate to respond to the output gap and the retail price index inflation. We find that inflation increased after a one standard deviation positive shock in interest rates. The aim of the second part of the chapter, therefore, was to find an economic, rather than econometric, explanation of the price puzzle.

We analysed the responses of the flow of funds of industrial and commercial companies and other variables which we regard as important to describe the monetary transmission mechanism to monetary policy shocks. These variables were modelled last, assuming that they responded within the quarter after the shock occurs. We found that after the shock, output and inflation return to their steady-state values, supporting the idea that money is neutral in the long run. One of the major results was the stickiness of the credit aggregate. Real investment showed a steady decline: this dynamic matched the path of the total funds raised internally. However, this fall in real investment was not matched by a decrease in the level of external funds available; in fact, they showed a positive response. We have found that the majority of this increase in external finance is due to bank loans. We argued that the dynamic of our result is not incompatible with the credit channel since credit variables seem to be an important vehicle in transmitting the monetary policy shocks. Furthermore, we have found that the high coverage ratio and the interest rate payment were induced by the fact that firms need to borrow at a higher level of interest. Our results suggest that monetary impulses which are unanticipated by the market participants increase firms marginal costs and therefore the price level. We concluded that the prize puzzle is just the result of the supply side effect of the monetary policy

One final word should be spent on the sample of our investigation. Our investigation has a limited time dimension for two reasons: first, monetary policy has a structural break in October 1992 with the adoption of inflation targeting. Second the flow of fund data as used to explain the prize puzzle has been subject to revision with the 1998. Although these are serious problems to overcome to obtain a reliable econometric estimate, there is not reason to believe that our main conclusions would not hold for the inflation targeting period.

Appendix

All financial data are from the, Office of National Statistics (ONS, and refer to section 10.6B and 10.6C. All data are in real terms: their value has been divided by the price level.

GDP, INT, EX are collected from DATASTREAM and correspond to the data published by the ONS.

- Real GDP (GDPD) was detrended using the Hodrick and Prescott filter with a smoothing parameter equal to 1600. It consists of solving the following sum of squares:
$$(1/T)\sum_{t=1}^{T}(y_t-\mu_t)^2+(\lambda/T)\sum_{t=1}^{T}[(\mu_{t+1}-\mu_t)-(\mu_t-\mu_{t-1})]^2$$
where y is the real GDP, μ is the trend component and λ is the smoothing parameter.
- Annual Inflation Rate (INFA). It is calculated as an index from the first difference of the natural logarithm of the Retail Price Index (RPI): $[Ln(RPI_t)-Ln(RPI_{t-12})]*100$.
- Interest rate (INT). It coincides with the official interest rate. Up to 11th of March 1982 it corresponds to the Minimum Lending Rate. Between 1982Q2 and 1996Q4 it is the Band One "Stop" Rate. Afterwards (1997Q1) the Repo Rate.

Table 2.1: VAR Lag Order Selection Criteria

Lag	Log-Likelihood	Akaike information criterion
0	-463.1922	12.34716
1	-305.5864	8.436485
2	-288.9281	**8.234951***
3	-285.4685	8.380749
4	-282.5164	8.539906
5	-273.2474	8.532827

Table 2.2: VAR Residual Portmanteau Tests for Autocorrelations

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
3	10.28302	0.3281	10.57684	0.3058	9

H0: no residual autocorrelations up to lag h

Table 2.3: VAR Residual Serial Correlation LM Tests

Lags	LM-Stat	Prob
1	4.890559	0.8437
2	8.575251	0.4774
3	4.173977	0.8996
8	3.527877	0.9397
10	4.975163	0.8365
12	4.770161	0.8539

Probability from chi-square with 9 df

Table 2.4: Root of the characteristic polynomial

Root	Modulus
0.749667 - 0.282682i	0.801192
0.749667 + 0.282682i	0.801192
0.695868	0.695868
0.666914	0.666914
0.035859 - 0.195497i	0.198759
0.035859 + 0.195497i	0.198759

Fig. 2.1: Root of the characteristic polynomial

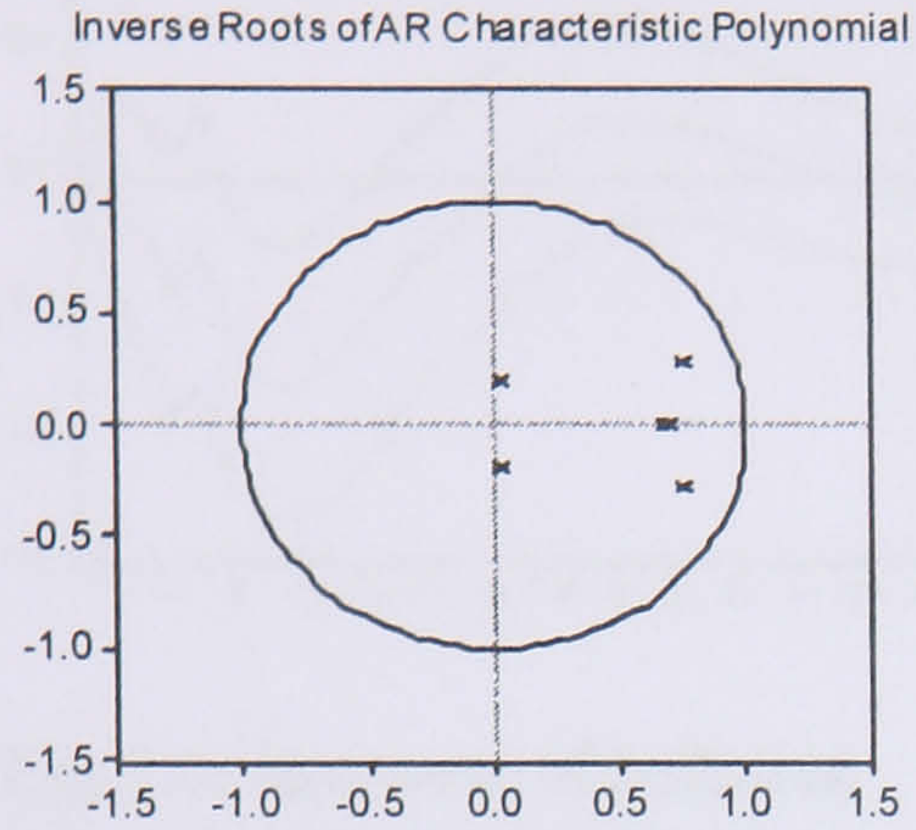


Fig. 2.2: Quarterly Inflation and linear trend

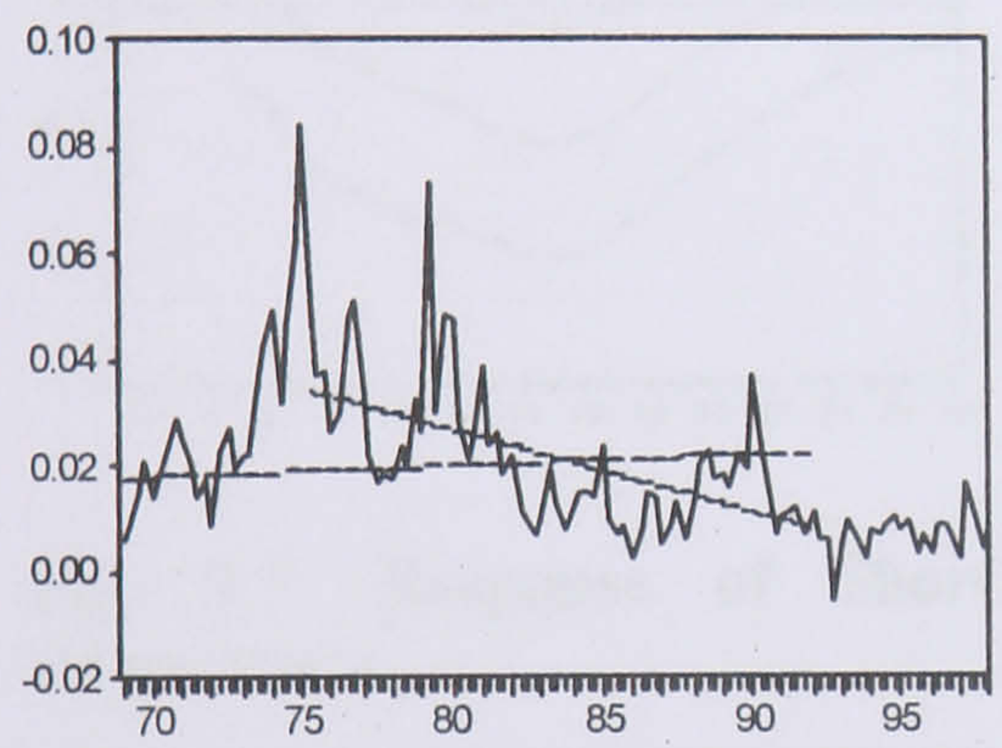


Fig. 2.3: Annual Inflation Rate

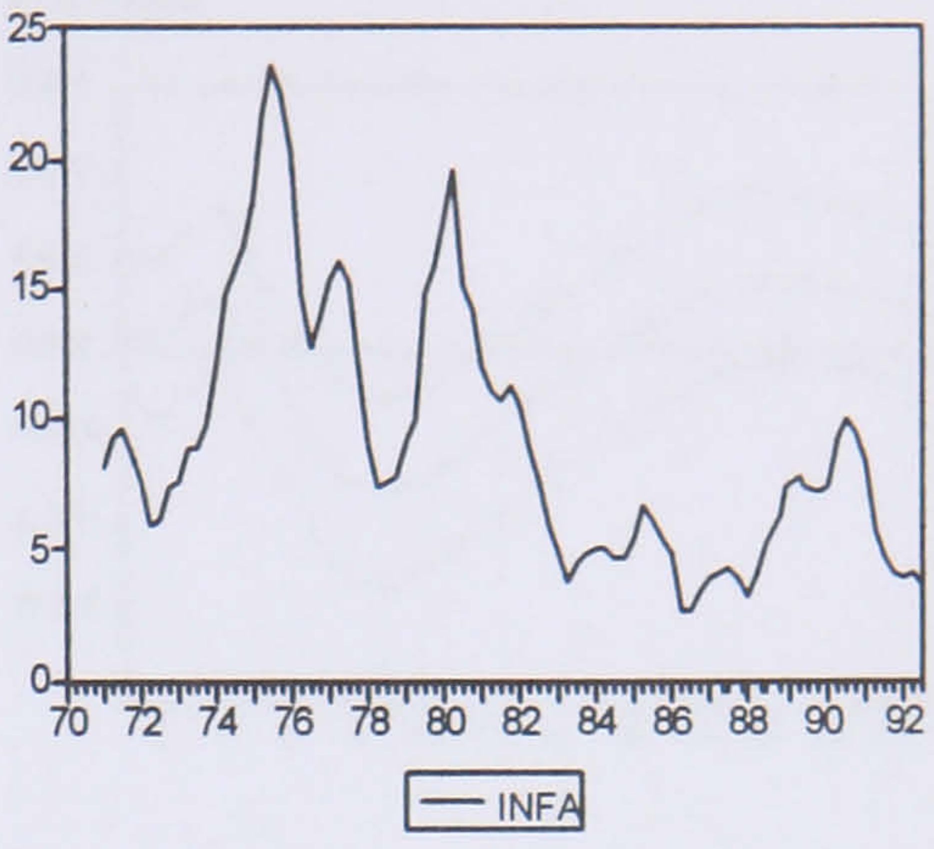


Fig. 2.4: Output: deviation from the trend

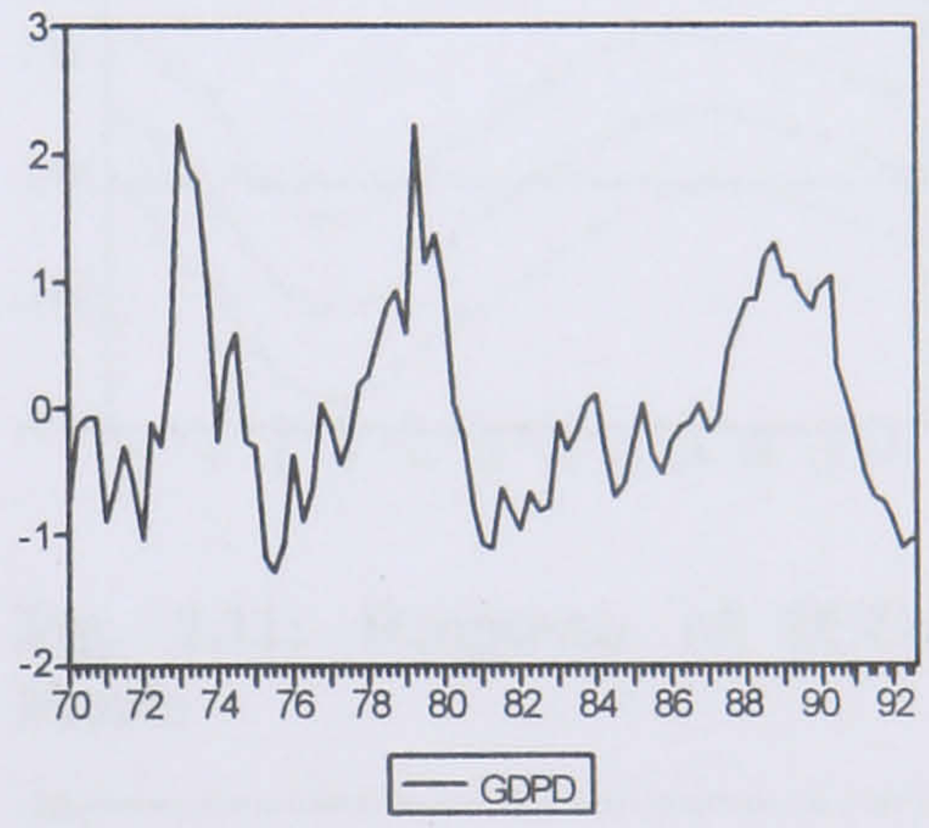


Fig. 2.5: Response of Output gap

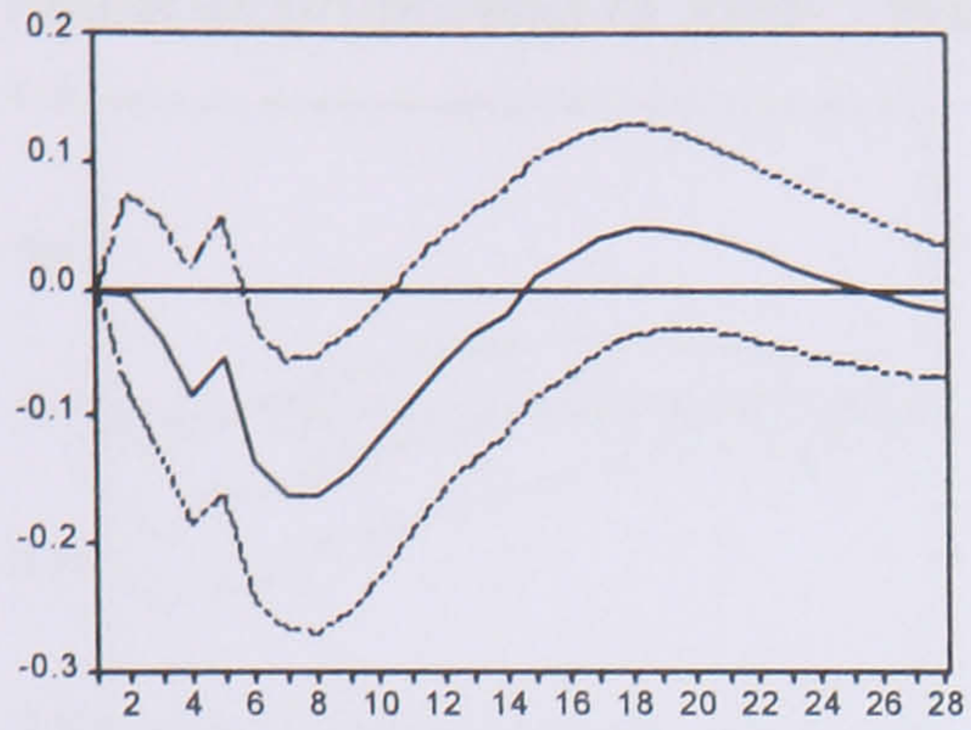


Fig. 2.6: Response of Inflation

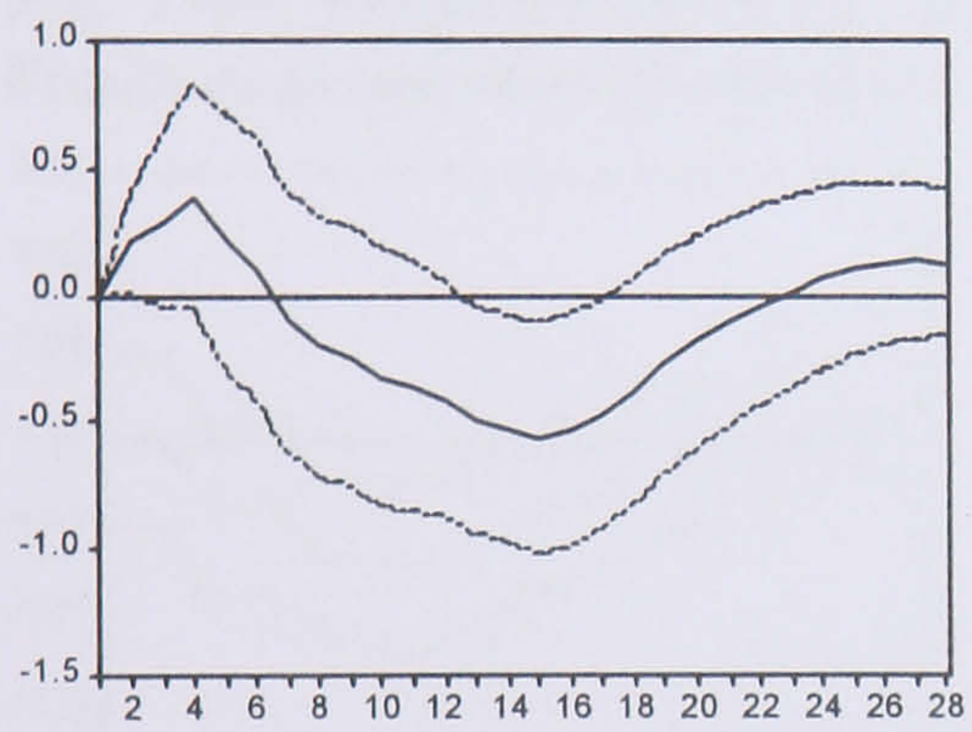


Fig. 2.7: Response of Short term interest rate

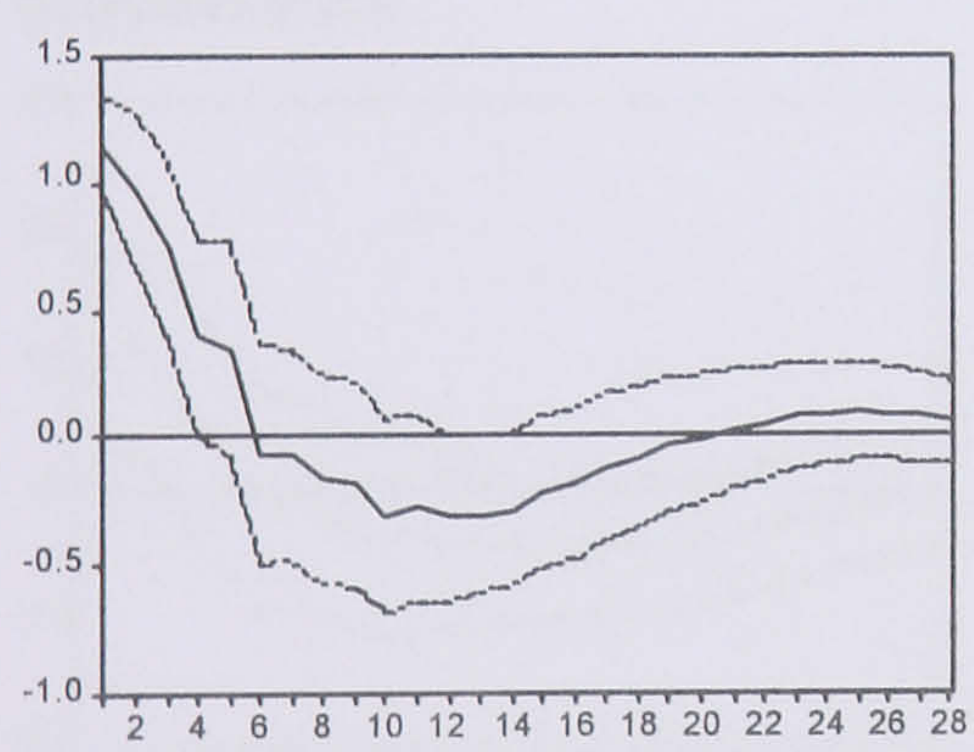


Fig. 2.8: Response of Real Investment

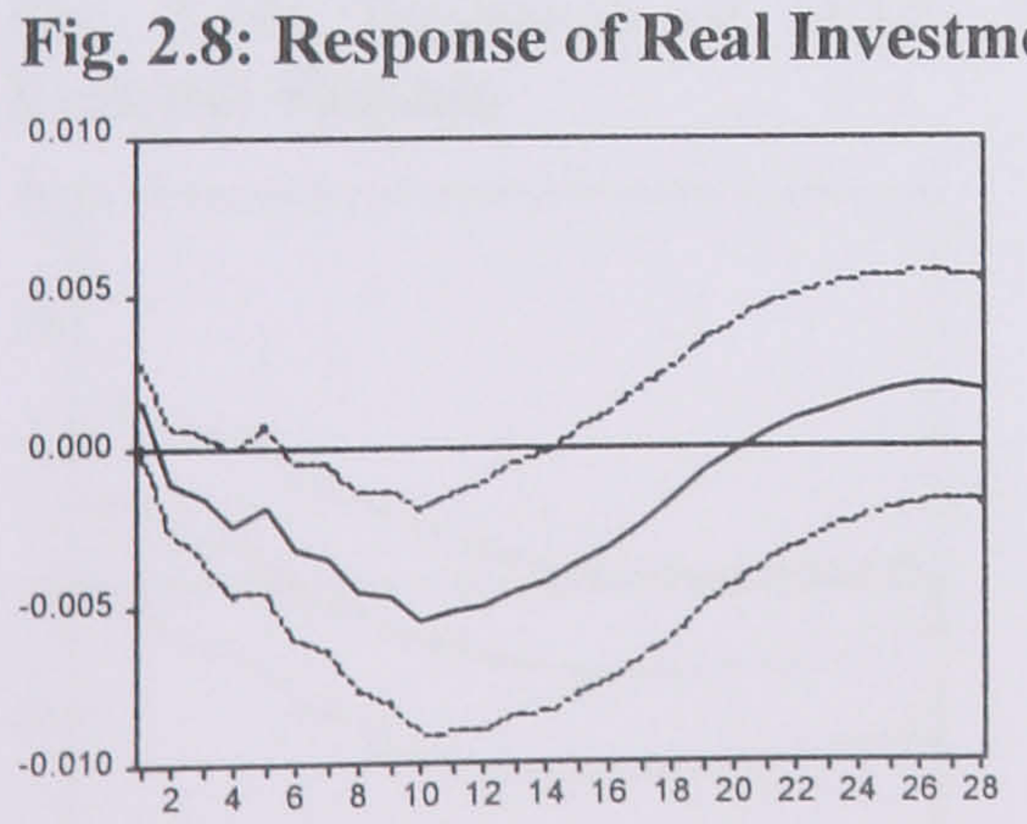


Fig. 2.9: Response of ICCs' Total Income

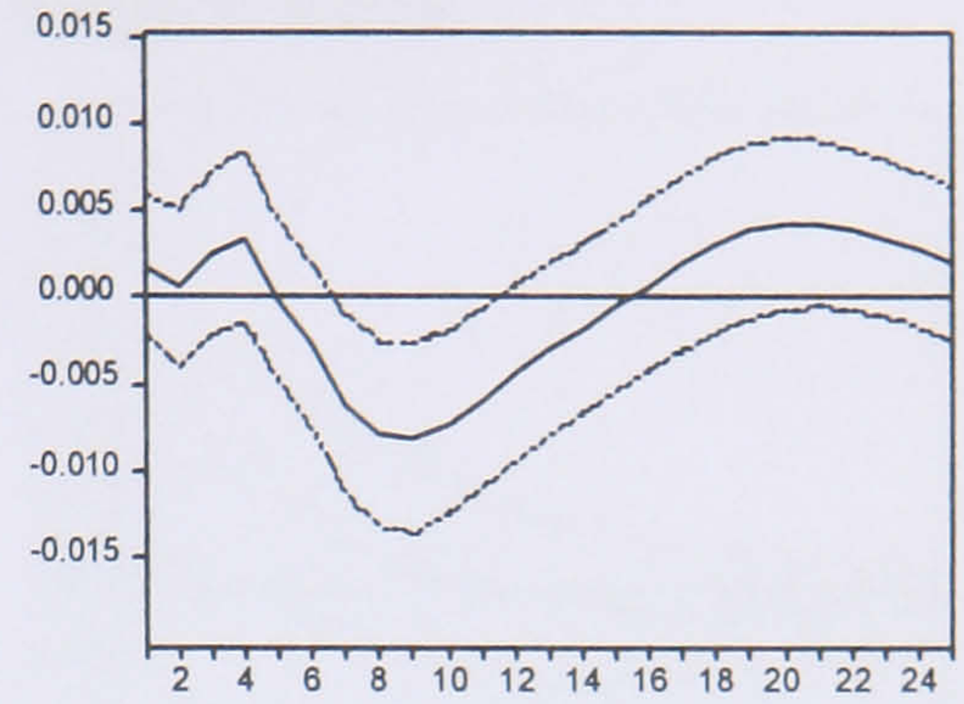


Fig. 2.10: Response of ICCs' Profits

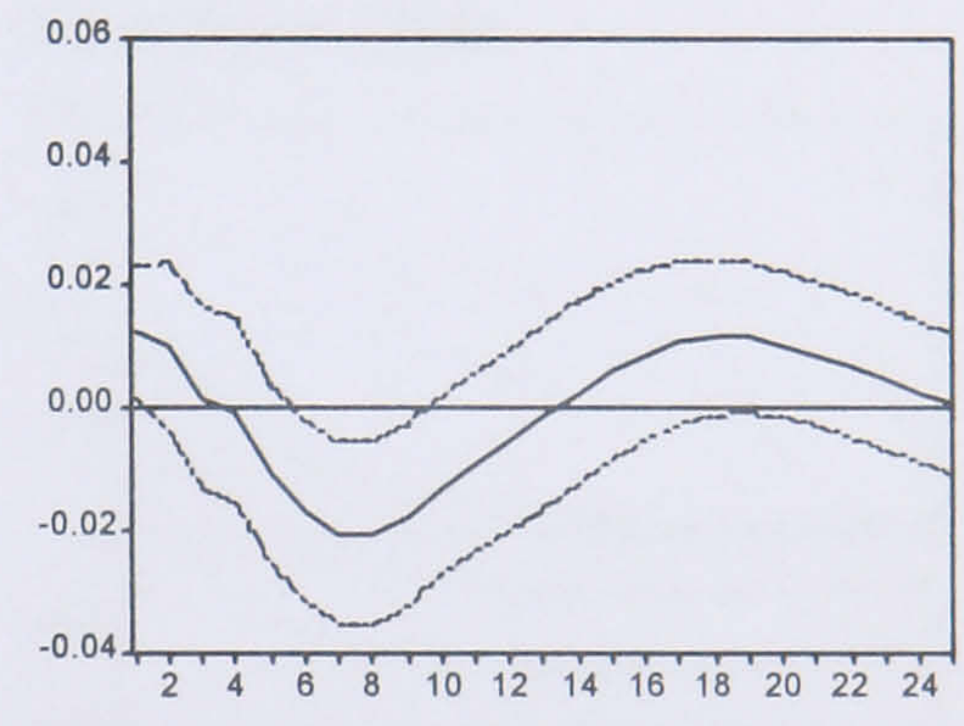


Fig. 2.11: Response of ICCs' Total Funds

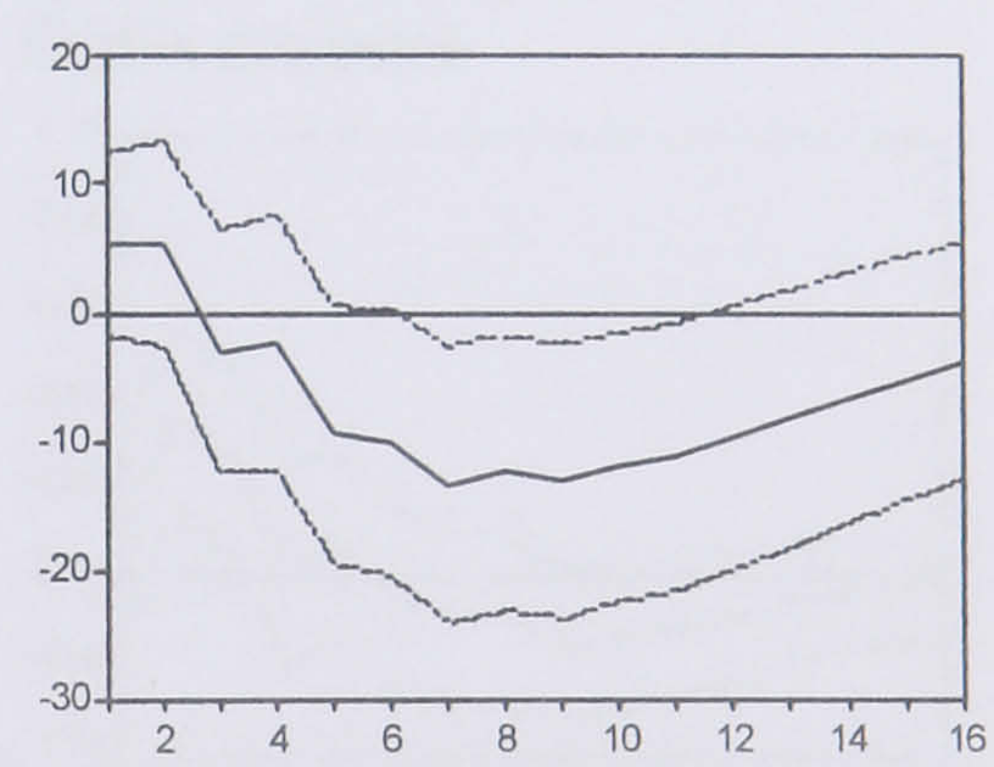


Fig. 2.12: Response of ICCs' Internal Funds

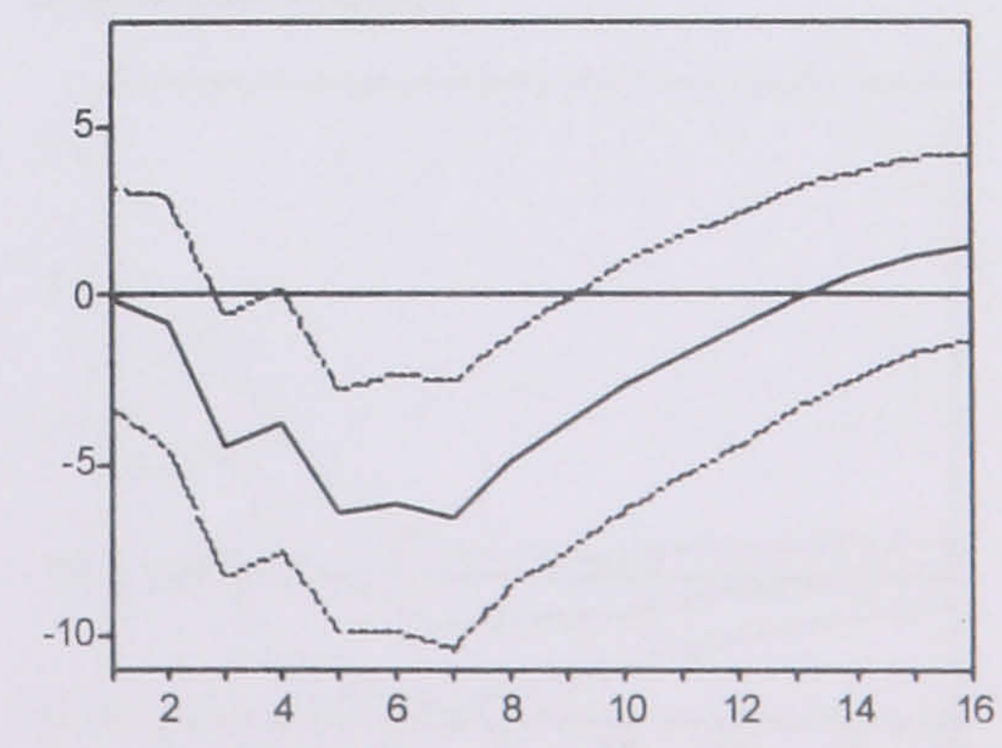


Fig. 2.13: Response of ICCs' Internal Funds as proportion of Total Funds

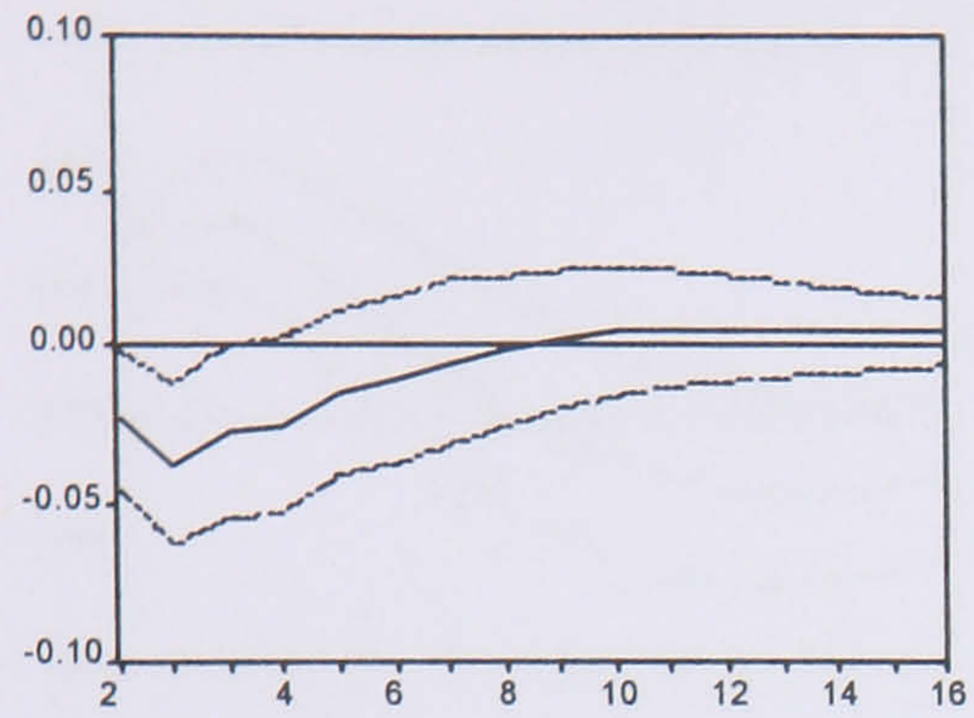


Fig. 2.14: Response of ICCs' Internal Funds as proportion of real GDP

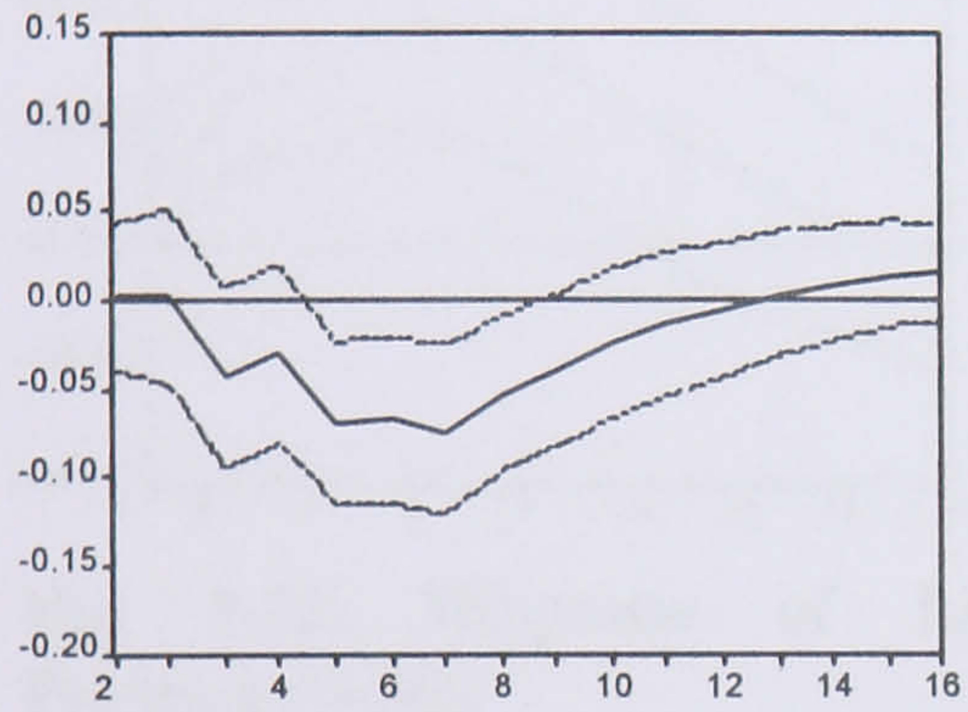


Fig. 2.15: Response of Net Borrowing Requirements

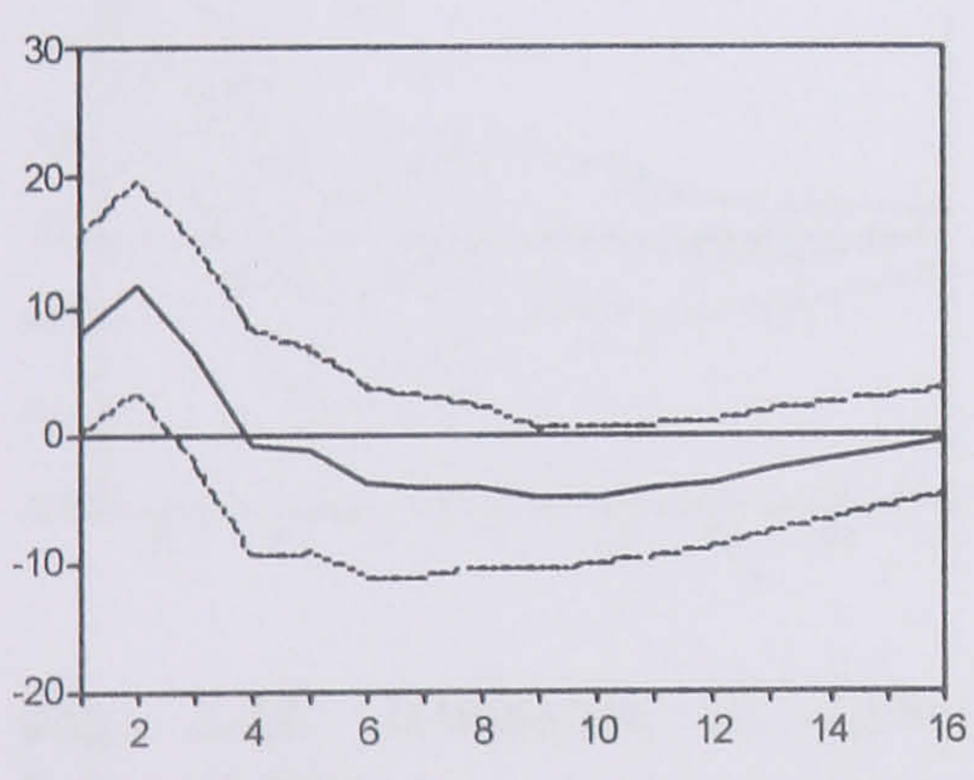


Fig. 2.16: Response of ICCs' Total External Finance

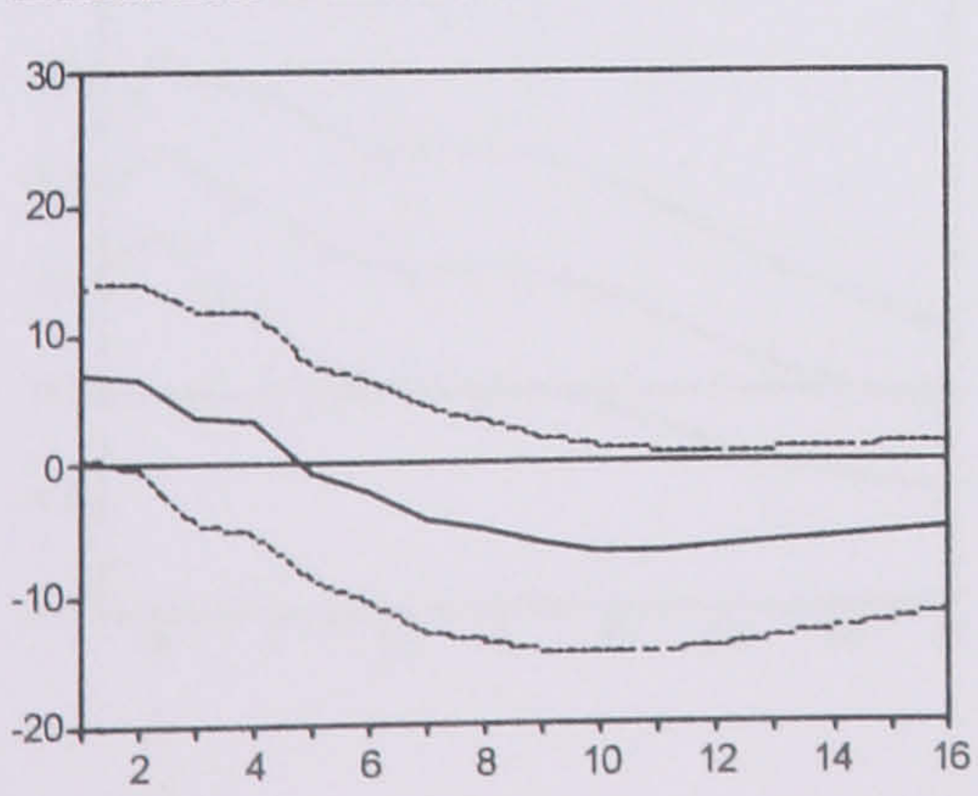


Fig. 2.17: Response of ICCs' Total External Finance as proportion of Total Funds available

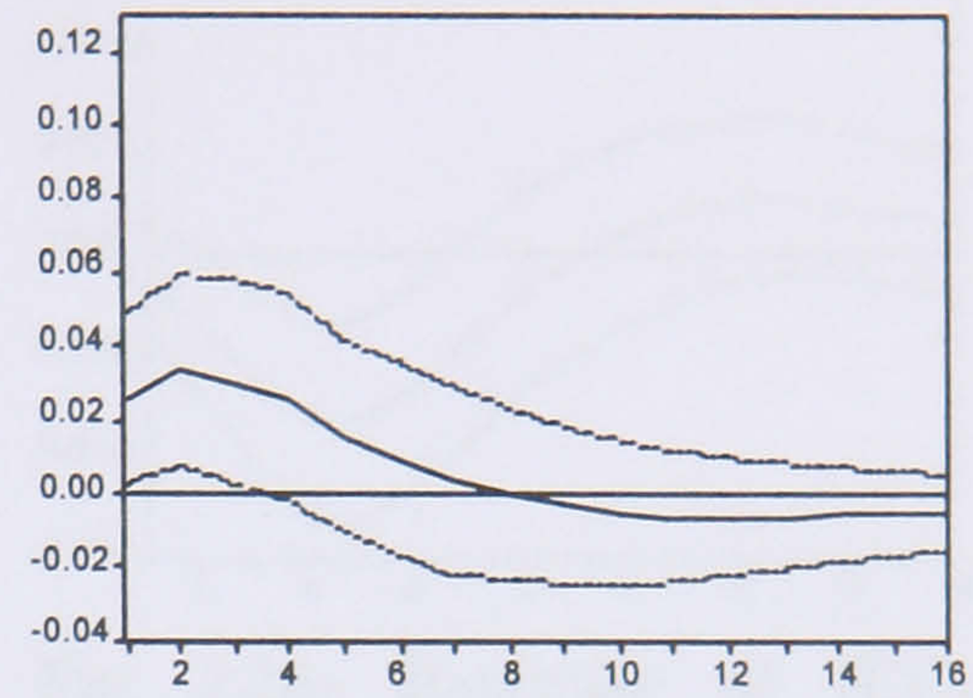


Fig. 2.18: Response of ICCs' Level of Bank Borrowing

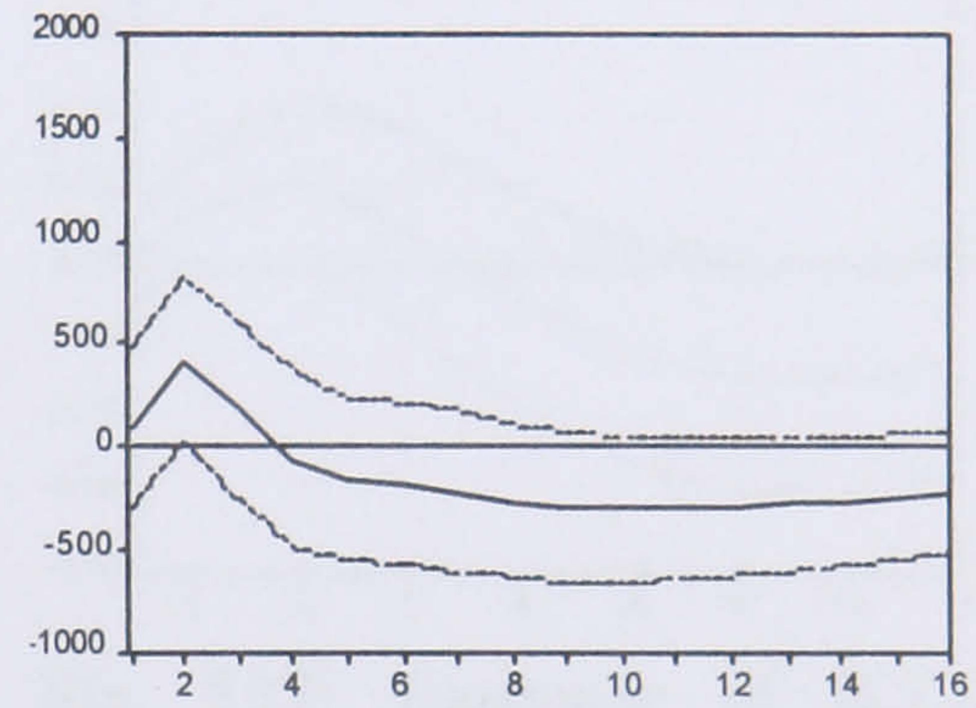


Fig. 2.19: Response of ICCs' Level of Bank Borrowing on the Total level of Funds available

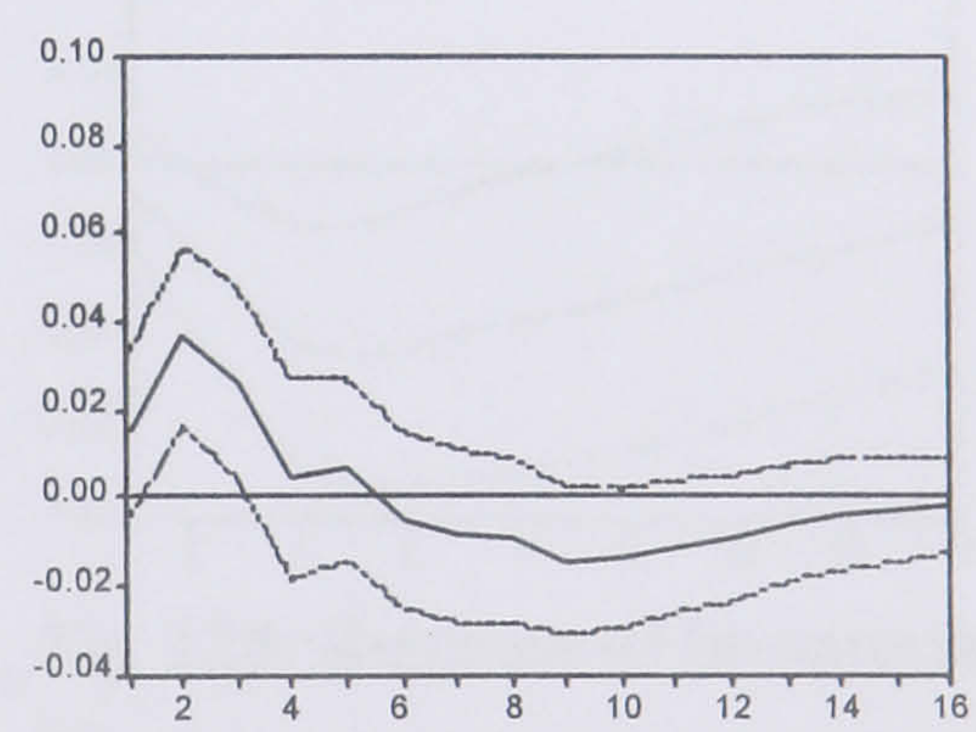


Fig. 2.20: Response of ICCs' Level of Bank borrowing on the Total level of External Funds

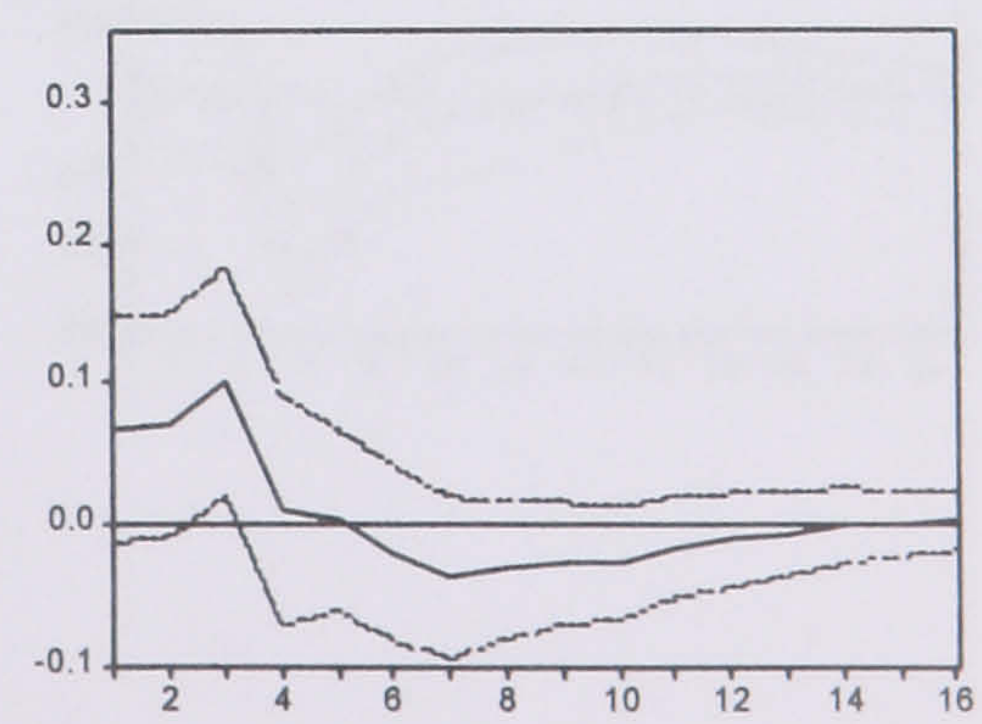


Fig. 2.21: Response of ICCs' Interest Rate Payment

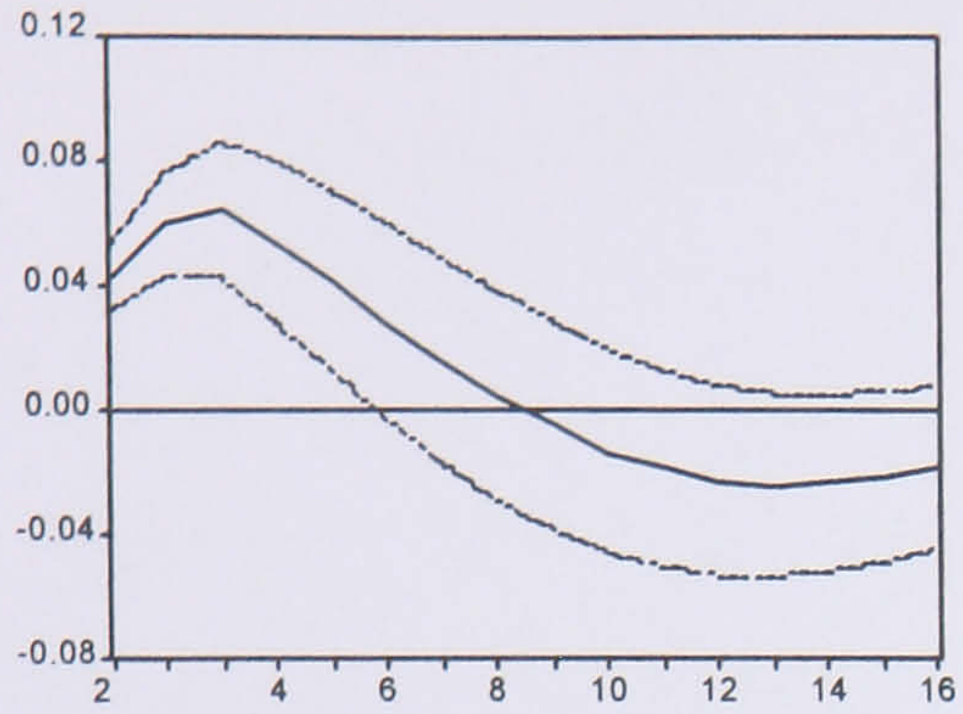


Fig. 2.22: Response of Coverage Ratio

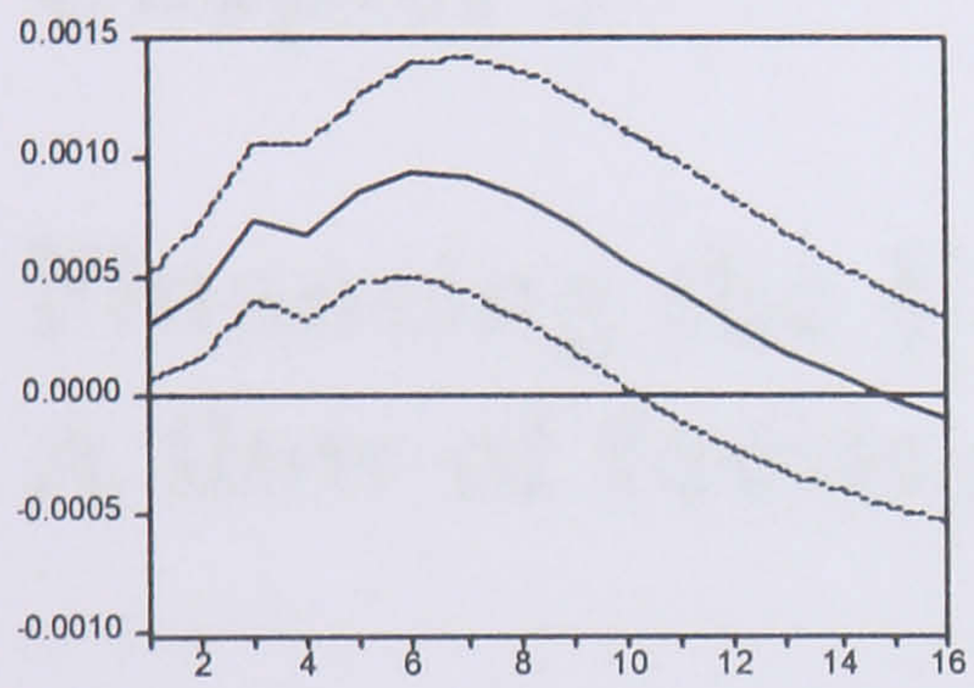


Fig. 2.23: Response of Liquidity Premium (LIQ)

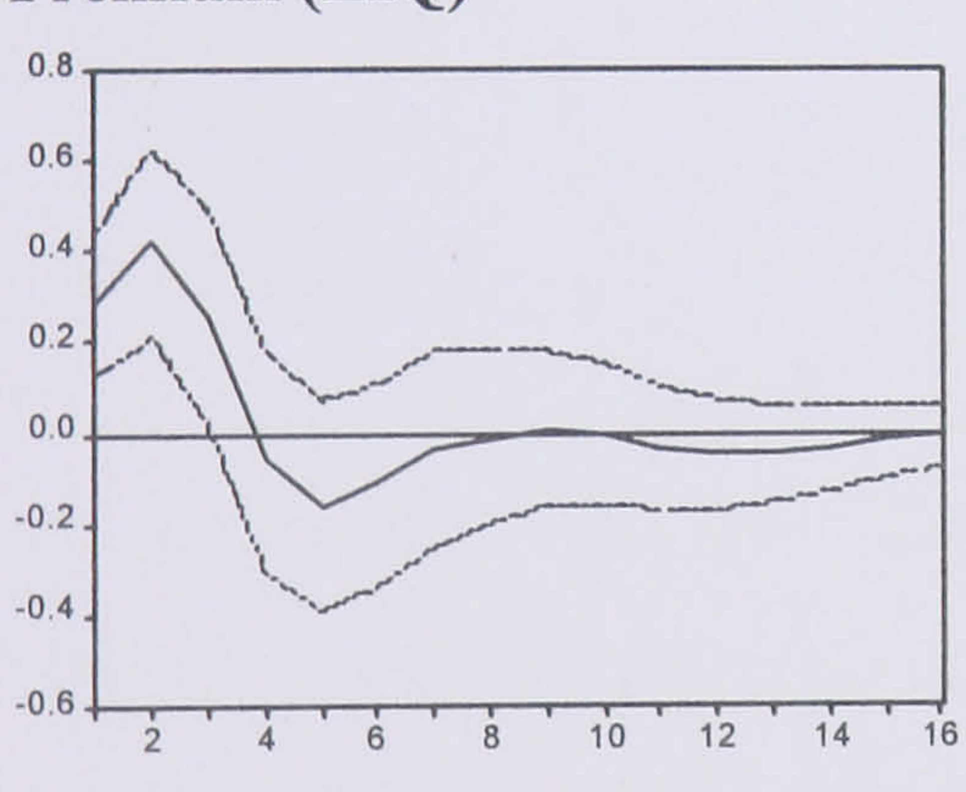


Fig. 2.24: Response of Long Term Interest Rate

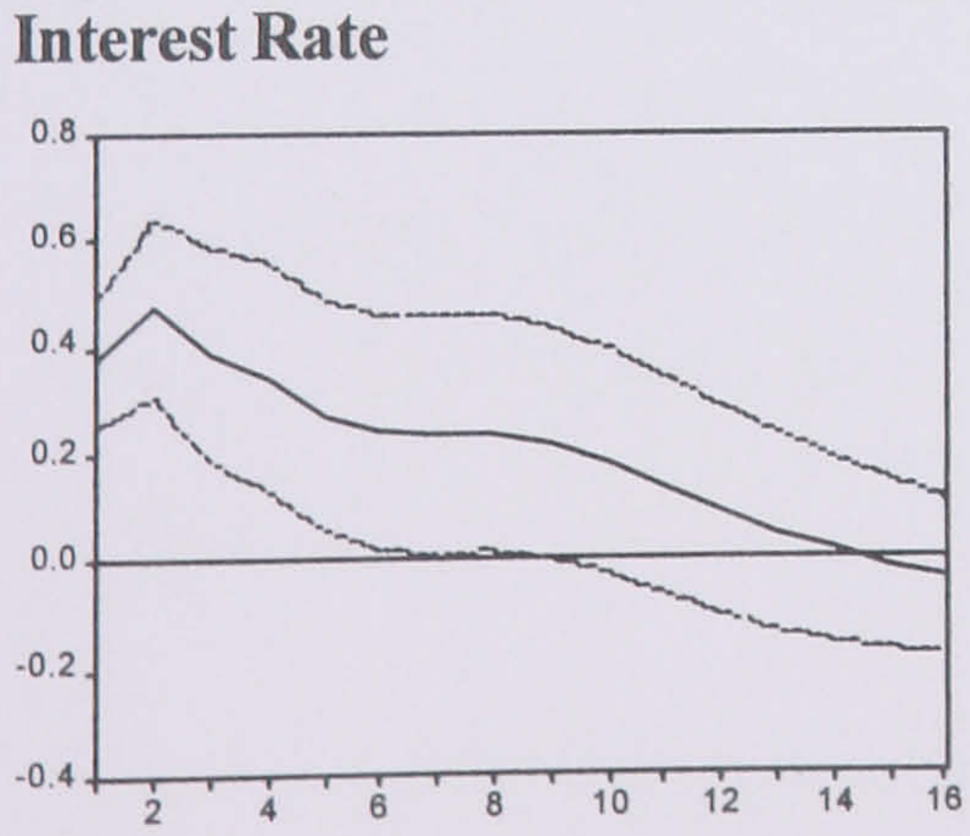


Fig. 2.25: Response of ICCs' Liquidity Ratio

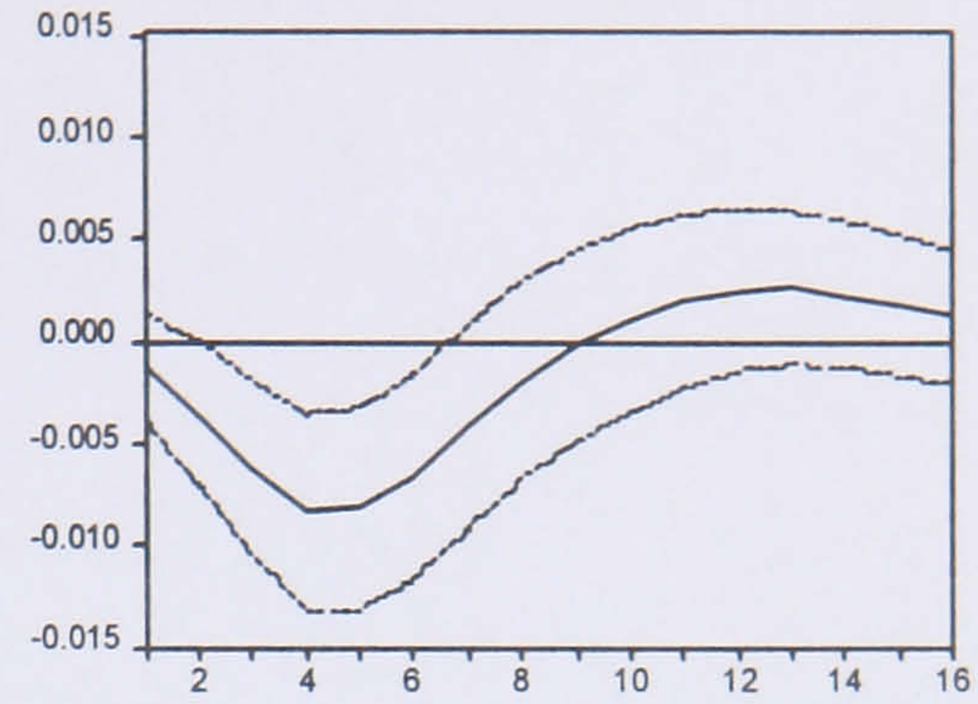


Fig. 2.26: Response of ICCs' Real Liabilities

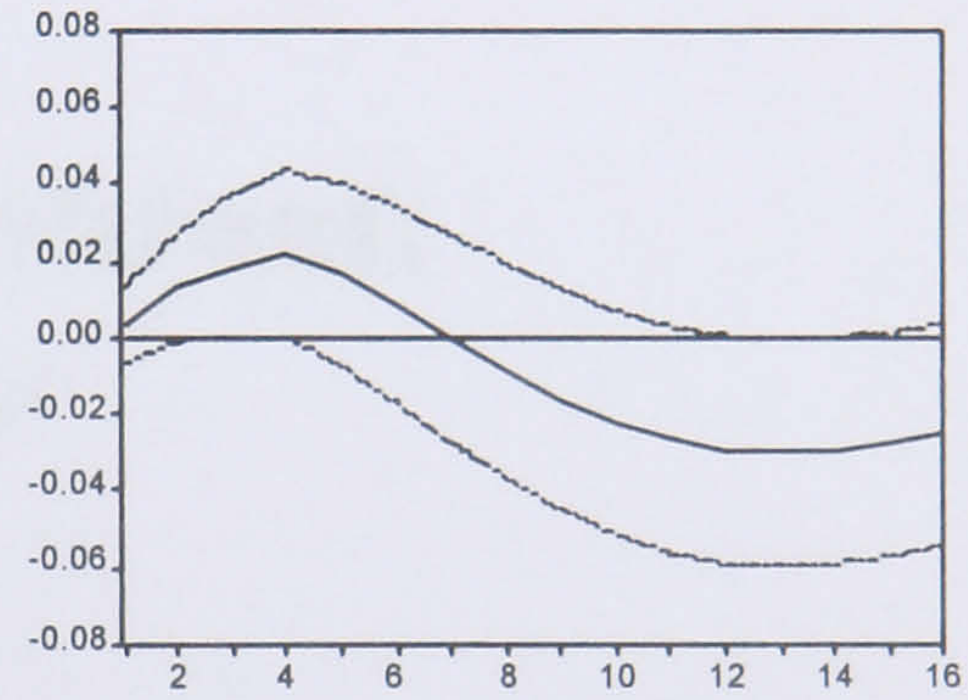


Fig. 2.27: Response of ICCs' Real Assets

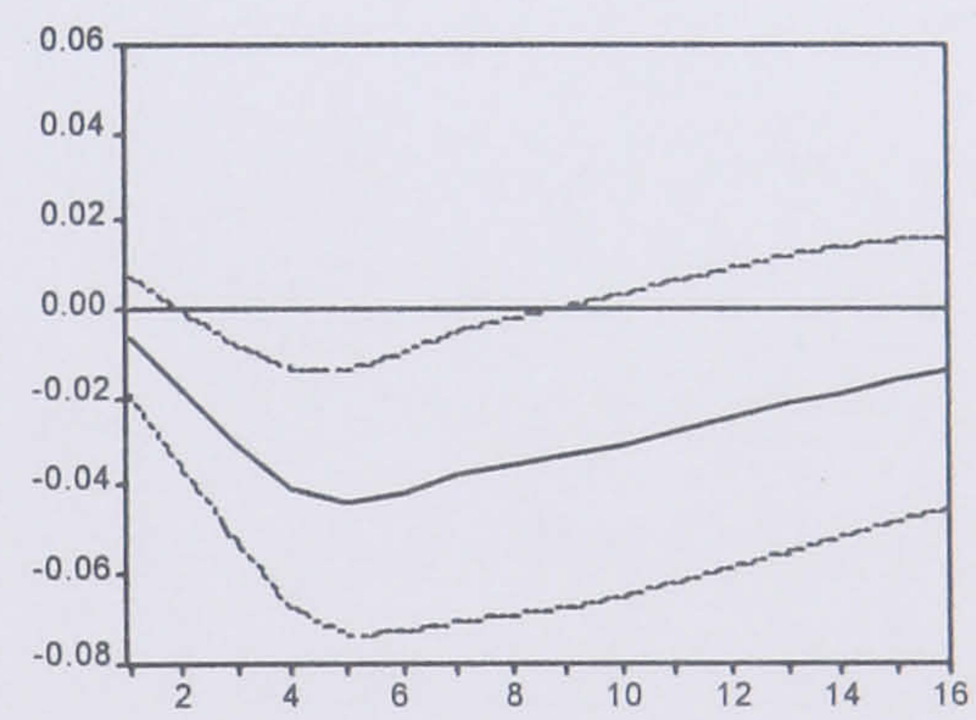
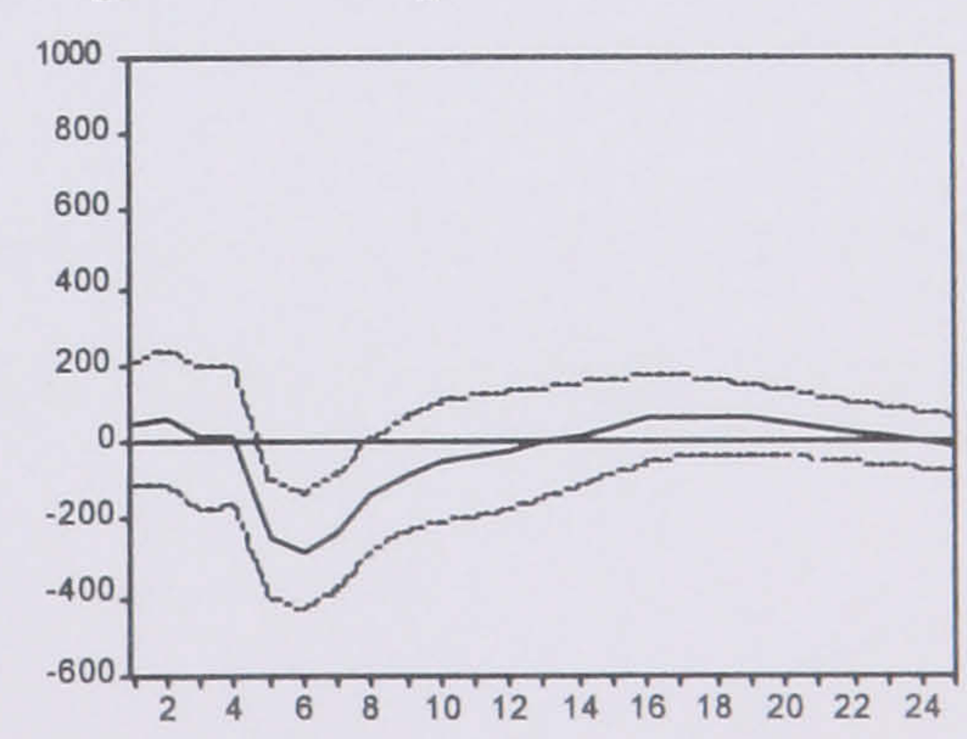


Fig. 2.28: Response of Inventories



Chapter 3

Financing the UK investment: A flow of funds analysis

3.1 Introduction

In the last twenty years, a great strand of literature has investigated the relation between internal and external finance in non-financial companies. The main result is that external financing is not a perfect substitute for internal funds; such imperfection is the result of asymmetric information resulting in moral hazard and adverse selection problems. These create a risk premium which is a direct function on the level of firms indebtedness and the level of risk free interest rate (Hubbard, 1997). The higher either of these two indicators, the higher is the cost of capital that firms have to face if they want to finance their investment with external capitals.

To test the importance of internal and external funds, two methods have been applied in the existing literature. The first is to use a panel data in order to examine how different classes of firms react to some macroeconomic shocks, typically interest rate shocks: Fazzari, Hubbard and Petersen (1988), FHP hereafter. The main result is that large firms are less constrained than small firms. The second methodology is to employ time series data at a country level. This successful line of research starting from Mayer (1988) has employed flow of funds data. Mayer (1988), and after him, Corbett and Jenkinson (1997), using national income data, reach the conclusion that, by far, internal finance is the most important source of finance for firms in Germany Japan, United kingdom and the United States. At the same time, with the exception of the USA, bank loans are the most common type of external finance.

It is generally found that investment is highly sensitive to cash flow, particularly for firms that are financially constrained and for countries with a more market-oriented financial system.

The aim of this chapter is to investigate the role of internal and external finance in the last thirty years of the UK business cycle. To do so, we investigate the Industrial and Commercial companies sources and uses of funds. One of the main conclusions that we reach is that the 1988 financial liberalisation produced an unsustainable credit growth which, with the help of economic agents' perception of the economy could be considered the root of the early nineties recession. This accelerated growth of credit and the "*euphoric economy*" finds an explanation in Minsky's Financial Instability Hypothesis; in Minsky's economic theory, in fact, expectations and financial system dynamics endogenously determine the movement of the economy from being robust to being susceptible to Fischer-type debt deflation

The chapter is organised as follows. In the next section, we provide an overview of Mayers and CJ's work; we present the reason that brought CJ to state that the dichotomy between bank-based and capital market-based economies is incorrect, and highlight the reasons why internal finance is so important for firms investment. In Section 3 we provide a model of financial accelerator mechanism which describes the interrelation between investment and the cost of capital. We describe its macroeconomic implications and we point out that the financial accelerator model can cause financial instability similar to Minsky's financial instability hypothesis; we argue that such a hypothesis can be tested via the Kalman Filter technique. Section 3.4 is devoted to the presentation of the data. Estimates are in Section 3.5, and conclusions follow.

3.2. How is investment financed?

There is a large branch of literature that investigates the role played by financial factors in firms investment decisions. Thus, the purpose of this section is to highlight the firms most used source of finance for real investment. There are two methods by which to investigate this issue: the first is to use a firm-level panel data in which firms can be grouped in to two categories: 'large firms' with associated low information costs and 'small firms' with high information costs. The seminal work is by Fazzari, Hubbard and Petersen (1988, 1996)[77]. FHP use a cross section analysis with 421 manufacturing firms over the period 1970-1984, where internal finance is approximated by the firm's cash flow. They reach the conclusion that "a priori grouping of 'constrained' and 'unconstrained' firms have different determinants of investment, with internal funds being an important

[77] Hubbard (1997) provides an overview of the literature.

explanatory variables only for the former group" (FHP, 1996 p.6). Bond and Meghir (1997) investigating a panel of UK firms find that cash flow is highly correlated with current investment[78]. In a different study, Bond *et al.* (1997) test the sensitivity of investment to cash flow across four different European countries[79]; In all the three models employed, namely acceleration model of investment, error correction specification and Euler equation, they find that cash flow is statistically significant in all countries, where the UK firms have the highest sensitivity. The availability of internal finance seems to be an important constraint for investment.

The second methodology is through the examination of time series data in which reduction in net worth reduces the level of investment. An interesting prospective is taken by Mayer (1988). He focused his analysis on national income data, and more specifically, on flow of funds data. The justification is that this dataset does not depend upon accounting rules and conventions; furthermore, flows of funds data cover all firms in the economy, and intra-sectoral flows are almost entirely eliminated. The two main results were that internal finance was by far the most important source of financing in all the countries considered, and secondly that the different countries's financial patterns did not seem to differ substantially. A natural consequence was the breaking down of the usual dichotomy between bank- and capital market-dominated financial systems[80]. Corbett and Jenkinson (CJ, 1996, 1997) brought supporting evidence to Mayer's findings. Tables 1 and 2 summarise some of their results.

Table 3.1: Sources of Funds (1970-1994)

	Internal Funds	Bank Loans	Bonds	New Equity
UK	93.3 %	14.6 %	4.2 %	-4.6 %
US	96.1 %	11.1 %	15.4 %	-7.6 %
Germany	78.9 %	11.9 %	-1.0 %	0.1 %
Japan	69.9 %	26.7 %	4.0 %	3.5 %

Source: CJ (1996), Tables 3, 4, 5, 6

Notes: Negative figures for 'New Equity' are associated with high level of merger and acquisition. Figures in percentage of physical investment.

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78 They show that the results are robust even after controlling for imperfect competition and bankruptcy costs.

79 UK, Germany, Belgium and France.

80 Hackethal and Smidth (2003) talks about a 'Mayer puzzle' since there is not correspondence between financial pattern and corporate governance practice.

Table 3.2: Source of Finance (Figures in Percentage)

	1970-74	1975-79	1980-84	1985-89	1990-94
			United Kingdom		
Internal Finance	98.1	102.3	115.4	81.2	81.2
Bank Finance	26.2	6.8	12.4	29.8	0.2
Bonds	3.3	-1.3	2.0	8.8	6.3
New Equity	-7.3	-3.3	-7.6	-2*.4	12.4
			United States		
Internal Finance	74.5	91.5	89.6	103.7	109.8
Bank Finance	26.6	14.1	12.9	15	4.5
Bonds	15.7	14.9	10.9	24.8	10.4
New Equity	7.3	0.7	-4.8	-29.6	-4.2
			Germany		
Internal Finance	68.6	82.8	79.7	89.3	71.8
Bank Finance	15.7	8.4	11.2	7.9	16.9
Bonds	1.9	-2.8	-2.1	0.6	-2.8
New Equity	0.7	0.5	-0.5	2.3	-3.1
			Japan		
Internal Finance	59.1	70.8	74.6	70.5	71.2
Bank Finance	42.7	33.9	31.7	23	19.6
Bonds	2.7	2.5	0.6	9.1	2.1
New Equity	2.5	3.3	3.6	4.4	3.1

Source: CJ (1996), Tables 3, 4, 5, 6
Notes: Figures in percentage of physical investment.

The data was aggregating using $\sum_{t=\tau}^{T} i_t^j \frac{CPI_t}{CPI_{1985}} \Big/ \sum_{t=\tau}^{T} I_t \frac{P_t}{P_{1985}}$ where CPI_t and P_t represent the consumer price index and the "capital goods price respectively in year *t*" (CJ, 1996, p.77). The numerator represents the net financing (i_t^j) from any sources of financing (internal funds, banks, bonds, equity, trade credit, capital transfer and other) and the denominator (*I*) is the total amount of gross investment in plant, machinery and other fixed assets and net addition of working capital in year *t*. The aggregation of the series is made in such a way that figures do not add up to 100. The reason can be easily explained with an example. During year *t* firms retain profits equal to 150, and these are then used for new investment and to reduce debt. If 100 is the level of new investment and 50 is the debt paid back, then this will show as investment funded by 150% internal funds and -50% by debt.

Some of the figures exhibit a negative sign, following CJ (1997, p.75). This is the result of two factors: 1) merger and acquisition activities: "a firm that uses its cash flow to buy the equity of another company [...] and issue no additional equity, will produce a negative net source of finance figure for equity"; 2) Restructuring of firms balance sheets. In the recent years many firms have substituted equity with debt finance.

Table 3.1 presents the net sources of finance for the period 1970-1994. The figures are quite striking. The level of internal finance dominates all other sources of finance. The results brought (CJ) to write in their conclusion (1997, p85) "the celebrated distinction between the 'market-based' financial pattern of the UK and the US and the 'bank–based' pattern of Germany and Japan is inaccurate". They noted, in fact, that in the late eighties the contribution of bank financing was over a half of the net sources of finance. Davis (2001) brings support to this theory. He finds that in the UK real loans are 2.90% of GDP, a figure that increases to 2.96% for the period after 1985. On the other hand, real debt securities are only 0.67 of GDP and 1.20 after 1985. The bank borrowing as a percentage of GDP is the leading external source of finance even in Japan and Canada, although its importance seems to decline. Only in the US do corporate bonds seem to count more (as a fraction of real output) than real bank loans.

One important point that we would expect is that with the liberalisation of capital markets, equity and bonds would have increased in importance relative to bank borrowing and internal finance. The figures presented in Table 3.2 seem to suggest that the different sources of finance do not have a particular trend. The only two series that do not conform are bank finance in Japan and internal finance in the UK. The former is the result of the "fact that companies were actually repaying loans [...] at the same time as they were increasing deposits at banks" (CJ, 1997 p. 80). The UK result is quite interesting since, as will be shown later in the text, it could be the basis of the early nineties recession.

Although the dichotomy between market- and bank-based systems is not supported, it should not be a surprise that internal finance plays a central role in investment financing. There are two distinct theories which provide such an explanation. The first relates to Jensen (1986): agency costs and free cash flow. Free cash flow is the difference between the firm's cash receipts and cash disbursements (mainly payment to equity-holders and debt-holders). In an environment with efficient capital markets, if a firm has no new investment opportunities and some cash flow left over, then the funds should be redistributed to the owners so that they can reinvest it in more profitable projects. Conversely, when agency costs are present, the conflict between managers and shareholders could bring the former to overuse internally generated funds due to the principal's inability to control and discipline management[81].

While Jensen's theory has been recognised as an important part of corporate finance, overinvestment of internally generated funds is not easy to quantify and measure since the results are usually open to different interpretations and therefore are quite inconclusive. One of the most important and convincing studies on this issue is a work by Lamont (1997) on US oil companies with subsidiaries in unrelated industries. He finds that when the price of crude oil halved, oil companies had less internal funds available, so they cut back investment, usually regardless of individual project Net Present Value. This brings him to the conclusion that internally-funded projects are less subject to stringent scrutiny than those financed externally.

Another important hypothesis of the overuse of internal financing is that external finance is more expensive. As shown in Chapter 1, the Broad Credit Channel advocates that the two forms of finance are not a perfect substitute. This imperfection arises from the asymmetric information between lender and borrower. This creates an external finance premium which makes firm investment financially constrained. In the next section we present a model of how this mechanism, usually referred as the broad credit channel, works.

[81] Buffett refers to the Principal-Agent problem as the 'Institutional Imperative'. He says that "just as work expands to fill available time, corporate projects or acquisitions will materialise to soak up available funds" (p.84)

3.3 Internal Vs. External finance

In this section we develop the idea of the broad credit channel and we analyse the role of the level of borrowing and of the level of internal funds on the investment decision.

As we highlighted in the previous chapter the idea underneath the broad credit channel is that markets are not efficient since they are dominated by asymmetric information between lenders and borrowers. This creates a *spread* between the cost of investment generated with retained earnings and the cost generated *via* external finance. When investment is financed only via internal funds the cost is represented by the risk free interest rate and it is constant. After this point, firms require external capital to finance their investment. It is here that the risk premium enters into play: it is the return that the lender requires to finance entrepreneurs' investment.

There are two factors that make the asymmetric information problem more severe and therefore increase the risk premium: the level of the interest rate set by the Central Bank $\bar{r}$, and the level of indebtedness ***B***. We can write the cost of capital as:

$$i = \bar{r} + c\exp\left(\bar{r}, B\right) \qquad (3.1a)$$

where i is the cost of capital and $c\left(\bar{r}, B\right)$ is the risk premium[82]. At a macroeconomic level, c can be seen as an average of the different risk premia and we can interpret this as the economy systemic risk. c is an increasing function in terms of $\bar{r}$ and B. This implies that:

1. The higher the level of borrowing, the higher is the risk premium. As B increasing so does moral hazard because the borrower would have an incentive to take higher risks so that the return on invested capital is higher that the interest due on the loan, thus increaseing the probability of default.

[82] For an entrepreneur we should add another term to the risk premium, Ų which represents the risk adjustment appropriate for the firm. Therefore even if the free interest rate is almost zero there will always be positive risk adjustment associated with the firm. For simplicity of the analysis we assume $\Omega = 0$. This does not imply any loss of generality in the main results.

2. Monetary policy contractions (i.e. increase in the level of the risk free interest rate) increase the cost of external finance relative to internal funds. In other words, monetary tightening increases the individual default risk and contributes to economic instability. As shown in Gertler and Hubbard (1988) and Oliner and Rudebush (1996), an increase in the risk-free rate reduces the value of the borrowers' collateral, therefore increasing the moral hazard problem. This point has great importance since it tells us that credit market imperfections magnify an increase in the free-interest rate by the Central Bank. This magnification effect is known as "Financial Accelerator". Later on, we will discuss its macroeconomic implications.

To see more formally how the risk premium affects the level of investment, let's consider a following set of equations:

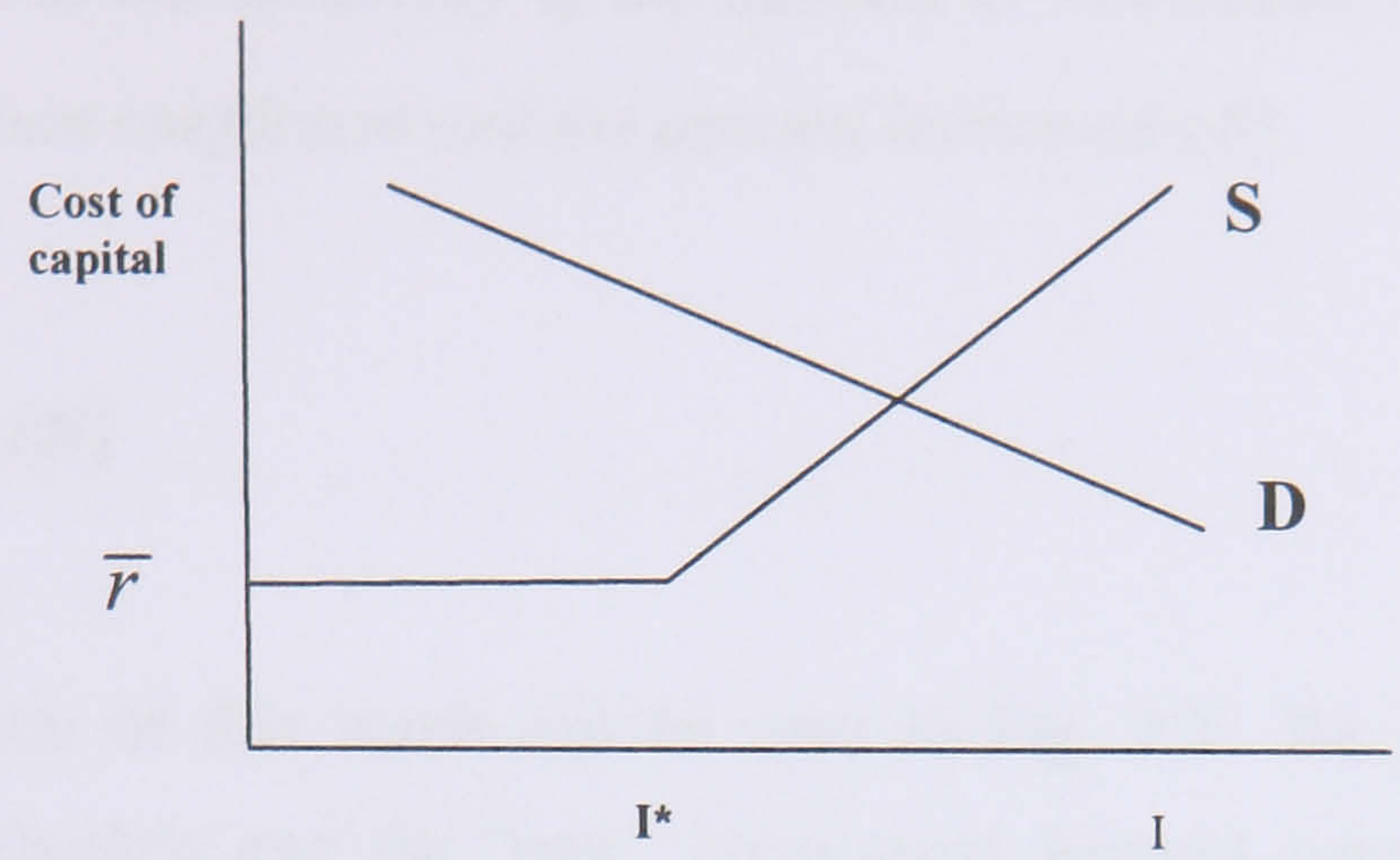
Investment Supply: $i = \overline{r} + c(B, \overline{r}) \Rightarrow i = \overline{r} + c\overline{r}B$ (3.1b)

Investment Demand: $I = I_0 - \beta_1 i \Rightarrow i = -\frac{1}{\beta_1}(I - I_0)$ (3.2)

where I is the level of investment, I_0 is autonomous investment[83], i is the user cost of capital and $\beta_1 > 0$. Investment supply is provided by Eq. (3.1a)[84]. Here we define B as the difference between the Total Investment and the Internal Funds. The parameter c (i.e. risk premium) depends positively on the risk free interest rate and B and has the following property: $c > 0$. Fig 1 plots the supply and demand for funds. What characterises this investment demand-supply framework is the shape of the supply function.

[83] Investment independent of the level of interest rate and income. It can be affected by changes in factors others than interest rate and in the "animal spirits" of entrepreneurs. It is shown by a parallel shift in the aggregate demand schedule.
[84] Previously we define the risk premium as an exponential function. The formulation that we adopt here, for simplicity of analysis, does not affect the final results.

Fig. 3.1 : The Supply and Demand of Funds



Substituting Eq. (3.1b) into Eq. (3.2) we get:

$$I = I_0 - \beta_1 \left(\bar{r} + c\bar{r}B \right) \tag{3.3}$$

From Eq. (3.3) we notice that in equilibrium the level of investment is a negative function not only of the risk free interest rate but also of the level of the total indebtedness. We can see that the equilibria all lie on the demand equation; they depend on the level of $\bar{r}$, B and c. From Eq. (3.3) we deduce the following results:

Result 1: *The risk free interest rate and the risk premium affect the level of investment financed via external funds.*

Taking the first derivative of the equilibrium level of investment with respect to the level of borrowing we obtain:

$$\frac{\partial I}{\partial B} = -\beta_1 c\bar{r}$$

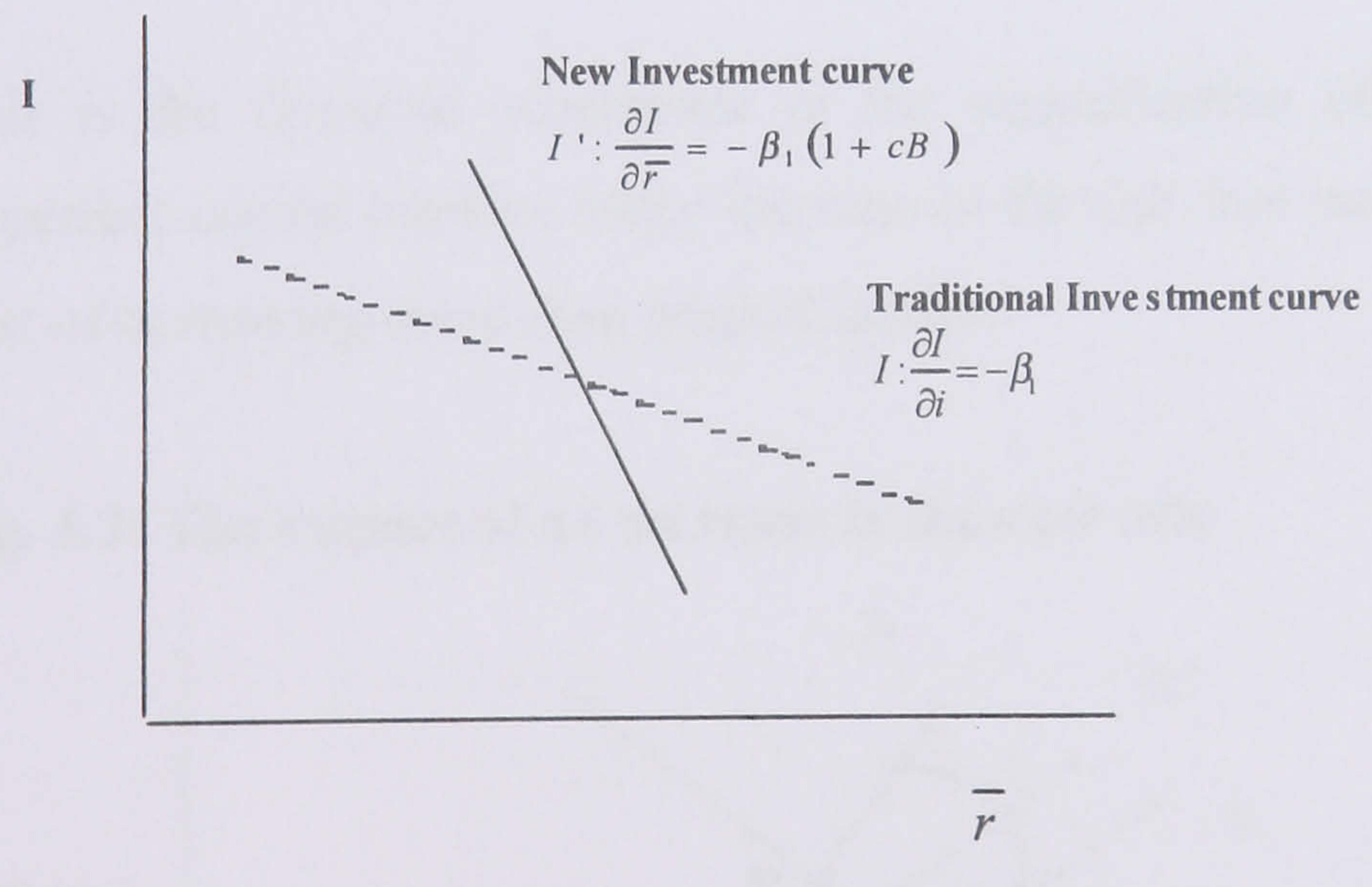
This tells us that the change in external financing on the total level of investment is affected not only by the 'traditional' sensitivity of I to i, β_1, but also directly by the risk free interest rate ($\bar{r}$) and the risk premium parameter (c), as the level of borrowing increases, the level of investment decreases.

Result 2: *The change in interest rate changes the level of total investment by an amount equal to the sensitivity of the demand of investment* (β_1) *augmented by the risk premium coefficient and the amount borrowed* (B).

$$\frac{\partial I}{\partial \bar{r}} = -\beta_1 (1 + cB)$$

The implication of this result can be seen in Fig. 2.2. We plot the traditional investment schedule and the "new" investment demand curve (I'). The latter is much steeper than the traditional investment schedule. The higher is the level of risk premium and/or the level of external borrowing, the higher is the sensitivity of firms investment to change in the nominal risk free interest rate: in other words, the steeper I' becomes. On the other hand, when c and/or B tends towards zero, the I' converges to the traditional equation. In the case of no external borrowing then changes in investment decisions, following a movement in risk free interest rate, would depend only upon the level of β_1.

Fig. 2.2 Old and New Investment Schedule



Considering now that $I = F + B$, where F is the level of internal funds used by firms to finance investment, we can rewrite Eq. (3.1b) as:

$$i = \bar{r} + c\bar{r}(I - F)$$

And substituting in Eq. (3.2) we obtain the level of Investment of equilibrium:

$$I = \frac{I_0 - \beta_1\left[\bar{r} - cF\right]}{1 + \beta_1 c\bar{r}} \qquad (3.4)$$

Result 3: *The greater is the risk premium the greater is the investment financed via internal funds.*

Taking the first derivative of I with respect to F we get:

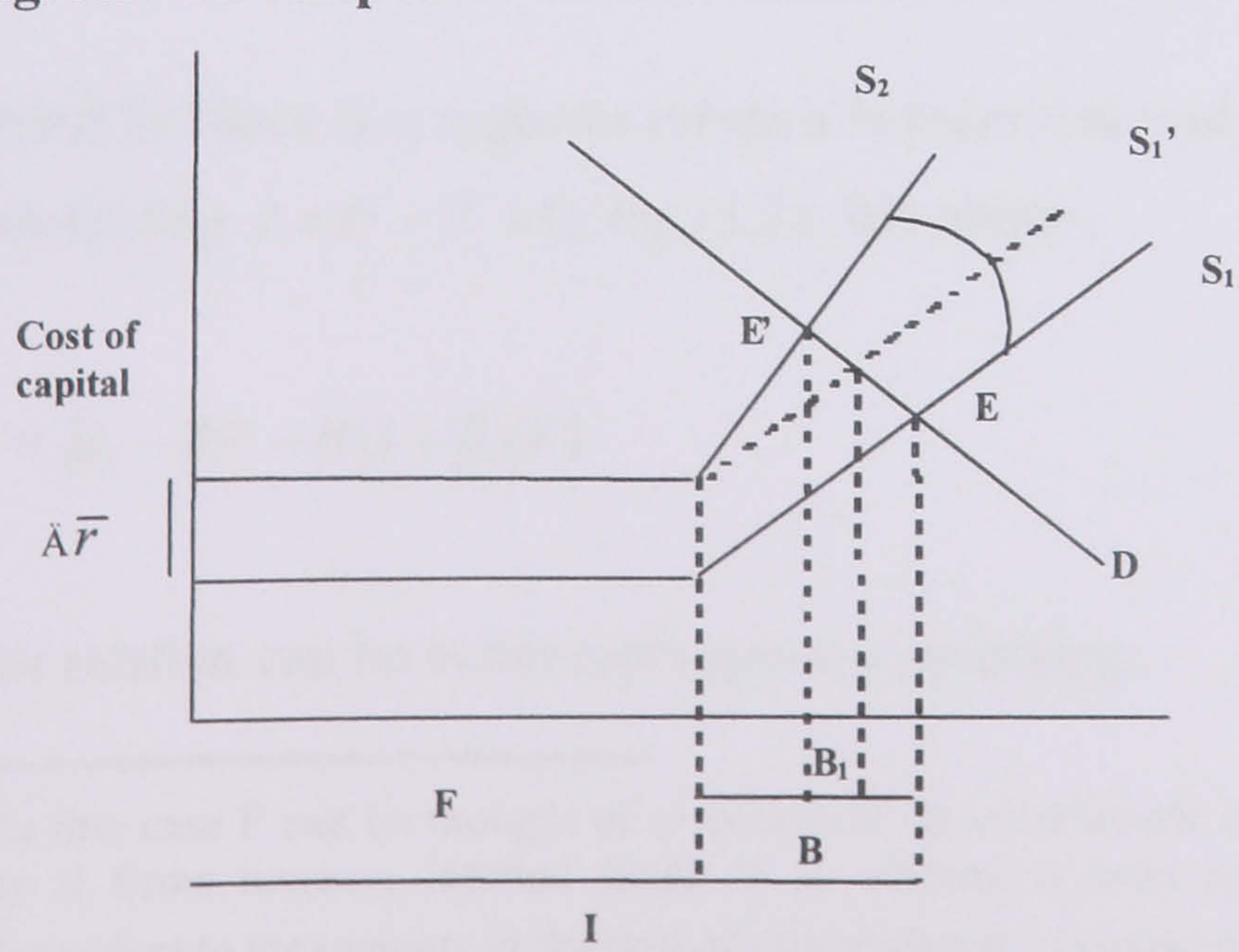
$$\Psi \equiv \frac{\partial I}{\partial F} = \frac{c\bar{r}\beta_1}{1 + \beta_1 c\bar{r}} > 0$$

where Ψ represents the sensitivity of investment to internal funds; the ratio is always positive. One interesting result derives from the derivative of Ø with respect to $\bar{r}$.

$$\frac{\partial \Psi}{\partial \bar{r}} = \frac{\beta_1 c}{\left(1 + \beta_1 c\bar{r}\right)^2} > 0$$

This is the financial accelerator or the magnification effect deriving from an imperfect capital market: every increase in the risk free interest rate increases the cost of borrowing more than proportionally.

Fig. 3.3: The impact of an increase in interest rate



The result is presented in Fig. 3.3. Given a risk free interest rate ($\bar{r}$), the market forces determine **E** as the equilibrium point. If there is a monetary policy tightening (i.e. $\bar{r}$ increases), then the new equilibrium point would be **E'**. The movement of the supply curve from $\mathbf{S_1}$ to $\mathbf{S_2}$ instead of $\mathbf{S'_1}$ is the result of the Financial Accelerator. Since the higher cost of capital increases the possibility of moral hazard and adverse selection, lenders require a higher rate of return on the loans. This determines a lower amount ($\mathbf{B_1}$) of capital borrowed.

Result 4: *Every movement in the risk free interest rate determines a more than proportional increase in the user cost of capital.*

This result is obtained substituting Eq. (3.1b) into Eq. (3.2) and taking the derivative of the user cost of capital with respect to $\bar{r}$:

$$\frac{\partial i}{\partial \bar{r}} = \frac{1 + c(I_0 - F)}{(1 + c\bar{r}\beta_1)^2} \Rightarrow \frac{1}{(1 + c\bar{r}\beta_1)^2} + \frac{c(I_0 - F)}{(1 + c\bar{r}\beta_1)^2}$$

Two implications are derived: (i) at any change in $\bar{r}$ the user cost of capital increases more than proportionally; (ii) the sign of the relation between changes in user cost of capital and change in the monetary policy instrument depends upon the availability of internal generated funds. When $F > \frac{1}{c} + I_0$ the first derivative assumes a negative value, implying that the risk premium decreases. This, in turn, would produce an increase in the demand for investment.[85]

Result 5: *There is a negative relation between internal and external finance.*

Substituting $I = F + B$ into Eq. (3.3). We obtain:

$$F = \beta_0 - \beta_1\bar{r} - B(1 + \beta_1 c\bar{r}) \tag{3.5a}$$

This relation can be better represented considering:

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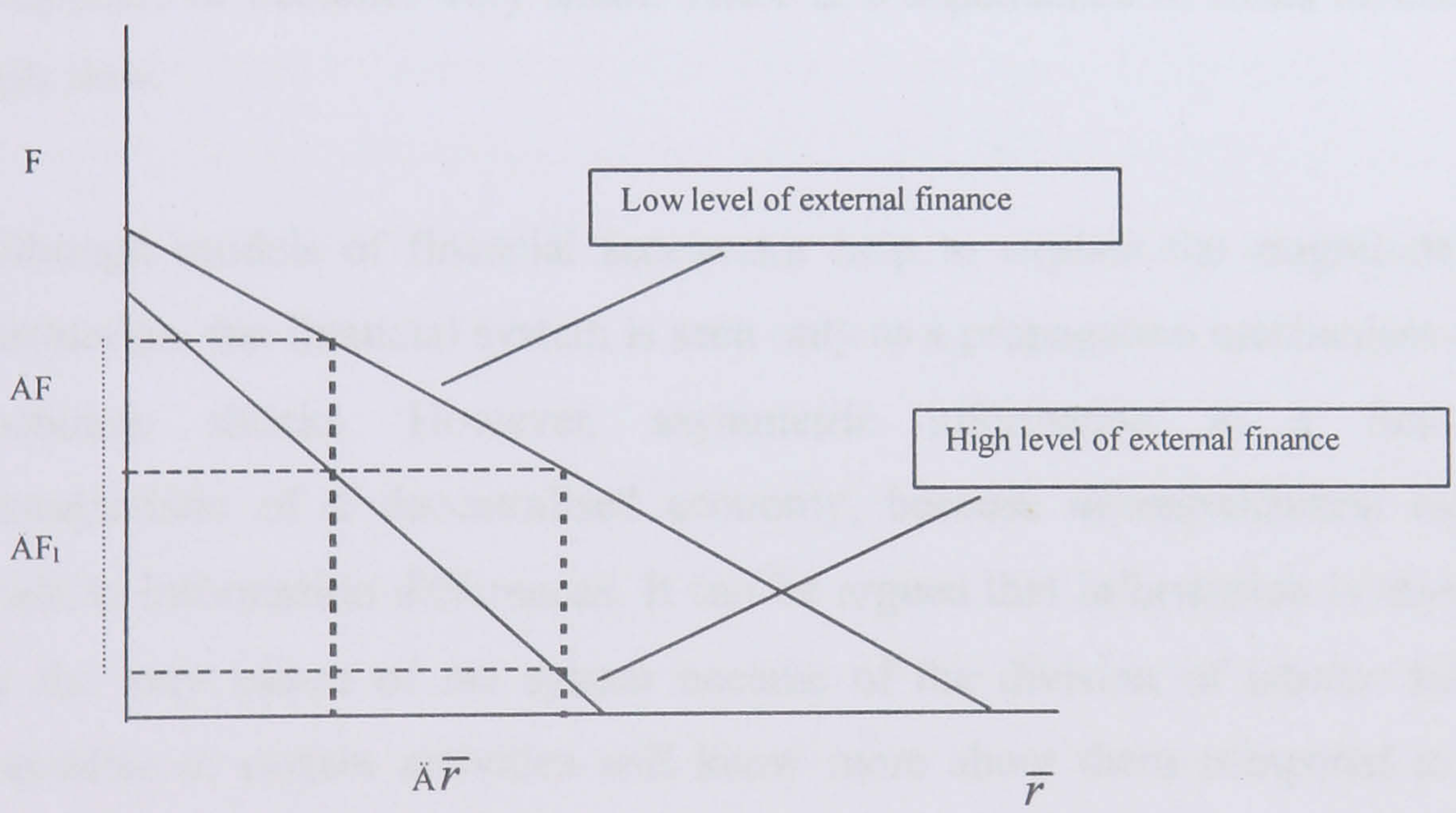
[85] In this case F can be thought of as collateral. In other words, the risk premia will not increase only if firms increase internal funds of an amount at least equal to that part of investment independent to movements in the cost of capital plus a 'systemic risk ratio', i.e. $1/c$.

$$B = \frac{-F}{1+\beta_1 c\bar{r}} + I_0 - \beta_1\bar{r} \Leftrightarrow F = -\beta_1(1+Bc)\bar{r} + (I_0 - B) \qquad (3.5b)$$

The result is presented in the Fig. 3.4. In the *y*-axis we plot the level of internal funds while on the ÷-axis we plot the risk-free interest rate. After an increase in B the internal finance schedule is on a lower position and has a steeper slope. This implies that changes in interest rate have a higher impact when the level of external finance (B) is high. When the firm is heavily indebted, a change in $\bar{r}$ would cause a more pronounced decrease in F. In the diagram, a change Ä$\bar{r}$ would cause a decrease in internal funds equal to ÄF_1 in the more indebted firm compared to ÄF of a less indebted one.

Fig. 3.4: Risk-free interest rate and internal finance



3.3.1 Macroeconomic Implications

In the previous section we presented a model that highlights how the financial "accelerator" works. When the above analysis is applied to micro studies, the conclusion is usually that shocks (typically monetary shocks) have a smaller impact on big firms than on small firms since the level of internal funds and the collateral of the former is much higher. The explanation is provided by the fact that asymmetric information plays a key role in determining the cost of capital. One implication deriving from macroeconomic models[86] which incorporate asymmetric information is that the dynamics of the cycle are intrinsically non linear. In other words, the financial accelerator (i.e. the more than proportional increase in i following a change in $\bar{r}$ and B) effects are stronger the deeper the economy is in the recession, but also the higher the level of indebtedness, and the higher the level of risk free interest rate. This characteristic arises from the fact that the agency costs faced by a firm become very small, as the share of internal finance become large. Firms with high cash flow (net worth) are expected to be able to meet their debt payment, so most financial shocks will not affect them. Therefore, they have a very elastic demand for external finance. The lower the cash flow, the more often a firm fails to meet its financial commitments and the more often a cash shortfall requires that debt be rolled over. Consequently, in an economy with sufficient internal finance, the financial propagation mechanism disappears or becomes very small. There is a dependence of firms investment to cash flow.

Although models of financial accelerator help to explain the magnitude of the fluctuation, the financial system is seen only as a propagation mechanism of some economic shocks. However, asymmetric information is a fundamental characteristic of a decentralised economy, because decentralization inevitably leads to information differences. It can be argued that information is asymmetric by the very nature of the system because of the division of labour: those who specialise in certain activities will know more about them compared to others. Fazzari (1992, p.129) writes: "if an entrepreneur seeks funds from an intermediary to finance an investment project, the natural starting assumption to make is that the entrepreneur has more information about the project's prospects than the banker. The banker may be able to obtain some information from independent sources, but this activity is costly. [...] To become fully informed would require that the banker becomes an entrepreneur". Thus, asymmetric information relates to lender perceptions of the adequacy of borrower balance sheets; these perceptions or creditworthiness fluctuate because expectation of future

[86] Bernanke and Gertler (1989, 1990), Calorimirs and Hubbard (1990) provide such evidence.

profitability is closely linked to the business cycles conditions. Minsky argues that these expectations are pro-cyclical, which implies that the cost of capital, and its availability, are pro-cyclical as well. Asymmetric information is, therefore, endogenously determined in the system. Accepting this notion brings us to say that the finance-expenditure link not only propagates shocks, and creates instability, but is itself a source of instability. This type of instability could be associated with Minsky's Financial Instability Hypothesis.

There are various factors that, according to Minsky, bring the system from a tranquil (though fragile) state to a crisis; the first is that expectations of future profitability depend on the market mood, on leveraging and credit condition and the outlook of the sales and production into the future. During the expansionary period of the business cycle, expectations rise, reducing lender and borrower risk. The reverse occurs at the inception of the crisis, when lender and borrower risk shoot up, thus reducing investment. The second determinant of a crisis is an endogenous rise in interest rate (i.e. cost of capital). Paraphrasing Minsky, as interest rates rise, low-safety margin units find it harder to continue operating. A more inelastic demand for credit meets a steeped supply of credit, making safety margins contract even faster.

The financial structure of a dynamic capitalist economy, therefore, endogenously evolves from being robust to being fragile, and that once there is a sufficient mix of financially fragile institutions, the economy becomes susceptible to Fischer-type debt deflation. This occurs because the economy moves from *hedge* to *ponzi* finance. In Minsky's words the latter occurs when "the cash flow from operations is not sufficient to fulfil either the repayment of principle or the interest due to outstanding debts by their cash flows from operations" (1995, p.7). The emergence of *ponzi* financiers is the result (among other factors) of an interest rate –and debts- insensitive demand. This is the result of a euphoric economy where the expectations are self-fulfilling. Declining risk aversion sets off increases in investment, and this determines that the economy grows faster. Asset prices rise, making speculation on assets profitable. Increased willingness to lend increases money supply; this enables riskier investments and validates asset speculation. But eventually, rising interest rates make many once-conservative projects speculative, and forces *non-Ponzi* investors to attempt to sell assets to service debts. The entry of new sellers floods the asset market determining a reverse in asset prices.

The consequences are: firstly, there is the bankruptcy of *ponzi* financiers since they cannot sell assets for a profit and debt servicing on assets far exceeds cash flows. Secondly, asset prices collapse increasing the debt/equity ratios. Third, investment evaporates, causing a slowdown or a reverse of economic growth. Finally, the economy enters a debt-induced recession (i.e. a Fisher's debt-deflation crisis).

Following the above arguments, to be able to capture the dynamic of a debt-driven economic crisis, we need to test that the contribution of external finance to real investment and compare it to the contribution of internal funds. Given the fact that we are interested in the evolution of the system from a tranquil to a crisis state, we need to examine the dynamics and interactions of the different types of source and uses of capital. In the next section we will present a statistical analysis of the flow of funds along the UK business cycle.

4.4. Financing the UK: patterns and trends

The data set used in this section relates to the Sources of Funds and Net Borrowing Requirement for Industrial and Commercial companies for the period (1970Q1-1998Q1). The data is from tables 10.6B and 10.6C of the Financial Statistics Publications from the ONS (Official National Statistics). They have been collected from DATASTREAM.

Before analysing the time-series data and presenting some descriptive statistics, it is worth highlighting the pattern of the UK business cycles in the period under examination. We can identify three recession periods[87]. The table below gives a summary description of the timing and the main causes.

[87] See Dow (1998) for an in depth description and identification of the UK business cycles.

Table 3.3: Recession Periods in UK

Period	Main Causes
1973-75	• 1st oil price shock • Tightening of the monetary and fiscal policy to control the accelerating inflation • (1974) 3-day working week
1979-81	• 2nd oil shock • Large increasing in exchange rate • Tight fiscal and monetary policy in order to control broad money[88].
1990-92	Recession not due to real shocks like the previous two. The economy experienced a reversal of the over-confidence that has been built up in the proceeding boom years. This recession was preceded by unsustainable increases in asset prices, property prices and equity prices.

3.4.1 Sources of funds: descriptive statistics

In this section we present a series of graphs which illustrate the behaviour of the source of funds during the UK business cycles. All the series have been converted in real terms by dividing them by the consumer price index.

From a first visual inspection we notice that all three pre-recession periods have been characterized by a large increase in total funds, and that the dynamic is clearly pro-cyclical. The value of these funds has almost doubled in the last recession compared with the previous ones. This does not come as a big surprise given the important capital market development in the eighties. In fact this pattern is captured by the plot of the total external borrowing (Fig. 3.7[89]). Most of this aggregate is represented by bank borrowing; again the same trend is repeated: a sharp increase in borrowing during the eighties. A different picture emerges from the plot of the total internal funds (Fig. 3.6). The two seventies recessions were preceded by a large increase in the amount of internal finance, but this did not happen during the third recession. After a pronounced increase in the use of these

[88] According to Guariglia (1998. p. 49) "The Thatcher government [...] attached great importance to reducing inflation, abandoning the commitment to high employment. [...] The sharp contraction of M0, in both nominal and real terms, as well as high level of real interest rates and the exchange rates over the period, show that the policy was tight."
[89] See Appendix

funds to finance investment, their employment remained quite stable during the whole period between the second and the third recession.

To have a better picture of the firms financial sources during the business-cycle, we construct some ratios.

R1. Internal Funds over Total Funds

R2. External Funds over Total Tunds

R3. Bank Loan Funds over Total Funds

R4. Bank Loan Funds over Total External Funds

The plot of the first two ratios provides some insightful information. The two variables have a strong negative correlation. A first important point is that during non-recessionary periods there is a strong tendency for R1 to dominate R2. During a downturn the series converge. This means that in periods identified as *tranquil* firms prefer to use internal rather than external funds. This behaviour changes after 1988: R2 assumes a value higher than R1. The more plausible explanation could be attributed to the financial deepening and financial broadening following the capital market liberalisation[90]. Progressively, firms have had the possibility of choosing among a larger variety of financing sources. Interesting information is provided from the plot of R4. Bank loans as a source of external finance do no exhibit a decrease until the end of the recession. It is clear that the reduction in the flow of bank loans is quite slow in the period prior to the crisis. We notice that a sharp decrease of this indicator appears only for the last period of the recession.

We consider another indicator of firms financial balances: the Net Borrowing Requirements (NBR)[91], which "measure ICCs' need for external borrowing, net of liquid and certain other financial assets; it reflects the amount by which the companies' expenditure on fixed assets, stocks, capital transfer (net), trade investment, acquisition of subsidiaries in the united Kingdom, investment abroad and net trade credit *exceeds the increase in their internal funds*[92]" (ONS, 1997

[90] Financial deepening is referred to as growth of the monetarisation of an economy. Financial broadening refers to the growth in financial instruments and financial institutions within the country.

[91] The data are from Table 10.6 C of the ONS Report.

[92] Emphasis added.

p.176). This indicator seems to be able to capture the dynamics and the pattern of all the time series presented above. According to Pettigrew (1978) there are three main reasons why this indicator is superior to the conventional net acquisition of financial assets (NAFA) and more generally to the other indicators of indebtedness[93]: first it includes retained profits of UK affiliates of foreign companies; secondly it measures the cash position of the industrial and commercial companies, and finally, the definition of investment is more broader, as it includes investments in fixed assets and stock outside the UK. The following table presents the contributing and financing items to the Net Borrowing Requirements.

Table 3.4: Net Borrowing Requirements

NET BORROWING REQUIREMENTS	
Contributing Items	*Financing Items*
• Internal Funds (adjusted for unremitted profits and including increase in tax balances) *Plus* • Imports and other trade credit received *Minus* • Exports and other trade credit given • Other accrual adjustments • Import deposits • Increase in book value of stocks • Gross domestic fixed capital formation • Cash expenditure on acquiring subsidiaries and on trade investments in the UK • Direct Investment by UK parent companies in overseas affiliates (excluding unremitted profits) and other investments abroad • Unidentified transactions.	• Borrowing from UK banks • Other borrowing in the form of loans and mortgages • Capital issues in the UK and overseas • Direct investments in UK affiliates by foreign parent companies (excluding unremitted profits) and other net borrowing abroad by UK companies *Minus* • Acquisition of liquids assets • Acquisition of other financial assets not included elsewhere.

(Pettigrew, 1978 p.115)

The contributing items can be divided in two categories: i) The amount of internal funds generated by the companies trading and investments activities, ii) The amount of internal funds available to finance investment and working capital,

[93] See Pettigrew (1978) for a detailed comparison between NAFA and net Borrowing Financial Assets.

after payments of interest and taxes and distribution to shareholders. The financing items are subdivided into: A) The amount of external funds required in addition to internally generated funds to finance the chosen level of trading and investments by companies, B) The net liquidity of industrial and commercial companies.

Fig. 3.14 plots the NBR for the period 1970Q1-1998Q2. From visual inspection some striking points appear: 1) NBR has a tendency to increase immediately before an economic downturn; this is explained by the fact that NBR is the net of internal funds. In proximity of an economic recession, firms income and profits start shrinking, inducing, consequently, a reduction in internal funds. Firms, left with a lower level of funds available, need to borrow (at least to cover working capital) in order to continue their production. External finance appears to be a safety net for Industrial and Commercial Companies. 2) The behaviour of the series for the period preceding the third economic recession (1990-92) in our sample is quite different. We observe an exponential dynamics of NBR; as we will highlight later, the reason for this can be found in the so-called financial big-bang. The major difference is that NBR decreases when the crisis begins, the behaviour indicating that banks did not operate as a safety net. This gives us a first indication of the nature of the crisis: over-indebtedness was one of the reasons underneath the economic crisis and its magnitude.

3.5. Empirical analysis and discussion of the results

The statistical evidences presented in the previous section support Mayer's idea that internal funds are much more important than the level of borrowing. In this section we provide a model to test if the contribution of the different items to the real investment has changed during the years and if this contribution follows the cyclicality of the business cycle. In order to test this dynamic we write the model in a state space form.

$$y_t = \mathbf{Z}'\beta_t + \mu_t \qquad \textit{(measurement equation)} \qquad (3.6)$$

$$\beta_t = F\beta_{t-1} + \eta_t \qquad \textit{(transition equation)} \qquad (3.7)$$

$$\mathbf{Z} = \begin{pmatrix} c & z_{t-1} \\ \vdots & \vdots \\ \vdots & \vdots \\ \vdots & \vdots \\ c & z_{t-n} \end{pmatrix} \qquad y_t = \left[y_{t-1}, y_{t-2}, \ldots, y_{t-n} \right]$$

$$\beta_t = [\beta_{t-1}, \beta_{t-2}, \ldots, \beta_{t-n}] \qquad \mu_t = [\mu_{t-1}, \mu_{t-2}, \ldots, \mu_{t-n}]$$

y_t will assume the values of investment, and the Z_t matrix, of dimension (Txk), that contains the financing variables of interest plus a constant. We now have the state vector $\hat{a}_t$, a (kx1) vector that contains all the slope coefficients, which are now varying through time. The F matrix, of dimension (kxk), contains the autoregressive coefficients of $\hat{a}_t$. We allow the coefficient $\hat{a}_t$ to follow a random walk process.

The error terms are assumed to be independent white noise $Var(\mu_t) = Q; \quad Var(\eta_s) = R; \quad Var(\mu_t \eta_s) = 0$ for all t and s.

Such a representation can, then, be used to compute the estimates of a state vector for $t=k+1;k+2\ldots T$ using the Kalman filter. For the purpose of our analysis, this algorithm is valuable because it allows us to recover the dynamic of the iteration between sources and uses of finance. Furthermore, this econometric technique has the strength to be valid even when we suspect structural change during the estimation period but are unsure as to when breaks might occur. This recursive algorithm, in fact, computes the linear least square of the forecasted state vector given data observed at time t.

The state vector $\hat{a}_t$ and its mean squared error $P = E\left[(\beta_t - \hat{\beta}_t)(\beta_t - \hat{\beta}_t)'\right]$ are recursively estimated by:

$$\beta_{t|t} = F\beta_{t|t-1} + H_{t-1}Z(Z'H_{t-1}Z + Q)^{-1}(y_{-1} - Z'F\beta_{t-1|t-1})$$

and

$$P_{t|t} = H_{t-1} - H_{t-1}Z(Z'H_{t-1}Z + Q)^{-1}ZH_{t-1}$$

where: $H_{t-1} = FP_{t-1|t-1}F' + R$, and $\beta_{t+1|t}$ is the forecast of the state vector at time period t+1, given information available at time t.

For each endogenous variable in the model it is therefore possible to observe how the respective coefficients are changing over time due to the effect of changing in the source of financing. If we calculate for every coefficient the first difference between, we can quantify the change in the contribution of each of the sources of finance to investment.

$$\underset{t-2,t-1}{\Delta}\beta_i = \beta_i^{t-1} - \beta_i^{t-2}$$

We start our investigation estimating, for the period 1970:Q1 until the 1998:Q3, the following two transition equations[94]:

$$INVR_t = C_{1,t} + \beta_{1,t}TOTINT_t + \varepsilon_t \qquad (3.8)$$

where INVR is total use of funds deflated by the Consumer price index, TOTINT is the real flow of total internal funds

The estimation of Eq. (3.8) should tell us if the behaviour of the flow of funds has changed significantly in the last thirty years and if the pattern changes along peaks and troughs of the business cycles. The patterns of the coefficients estimated are presented in Fig. 3.15. At a first glance we see that internal finance decreases along all the period under consideration. This downward process is quite pronounced during the eighties. It reaches the lowest level during the phase of the last recession. Afterwards the pattern appears to be quite stable.

[94] Footnote n. 94 at page 113 is now: Table 1. AII in Appendix II reports the estimates of $Var(\eta_s)$ and the corresponding standard error for each single model estimated hereafter.

As we saw in the previous paragraph the best measures to capture the level of external borrowing is given by the Net Borrowing Requirements. Therefore we estimate:

$$INVR = C_{2,t} + \beta_{2,t} NBR_t + \mu_t \qquad (3.9)$$

This allows us to see how much of the investment was financed through external finance, after using internal finance and net of other liquid assets. The first point emerging is that the amount of external finance used by Industrial and Commercial Companies shows a pronounced increase immediately after the end on the 1979-1981 recession. Moreover, the sizable investment spending in the late eighties was almost entirely financed through corporate debt. This could be attributed to the financial market big-bang that took place during 1986. The financial system expanded significantly: deregulation and liberalization lowered barriers to new domestic and foreign entrants eliminating interest rate regularization and removing restrictions on bank activities. The behaviour of the coefficients does not indicate any cyclical pattern. Since no economic theory suggests that too much corporate investment could be harmful for the economy, the result seems to indicate that a possible cause of the last economic downturn was the high level of indebtedness of non-financial companies. Another possible interpretation is that the external capital was not used to finance real investment but rather used for non-productive or speculative investment; where by speculative investment we mean an amount of money which chases up the price of extant assets. A third hypothesis would be that the economy was characterised by both an increased propensity to accumulate debt and speculative investment, which, in turn, created a crisis *à la Minsky*. To test this hypothesis, we define *INVRESID* as the difference between the total flow of funds used at each period and the Gross Fixed Capital Formation (*GFCF*). We test the impact of NBR for each of the two new variables. We estimate:

$$INVRESID = C_{3,t} + \beta_{3,t} NBR_t + \zeta_t \qquad (3.10)$$

$$GFCF = C_{4,t} + \beta^{*}_{3,t} NBR_t + \xi_t \qquad (3.11)$$

The null hypothesis is that during the late eighties speculative investment dominated productive investment; thus, this implies that $\alpha_1 > \alpha_2$ during the late eighties. The results are presented in Fig. 3.17; we notice that in the first part of our sample the coefficient α_2 as a great explanatory power for real investment. The opposite is true for the middle of our sample. Indeed the loans made for the purchase of companies were a major constituent in the huge expansion of credit supply which took place in those years. This acceleration in the availability of credit during the period 1988-90 was the result of increased competition among banks in order to gain market share; the result was that banks expanded their balance sheets. Furthermore another source of competition derived from foreign banks. Gardiner (1993, p. 146) recalls that "the increase in credit creation by foreign banks was at a rate at least three times greater than the rate of increase on the United Kingdom banks' lending". Schinasi and Hargraves (1993) argue that this increased competition caused a decline in the special role of banks and a lower degree of risk aversion.

The last equation that we estimate investigates the contribution of bank finance and capital market finance to NBR. We estimate:

$$NBR = C_{5,t} + \beta_{4,t} BANK_t + \beta_{5,t} NONBANK_t + \vartheta_t \qquad (3.12)$$

Where *BANK* is the flow of bank loans and *NONBANK* include all capital market finance, namely ordinary shares, preference shares and bonds; ϑ_t is the error term. We see how the need for external finance has been financed along the period under consideration. Fig. 3.18 shows that the coefficient of Bank has a tendency to decrease or stabilize in the second part of a recession period. This indicate that the banking system behaves as a safety net when the crisis begins, but when it starts deepening –with a consequent negative impact on the gearing ratio of lenders and borrowers- banks begin to cut funds[95]; this is in line with the results emerging in the previous paragraph. The idea is supported by the Bernanke and Blinder (1992); according to them adjustment of the stock of loans takes time. In order to match a decrease in deposits, banks initially sell liquid securities and only

[95] This implies that both lender and borrower do not know when a recession end.

in a second stage do they reduce the amount of loans. In their words "loans are quasi-contractual commitments whose stock is difficult to change". Furthermore, from the estimates is evident that in the last thirty years firms have chosen bank loans to other form of external finance. If we exclude possible restrictions imposed by market regulations, we think that Diamond's (1991) theory is the most appropriate to explain this pattern. He finds that a long-term bank-firm relation can help in reducing the cost of monitoring the firm and consequently the asymmetric information problem. Petersen and Rajan (1994), emphasize as the quantity of credit is positively affected by the bank-firm relation, and indeed our results show that the coefficient of BANK remain stable during recessionary periods. This seems to suggest that probably banks try to overcome firms' financing problems because an immediate cut in lending might correspond with bankrupts of the firm and the consequent impossibility to recover the amount previously lent. This, however, creates or aggravates the balance sheet's effect. Borrowing to overcome the liquidity problem in a period of recession means that more debt is created on the already existing debt deepening the financial situation. The result is a drastic cut in the bank's source of finance.

Some other considerations emerge from the estimations. Increasing external borrowing did not correspond to an in increase in internal funds and this rising debt increased vulnerability to bankruptcy (Davis, 1995). The fact that in that period we have a positive relation between interest rates and external financing, has brought some authors (Gardiner, 1993 p.43) to the conclusion that "why corporate borrowers were ready to pay well over asset value of shares, and also to pay high rates of interest to borrow the money to do so, seems to be a question for psychologists, or even for psychiatrists rather than for economists". However, high level of borrowing can find a sensible explanation if we accept the *minskian* notion that lenders and borrowers risks are determined mainly by the perception and expectations of economic fundamentals. Some insightful information is obtained comparing the pattern of BANK against the behaviour of the detrended GDP[96]. Expectations were accompanied by strong growth in investment expenditure this caused a sharp increase in asset prices and further positive

[96] GDP in Fig. 3.20 has been detrended using a HP Filter.

expectation of continued capital gains from the assets' market (particularly in the real estate). Nevertheless it is important to underline that this increase willingness to borrow was matched by a desire to lend: the increase competitiveness put pressures on the banking system and the development of a 'universal' type of bank induced wholesale banks to reduce the level of risk aversion. The result of this liberalisation was an altered monetary transmission mechanism; the expansion of credit via bank's balance sheets made have put the financial accelerator into operation and brought the system to a Mynskian fragile state.

Fig. 3.20 shows a strong positive correlation between BANK, interest rate payment and the level of interest rate. While internal funds exhibits a sharp decline in correspondence of the maximum point of those two variables, and at the same time we have a correlation between liquidation and bad loans[97]. Moreover it is important to underline that the increase in lending was supported by an increase in the asset prices inflation. This stimulated the willingness to borrow money via a higher level of collateral regardless of the level of the interest rate. The result was, of course, an increase of the credit supply in a period of tight monetary policy. The suggestion emerging from the data is, therefore, that prospects of continuing economic growth and rising asset prices might have led the financial system to have lent more than the safety 'threshold' point[98]. Further the persistent increase in the risk free interest rate accelerated the crisis making the cost of external capital, on which firms were heavily relying on, more and more expensive. The consequences of this *artificial* growth of credit and persistent cost of financing were an exponential increase in the bad-debt charges and of the liquidation rate. The result was the 1990-1992 recession[99].

3.6. Conclusions

[97] See Fig. 3.21.

[98] In that period national investment was a driving force of the economy, and most of this was financed through external borrowing. Indeed, the financial liberalization and increased competition provided the financial system with capital to finance firms' investment.

[99] Gardiner suggests that a more direct form of credit would have prevented this recession. He states that the increase in interest rate was just the wrong policy given the level of indebtedness of firms and consumer.

A number of theories and empirical research link the level of cash-flow with real investment. There are two main lines of research, the first rely on panel data analysis, the main conclusion that these studies reach is that cash-flow is an important determinant of the level of investment. When the sample is split between small and big companies, the major results is that the former are more vulnerable to external shocks (typically a monetary policy shock) than the latter; this is a consequence of the higher cash flow and net worth off big firms. A second line of research has been developed by Myers (1988) and Corbett and Jenkinson (1996, 1997), they employ flow of funds data at a country level. The results do not confirm the existence of the classical dichotomy between capital market based and bank based system; further they find that internal funds are the most important variable to explain real investment.

We argued that Corbett and Jenkinson (1996, 1997) results could be explained by the broad credit channel. At the heart of this theory is the proposition that external funds are not a perfect substitute for internal funds. This channel arises because of asymmetric information between the lender and the borrower; the cost of renting capital is therefore a positive function of the level of the indebtedness and on the level of the risk free interest rate. An increase in one of the two variables would increase the cost of capital in a more than proportionate way.

One major argument that we put forward is that credit channel theories, and more generally all the theories that make use of asymmetric information, not only provide an explanation for the magnitude of the business cycles fluctuations, but also could generate business cycles *a la* Minsky. We argue that asymmetric information is a characteristic of a capitalistic economy and they are the consequence of the division of labour. Since this asymmetry is pro-cyclical, the finance-expenditure link not only propagates shocks as in the broad credit channel, but also is itself a major source of instability.

We have suggested that the above statements could be tested with the Kalman Filter. We have employed flow of funds of Industrial and Commercial Companies in the United Kingdom in the last thirty years. Our results bring support to Mayer's (1988) idea that internal funds are the most important source of financing for UK companies. Furthermore we have find that the dynamic of the 1990-92 recession could be explained in term of Minsky's financial instability hypothesis. In fact we have found that speculative investment has dominated productive investment for the period antecedent the economic downturn.

Our last result suggests that bank loans dominate capital market sources of real investment. We explained that the result that the loans are a sticky aggregate given their "quasi-contractual" nature. At the same time we explained that banks can be seen as safety net for industrial and commercial companies.

Appendix I

Fig. 3.5: Total Funds

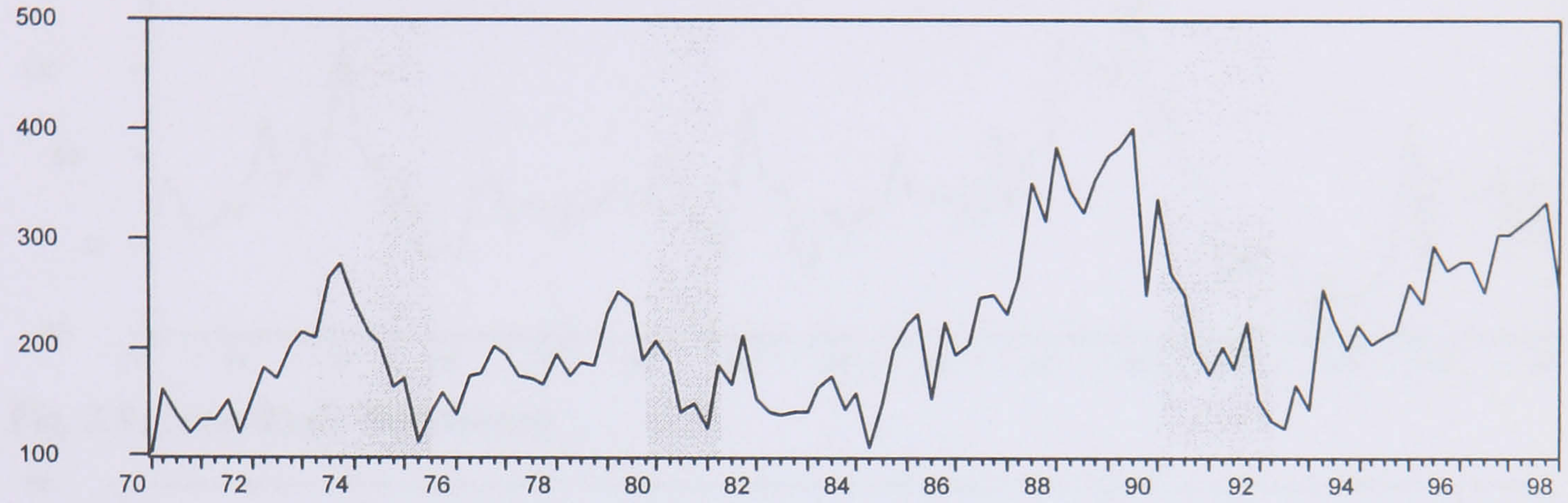


Fig. 3.6: Total Internal Funds

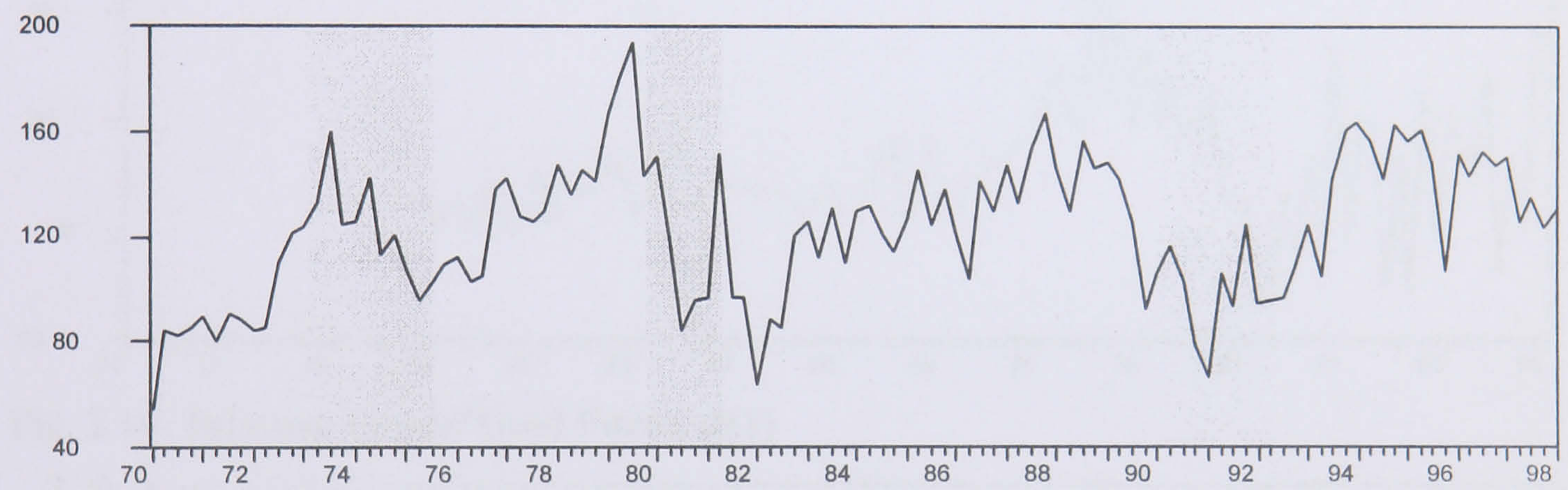


Fig. 3.7: Total External Borrowing

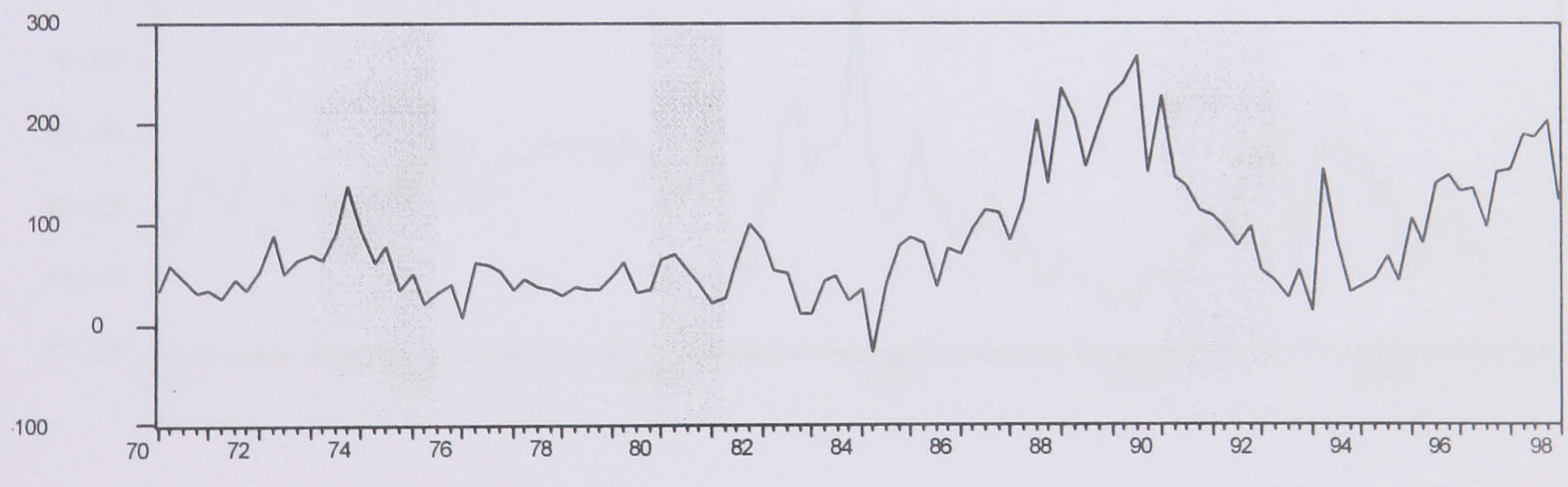


Fig. 3.8: Bank Borrowing

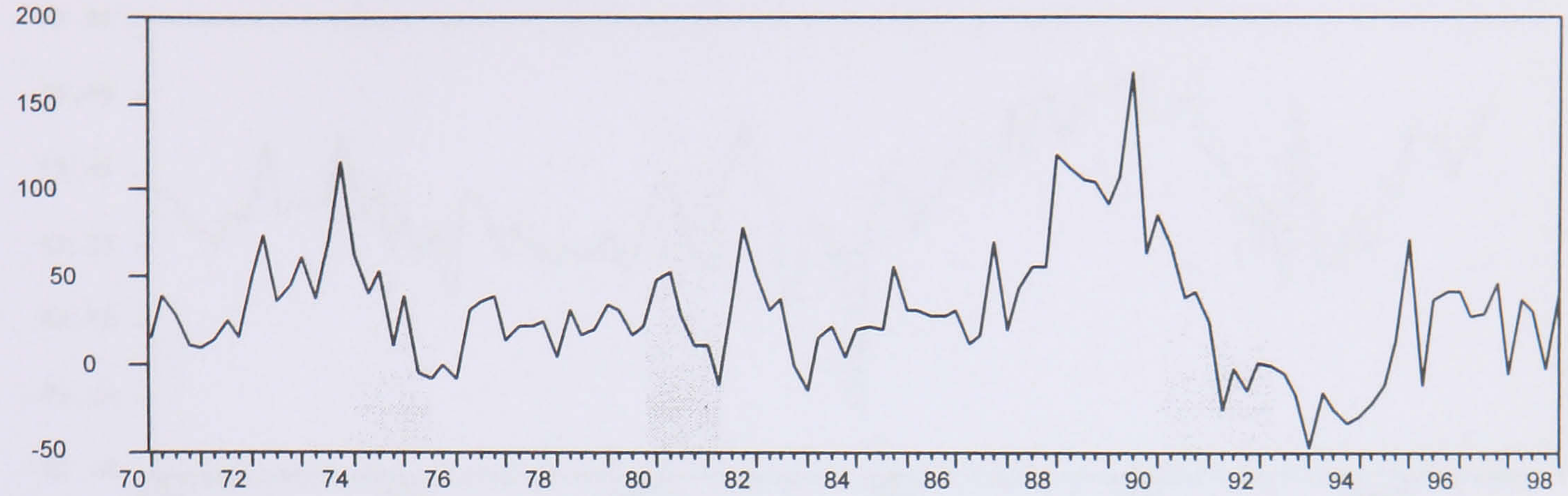


Fig. 3.9: Non-Bank Borrowing

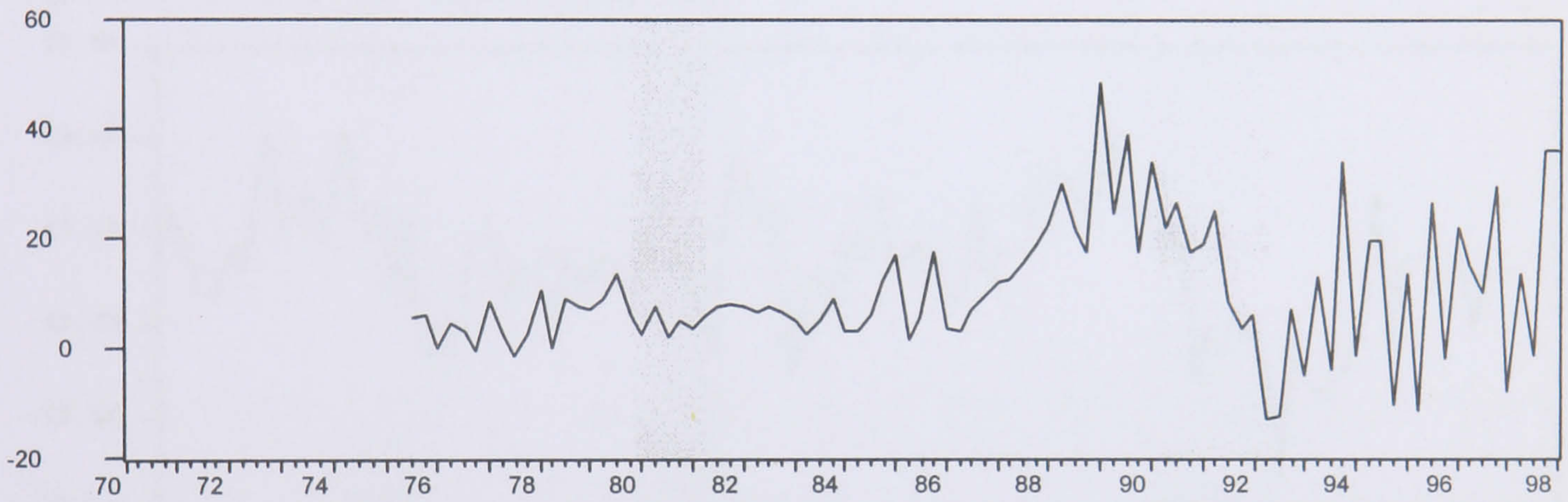


Fig. 3.10: Internal Funds/Total Funds (R1)

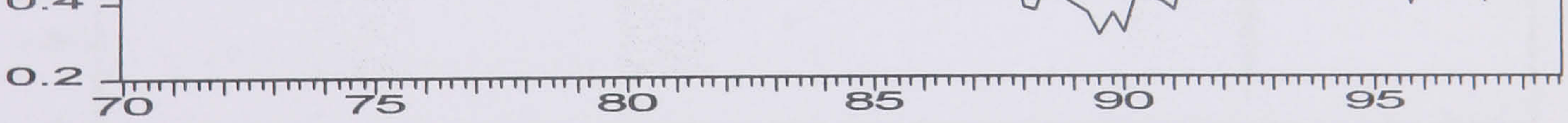


Fig. 3.11: External Funds/Total Funds (R2)

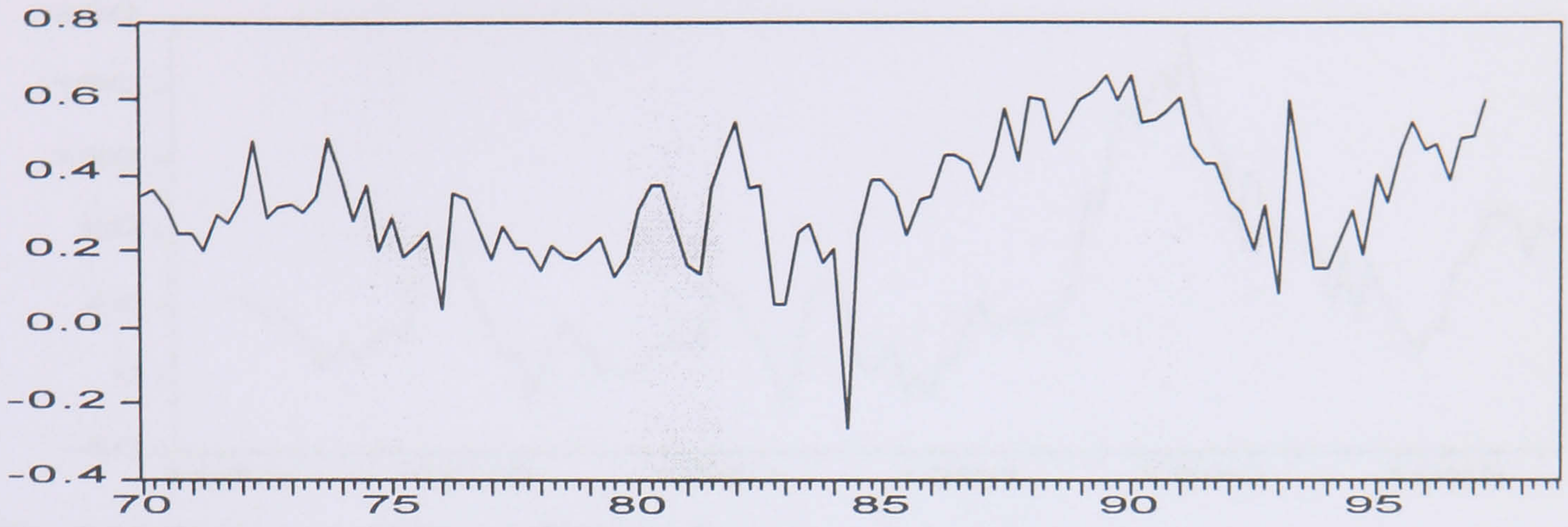


Fig. 3.12: Bank Loans/Total Funds (R3)

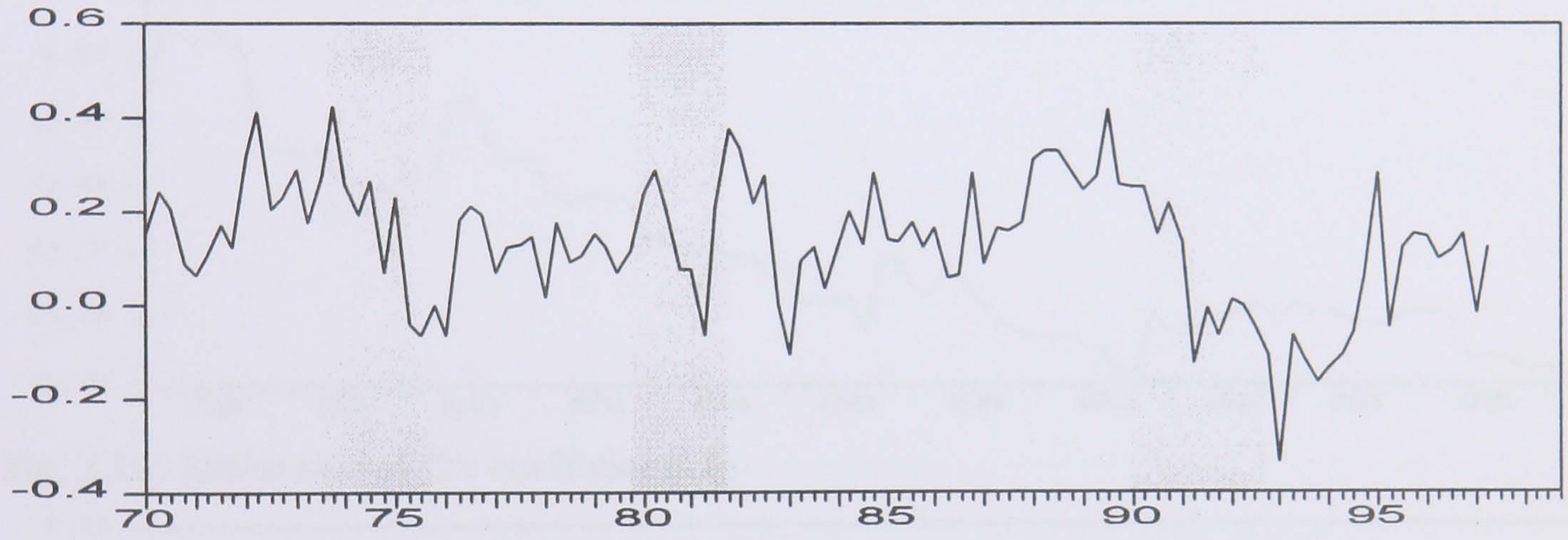


Fig. 3.13: Bank Loans/Total External Funds (R4)

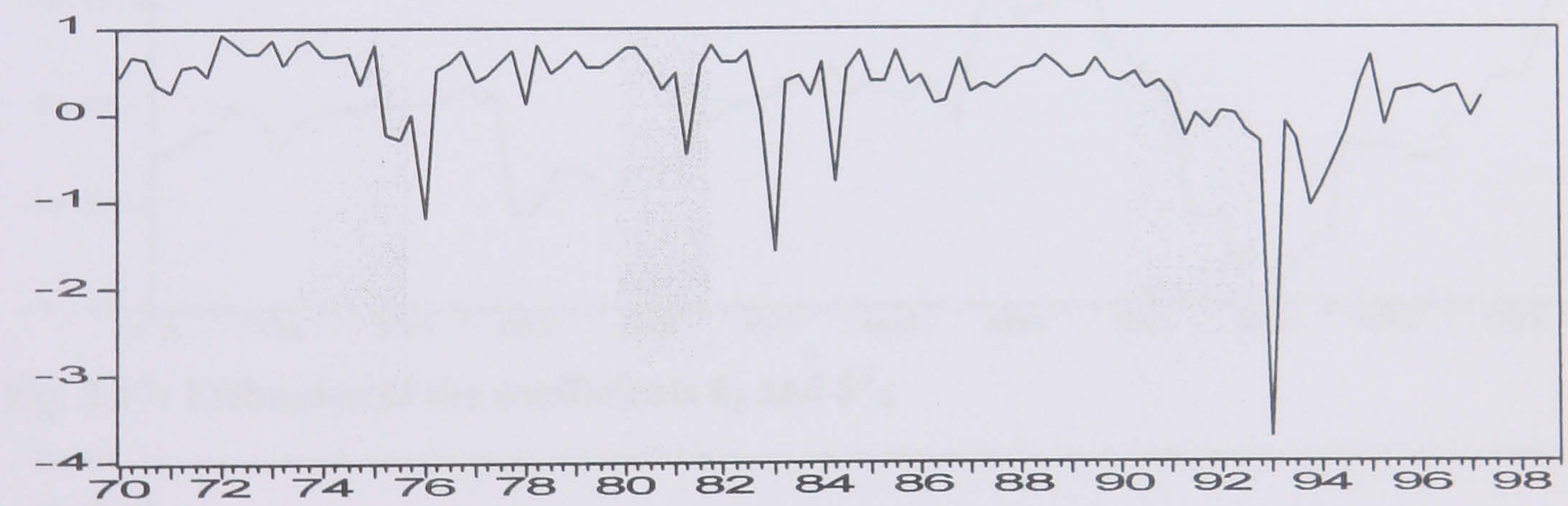


Fig. 3.14: Net Borrowing Requirement

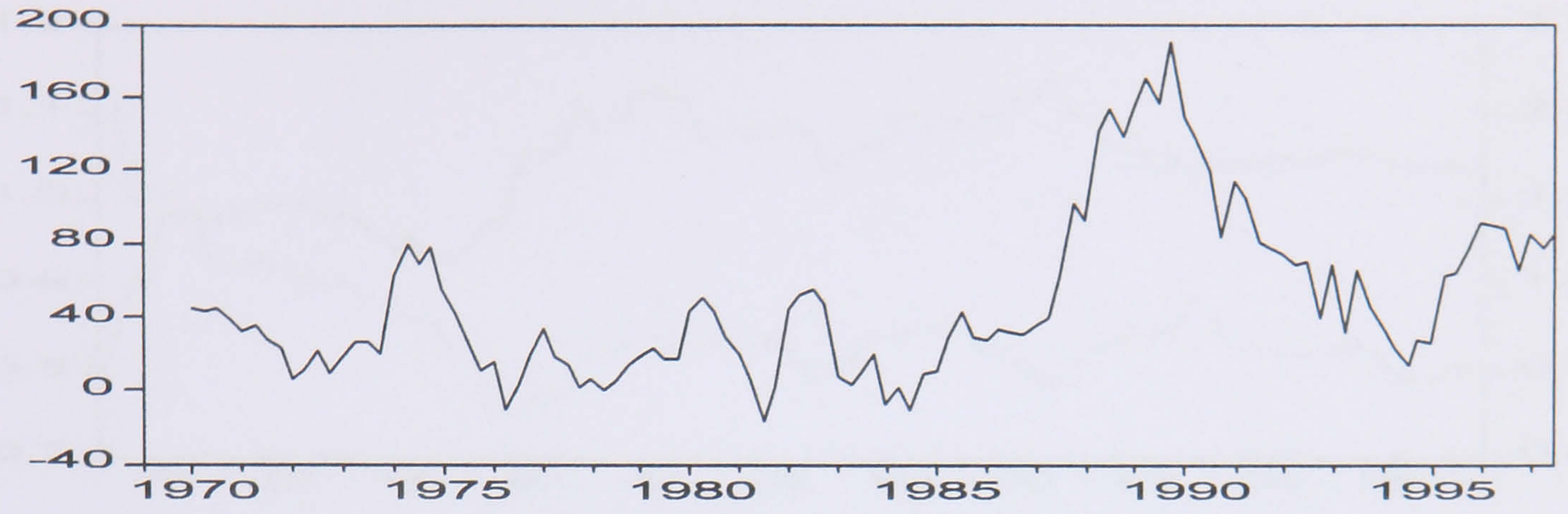


Fig. 3.15: Estimates of the coefficients $\hat{a}_1$

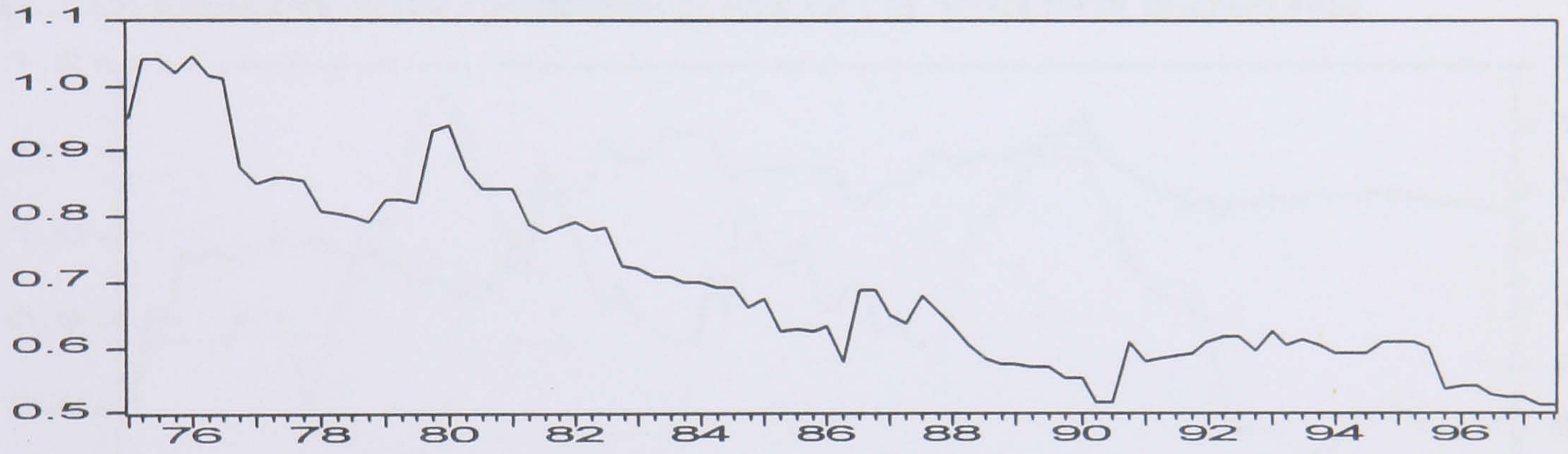


Fig. 3.16: Estimates of the coefficients $\hat{a}_2$

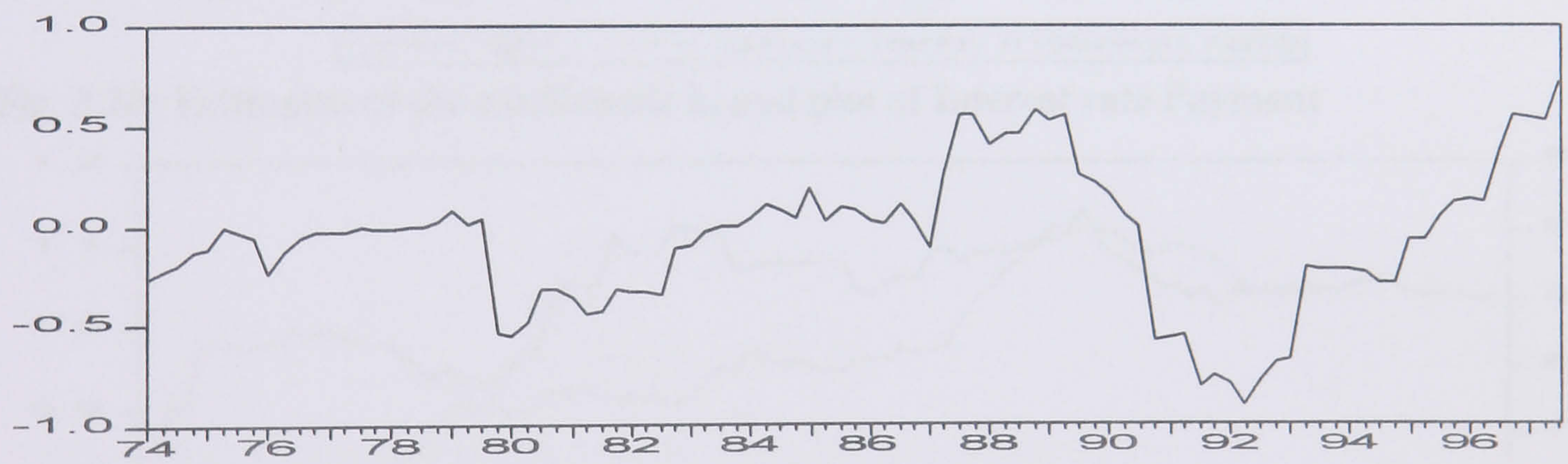


Fig. 3.17: Estimates of the coefficients $\hat{a}_3$ and $\hat{a}^*_3$

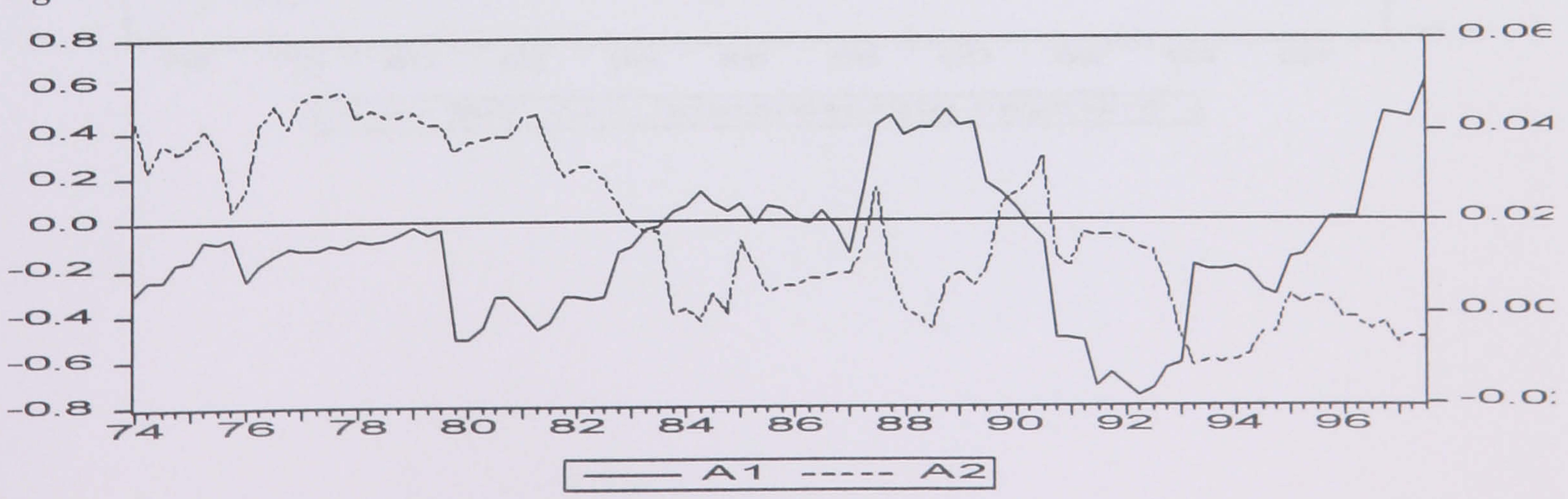


Fig. 3.18: Estimates of the coefficients $\hat{a}_4$ and $\hat{a}_5$

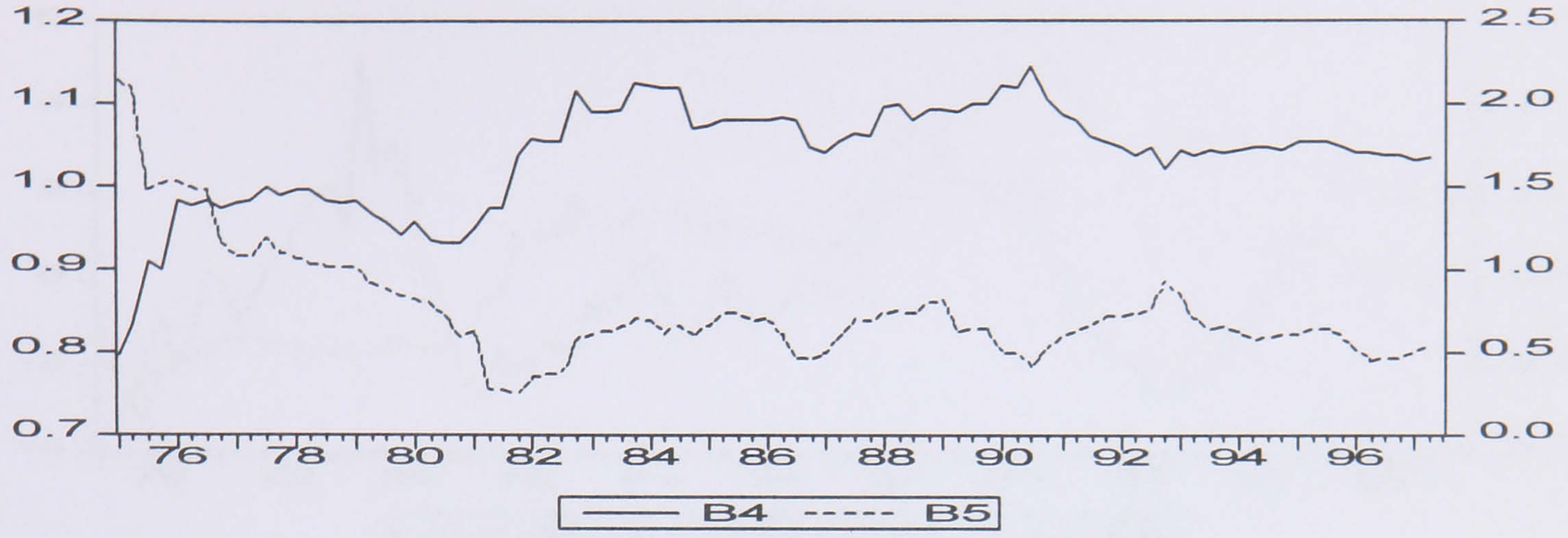


Fig. 3.19: Estimates of the coefficients $\hat{a}_4$ and plot of Short term interest rate

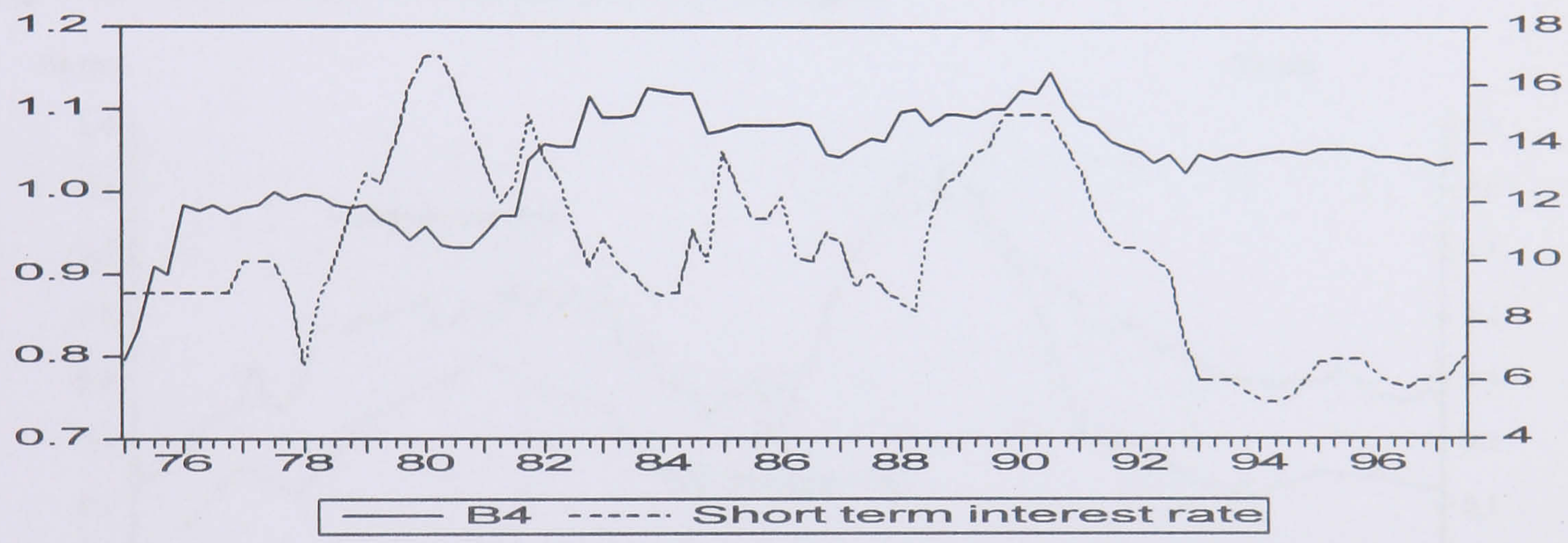


Fig. 3.20: Estimates of the coefficients $\hat{a}_4$ and plot of Interest rate Payment

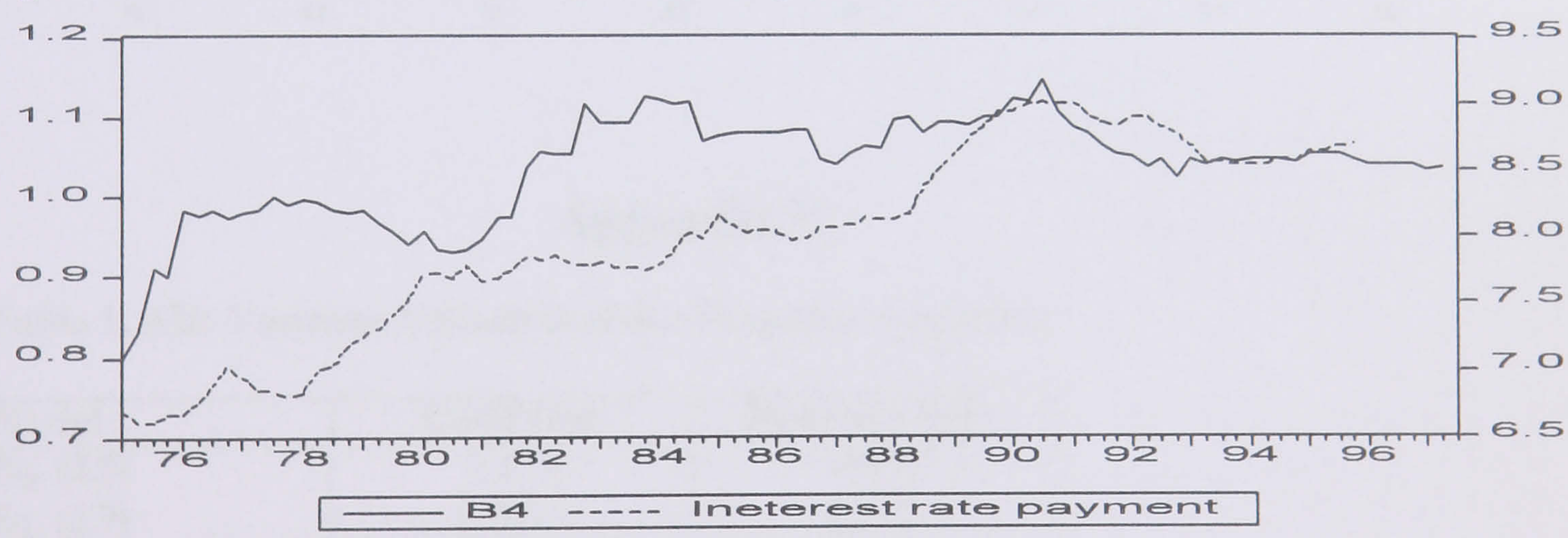


Fig. 3.21: Estimates of the coefficients $\hat{a}_4$ and plot of GDP detrended

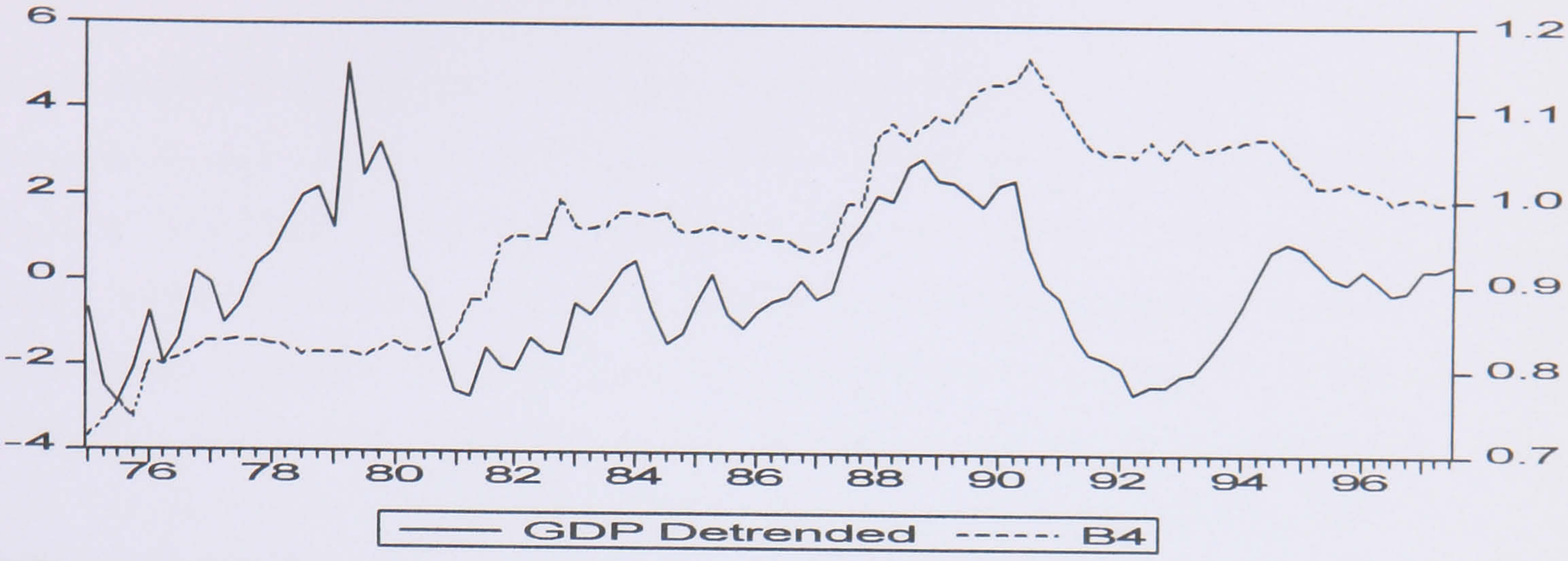
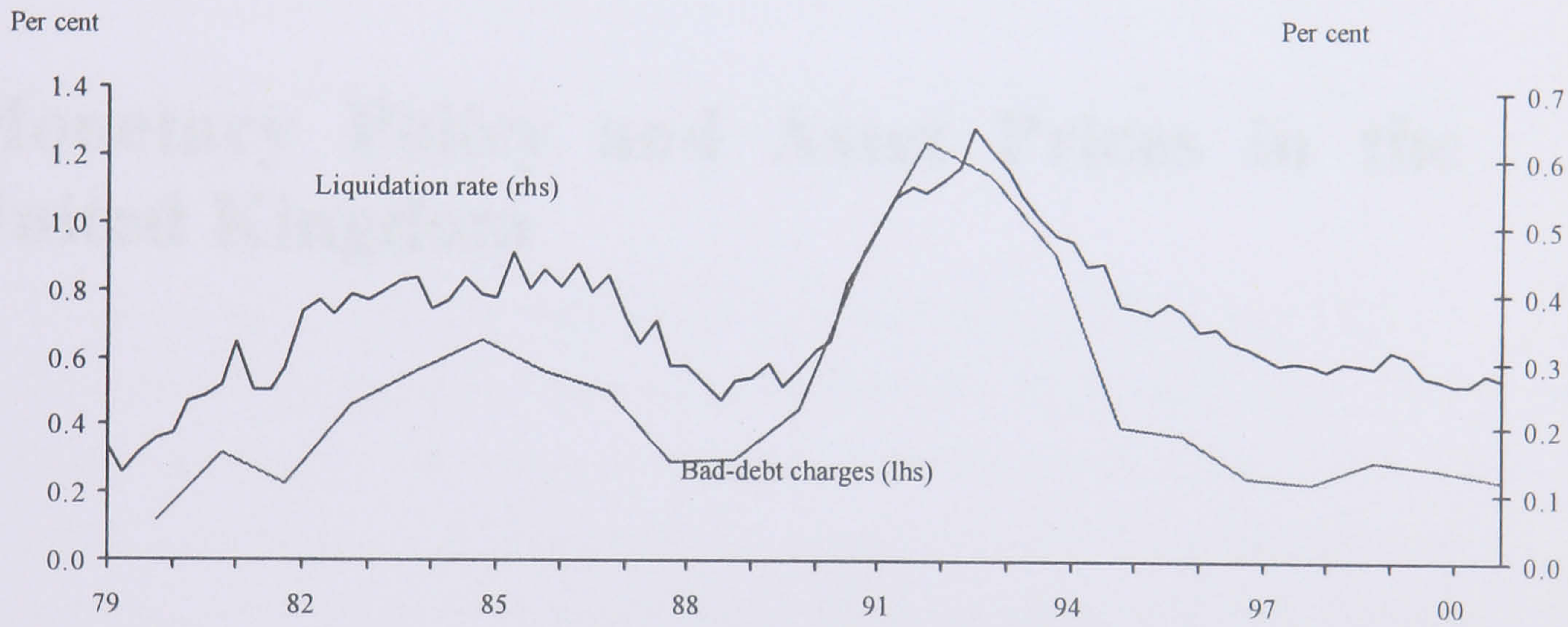


Fig. 3.22: Liquidation Rate and Bad-Debt Charges



Appendix II

Table 1. AII: Variance Estimates of the Transition Equations

Model	Coefficient	Standard Error
Eq. (3.8)	0.174	0.028
Eq. (3.9)	0.0217	0.017
Eq. (3.10)	0.015	0.009
Eq. (3.11)	39.524	9.699
Eq. (3.12)	0.018	0.0105

Chapter 4

Monetary Policy and Asset Prices in the United Kingdom

4.1 Introduction

As Bernanke and Gertler (2001) emphasise, asset market boom and busts have been important factors behind macroeconomic volatility in both industrial and developing countries. Following the financial deregulation in the early 1980s and the increased capital market globalization, industrial economies have witnessed an upward trend in asset prices. Alongside this trend, stock land and property prices have undergone swings around typical business cycle frequencies ranging from three to ten years. For some countries such as Japan and the Scandinavian counties during the late 1980s and the early 1990s, these swings had disruptive effects on domestic financial systems and contributed to prolonged recessions. In the U.K. case of 1990-92, the financial system withstood the asset price collapse but the ensuing recession was anyway severe.

As we saw in the first chapter, many recent theoretical and empirical contributions on the transmission mechanism of monetary policy imply that equity and property prices play an important role via consumption wealth effects and balance sheet effects. For example, a rise in stock prices decreases the perceived level of financial distress by households which leads to increased consumption spending. The balance sheet channel implies a positive relationship between the firms' ability to borrow and their net worth which in turn depends on asset valuations. This extra credit can be used to purchase goods and services and thus stimulates economic activity (Kyotaky and Moore, 1997).

Since banks and other financial institutions engage heavily in real estate lending, in which the value of the real estate acts as collateral, swings in property prices lead to increased financial instability. Sinclair (2000) reminds us that the Central Bank by setting the interest rate controls an important link between the monetary and financial stability. A low degree of policy smoothness may cause an excess volatility in the price of financial assets, especially when the policy is delayed. Borio and Lowe (2002) point out that while a low and stable inflation environment promotes financial stability, it also raises the likelihood that excess demand pressures will first show up in credit aggregates and asset prices rather than in consumer prices. They question the idea that Central Banks should focus only on monetary stability, given the fact that financial stability is automatically reached as a consequence.

Goodhart and Hofmann (2001) find that stock price and house price increases raise future aggregate demand in many major economies. Monetary policy affects asset prices via changes in expected future dividends and/or changes in the discount rate, which consequently affect aggregate demand and future inflation through balance sheet and wealth effects. Furthermore the evidence presented in the first chapter suggests that current asset prices inflation is a good proxy for future inflation. Some authors have suggested a pro-active view for monetary policy, claiming that macroeconomic performance can be improved by reacting to asset price bubbles, even if conventional measure of inflation appears to be under control (Cecchetti *et al*, 2000).

Goodhart and Hoffman (2001) estimate the potential benefit from including asset prices in a model that predicts inflation. By comparing the inflation forecasting properties of reduced form equations with and without asset prices they show that, particularly at the two-year horizon, house prices are useful indicators for consumer price inflation. Goodhart (1999) has recommended that, since asset prices represent the current price of claims on future as well as current consumption, policymakers should consider a broader price measure that includes housing and stock market indices[100].

The main objective of this chapter is to critically discuss the case of monetary policy in the context of financial instability; we extend the analysis as presented in Kontonikas Montagnoli (2004). We aim to provide further insight into the interest rate setting behavior of the Bank of England (BoE), by estimating reaction functions

[100] The theoretical foundation of this argument lays in pioneering research on the theory of inflation measurement by Alchian and Klein (1973).

that have been augmented to take into account the effect of asset price inflation. We depart from the traditional approach that considers the exchange rate as determinant of aggregate demand and interest rates, and focus on two other important asset prices, equity and house prices. The results indicate that UK monetary policy reacts to asset price fluctuations, especially when they originate from the housing market.

The remainder of the chapter is structured as follows. In the next section we discuss the link between monetary and financial stability. In section 4.3 we present the properties of the data. In Section 44 we provide some empirical evidence on the magnitude of the wealth effects using a small structural model of the UK economy. Section 4.5 contains the empirical results from augmented Taylor rules. Section 4.5.1 accounts for the effect of BoE independence on the inflation-policy rule parameter, and Section 4.5.2 compares the historical performance of the benchmark forward-looking rule versus the asset augmented rule. Section 4.6 concludes.

4.2. The financial stability case

In the last thirty years, there has been a widespread move towards financial liberalisation, both within and across national borders. The G7 countries typically began partial liberalisations in the mid-1970s, and then pushed such reforms considerably further in the 1980s and 1990s. By the early 1990s, their liberalisation efforts were virtually complete.

These developments in the financial markets brought about some changes of direction in the goals of central banks, and required some concepts, procedures, and strategies to be revised. In particular the concept of financial stability has gained new importance due to the introduction of new instruments into the international financial system, the exponential growth in the size of financial transactions, and the ever-increasing costs of financial crises[101].

[101] IMF (2000), Bordo *et al.* (2001).

It is generally accepted that monetary policy must pursue two kinds of stability at once: monetary stability, and financial stability. The fundamental purpose of the former is to protect price stability. Since the early nineties this has become the main goal of monetary policies. The implementation of inflation targeting strategies and Central Banks' independence has dramatically reduced the variance and the mean of inflation. There is little doubt that changing relative prices play a crucial and beneficial part in economic adjustment and decision making by individual actors be them companies or households. The price index and the optimal horizon over which to define price stability, in general the concept is widely accepted and relatively straightforward to handle both conceptually and in central banking practice.

The second objective of Central Banks has been and always will be financial stability. The term financial stability encompasses the stability of institutions, markets, and payment systems. Financial stability requires close, smooth interaction of all three, with each functioning correctly; large swings in asset prices possibly leading to some failures of monetary and financial institutions in the aftermath of a large real or financial shock could even be a sign of stability and of self-purifying powers of the system, as long as an efficient financial intermediation and financing process can be maintained. Indeed, many central banks around the world were established in part to serve as barriers against chronic episodes of financial instability and the attendant adverse consequences for the economy. Regardless of the different approaches used in various parts of the world, it is agreed, in principle, that a major goal of all central banks is to maintain a close, stable relationship between the financial system and the real economy. In fact, as we have presented in the first chapter financial markets play a vital intermediary role in the economy; thus, instability in the financial system quickly affects the fundamentals of an economy. This causes serious problems at once for the real economy, and later on for the social economy as well. For this reason, many central banks give the issue of financial stability a permanent place on their agendas. That said, some difficult issues may arise at times in judging how much weight should be attached to financial stability versus other central bank objectives and also in judging just how "activist" central banks should be in pursuing their financial stability objectives.

One important issue concerns the link between the two central bank's objectives. The relevant questions to be answered by academics and policy makers are: does a trade off between monetary and financial stability exist? Does monetary stability necessarily guarantee financial stability? The literature proposes two opposite views. The first is frequently defined as the "conventional view", it denies the existence of a trade-off between monetary and financial stability. According to Bordo *et al.* (2001, p.27) "the monetary regimes that produces aggregate price stability will as a by-product, tend to promote stability of the financial system". The reason is that inflation volatility is the major source of financial instability. This view has, as a central point, the fact that misperceptions about future returns are the results of inflation uncertainty. Asymmetric information worsens in an environment characterised by high inflation: moreover a sudden unexpected decrease in inflation has negative effects on the borrower since his/her outstanding debt would increase in real term. Indeed an environment characterised by high inflation volatility has a high probability to see disruption in the financial markets and, thus, to host some form of financial instability. The advocates of this view see the monetary stability as a necessary and sufficient condition to overcome financial system instability problems. In practice a separate weight on inflation stability, within a Taylor rule specification of the monetary policy, would not be beneficial for the overall system (Schwartz, 1995). A less strong view is assumed by Bordo and Wheelock (1998); they agree that the main objective should be price stability, and this, in the long run, will tend to promote financial stability.

A negative implication of this view is presented by Crockett (2003; italics in original) "(I)n a monetary regime in which the central bank's operational objective is expressed *exclusively* in terms of short-term inflation, there may be insufficient protection against the build up of financial imbalances that lies at the root of much of the financial instability we observe. This could be so if the focus on short-term inflation control meant that the authorities did not tighten monetary policy sufficiently pre-emptively to lean against excessive credit expansion and asset price increases. In jargon, if the monetary policy reaction function does not incorporate financial imbalances, the monetary anchor may fail to deliver financial stability." Indeed an optimal monetary policy should incorporate the notion that distortions in the financial system might be such that deviations from the desired inflation rate during short period of time might be accepted.

A "contrarian view" has recently been presented by Borio and Lowe (2002) and Borio, English and Filardo (2003). They argue that financial imbalances may develop even at times when prices are stable and output is close to potential. Borio and Lowe (2002, p.25, emphasis added) writes that "*it is the unwinding of financial imbalances that is the major source of financial instability, not an unanticipated decline in inflation per se*". They argue that the presence of a credible stabilisation program, an improved supply side[102] and a credible monetary policy could create favourable ground for financial instability. High levels of monetary credibility lead to well-anchored inflation expectations. And this, in turn, has led to many economic benefits. But Borio and Lowe (2002) argue that this is a potential problem here. People can come to believe that a central bank will always be able to guard against swings in inflation or downturns in the economy. At the same time investors could believe that the central bank would take decisive action to prevent the stock market from falling but not from rising (Miller *et al*, 2001). This is consistent with the view that, the central bank does not want to be seen as a "wealth destroyer"; it has been suggested as an explanation for the inaction of the Fed to substantially increase interest rates during the first stage of the US equity bubble on 1996-97. As Baker (2002) argues, a likely explanation for the Fed's inaction is that Greenspan and his colleagues may simply have felt constrained by their public mandate. The Fed, though operationally independent of political control, it derives its authority from Congress, which dictates the goals it should pursue through legislation.

[102] They are identified as improvements in the technology, labour market reforms, and productivity gains.

This optimism, deriving from this unconditional trust in the Central Bank, can then unduly lower perceptions of risk, leading to higher asset prices and an increased willingness for investors to borrow and for creditors to lend—the so-called "Greenspan put" (Miller *et al.*, 2001). Such economic environment would be characterised by a low and stable inflation, but also it could lead to unsustainable credit and asset prices expansion created by overoptimistic expectations. Optimism about future returns would drive up asset values, prompting private agents to borrow in order to finance capital accumulation. Moreover, appreciating asset values raise the value of collateral, hence facilitating the accumulation of debt. During the upswing, balance sheets may look healthy as the appreciation in asset values offsets the build-up of debt. As a result, central banks need to be prepared to take pre-emptive actions to prevent potential financial instability even when such policy actions may not be fully justified by the outlook for inflation and output. In other words central bank should take all those measure which would prevent a financial crisis when the investors optimism turn to pessimism, leading to a correction in asset valuations and a sharp deterioration in net worth. This imply that monetary authorities should try to stop any building up of financial imbalances, and try to smooth the impact of eventually already built up imbalances. Even this view is not immune by critiques. Issing (2003, p.7, 8) argue that "fragility during periods of disinflation is a transitory adjustment problem and would vanish as soon as the economy gets accustomed to the new and stable environment. Furthermore, in a broader, longer-term perspective it is again high inflation, which causes the problem. Without a preceding period of higher inflation, the economy would not have to go through a potentially vulnerable period of disinflation and adaptation to a regime of low inflation in the first place". Therefore, he concludes we are not in presence of a trade-off or a conflict between monetary and financial stability, even in the short run. In fact if asset prices were seen as future level of economic activity and therefore inflation, central bank would have to react in order to keep under control its objective of long run price stability. This therefore does not imply financial stability entering into the loss function (and in the Taylor rule) as a single argument.

In a context of an inflation-targeting rule a conflict might exist when the policy rule, which is optimal from the point of view of overall price stability, leads to inflation deviations from target in the short-run. Thus the question here is whether a central bank only caring for overall price stability, would optimally chose to refrain from keeping inflation right at target in the short term in order to stabilise the financial system.

This reflects clearly the current situation in the UK where inflation is low and stable which call for low interest rates, but the economy is characterised by an increasing in asset prices (mainly house prices[103]), which would require a tighter monetary policy.

In order to identify the optimal monetary policy Bordo and Jeanne (2001) construct a model in which firms can only borrow against collateral, and when asset prices fall there is a possibility of credit crunch. They show that if central bank adopts a forward-looking policy, which responds to the increase in financial imbalances and initial asset price inflation, this policy would be superior (in ten of output-inflation volatility frontier) to a policy which responds only to current inflation and economic activity. Their conclusion is that an even richer policy reaction function is desirable in a case of inflation targeting.

The above discussion and the evidence presented in chapter one, suggest that the potential role of asset prices is highly important in the context of a monetary policy framework like the British one, that is, a regime that targets medium-term prices of goods and services. Many authors justify the necessity for Central Banks to control for asset prices on the basis that (i) the share in the households' net financial wealth has increased[104] and (ii) firms have increased the amount of external borrowings[105]. Since the mid eighties there as been a sharp increase in the numbers of firms issuing

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[103] We will see in the next paragraphs that house prices are more important in the British economy, than other assets prices.
[104] See evidence presented in Table 1 and Table 2 in Chapter 1.
[105] See evidence in Chapter 3.

shares; (iii) 59% of U.K. loans is secured by real estate collateral[106]. Moreover real stock prices have rose steadily in the last ten years, but not without dramatic falls. This being said we can expect that the balance sheet channel can have severe implication in the UK.

The Bank of England seems to have acknowledged the importance of asset prices, in fact, as reported by Gramlich (2002) the households wealth is a significant component of the Bank's model for consumption expenditures. Following this model it is estimated that in the long run, a 10 per cent increase real gross housing wealth and net financial wealth boost consumer spending by 0.5 per cent and by 0.7 per cent respectively.

Indeed the monetary policy makers seem to have fully captured and incorporated this notion. In February 2002 the minutes of the Monetary Policy Committee states: "persistently rising debt levels potentially increased the probability that any adjustment to household balance sheets would be abrupt rather than smooth, with an attendant risk of a fall in asset prices and, thus, in the value of collateral". During October 2002 the Committee wrote: "an interest rate reduction seemed likely at present predominantly to affect house prices, household borrowing and consumption, which were already increasing strongly. A further reduction in the repo rate risked creating an unsustainable increase in debt which might subsequently unwind sharply. This would increase the risk of undershooting the inflation target in the medium term". Both statements are clear examples of the emphasis placed on risk factors for future economic development[107]. These statements fully incorporate the idea expressed by Borio and Lowe (2002) that even in a period of low and stable inflation, an economic system can move from a tranquil to an instable state. In a practical term the Committee analysis pointed to the build-up of financial imbalances as a factor which implied that the interest rate should be kept unchanged rather then reducing it.

[106] Source: Borio (1996) table 12, p. 101

[107] Checchetti (2003) analysing the Federal Open Market Committee (FOMC) points the finger in the same direction. He references the keywords concerning asset market valuations, he finds that "as the stock market become a concern in the mid 1990s, the frequency with which it was mentioned rose dramatically", Cecchetti (2003, p.86)

Thus, it is a Central Bank role to act in order to prevent a situation of financial instability.

3. Data description

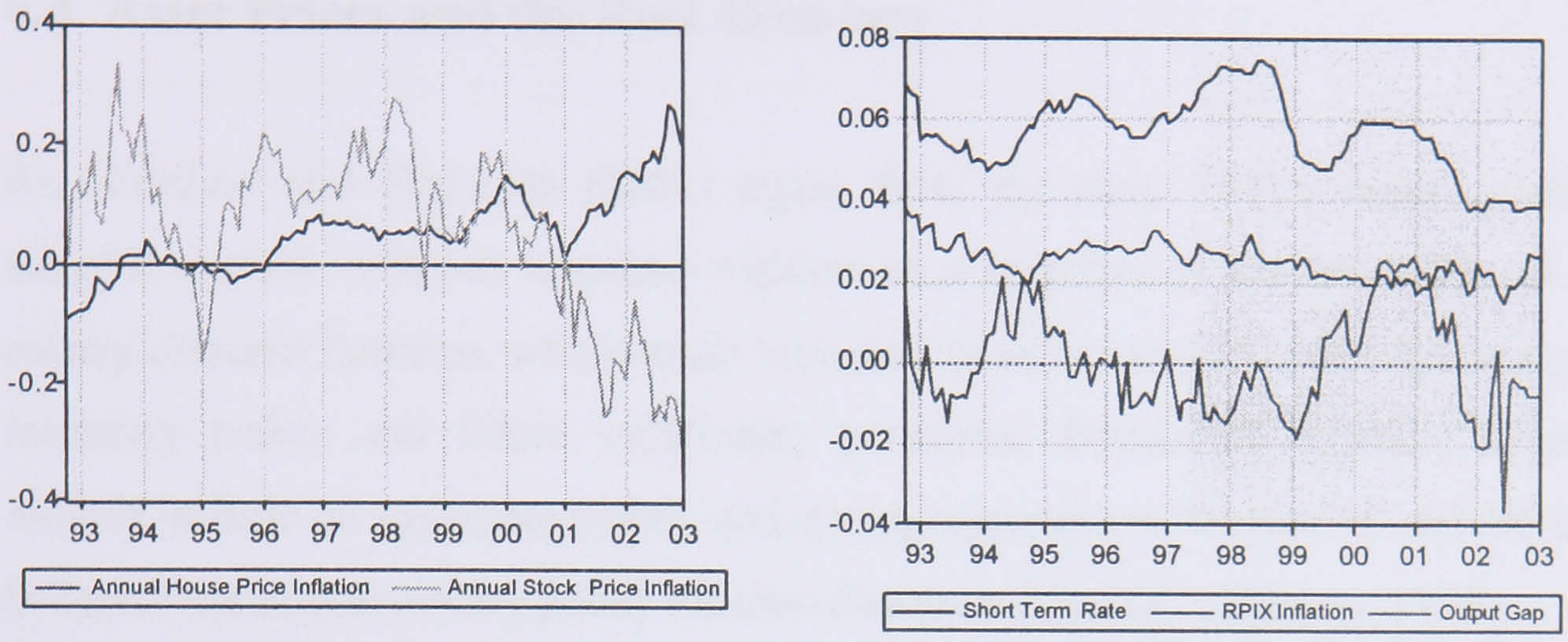
We employ monthly data on short-term interest rates, industrial production, Retail Price Index minus mortgage interest payments (RPIX), stock prices and house prices for the United Kingdom from October 1992 to January 2003. All data is obtained from Datastream, *OECD Historical Statistics* series. Our sample period commences with the establishment of an explicit inflation targeting regime on October 1992. An inflation target of 1-4 % was initially adopted and on June 1995 the target was reset at 2.5% or less. In addition, on May 1997 the Bank of England was awarded operational independence in setting interest rates.

The (annualised) output gap, $\tilde{y}_t$, the difference between actual and potential output, is calculated via quadratic de-trending of the industrial production series, as in Clarida, Gali, and Gertler (1998), and Nelson (2000). The 3-month Treasury Bill rate, R_t, is employed as a measure of the stance of the monetary policy[108]. The annual change in stock prices, $\eth_t^{SP}$, house prices, $\eth_t^{HP}$, and retail prices, $\eth_t$, is proxied by the 12th difference of the natural logarithm of the monthly FTSE All Shares stock index, the Halifax house price index, and the (seasonally adjusted) RPIX respectively. We used annual, rather than monthly, changes for retail prices, stock prices and house prices since year on year changes on these variables are much more relevant for monetary policy decisions (Goodhart, 2001).

[108] The actual interest rate used by the Bank of England as its instrument has varied over time, and has included Bank Rate (until September 1972), Minimum Lending Rate (1972-81), and the two-week Repo Rate (since 1996). The Treasury Bill rate has historically moved close with these instruments, and is available for the entire sample period.

Fig. 4.1: Annual House Price and Stock Price inflation, 1992:10-2003:01.

(a) (b)



As we see in Fig. 4.1(a) stock prices have been far more volatile as compared to house prices. In the aftermath of the burst of the stock market bubble in 2000, the two series start diverging significantly, with house price inflation accelerating, while the stock market collapsed. The output gap in Fig. 4.1(b) indicates a post-bubble weaker UK economy since it is generally declining after peaking in early 2001. Finally, the nominal interest rate is consistently above the strikingly stable (as compared to its 1970's 'rollercoaster' behaviour) inflation rate. Standard Phillips-Perron (PP) tests are employed in order to test for unit roots in our data. The results in Table 1 clearly indicate the rejection of the unit root null hypothesis at the usual levels of significance. Therefore we employ all the aforementioned variables at their levels.

Table 4.1: Unit Root tests

Variables	Phillips Perron t-statistic
R	-3.620234 **
y^{gap}	-4.529641 ***
$\eth$	-4.001144 **
$\eth^{SP}$	-3.803221 **
$\eth^{HP}$	-3.748362 **

Note: 1. In order to correct for serial correlation the Phillips Perron (PP) test uses a non-parametric estimator of the variance-covariance matrix. A truncation lag of twelve was employed. An intercept and a linear trend term were included in the PP regressions.

2. The reported t-statistics test the null hypothesis that the variable contains a unit root.

3. *, **, *** indicate rejection of the unit root - null at the 0.10, 0.05, and 0.01 significance level respectively.

4.4. Asset Prices and the Real Economy

As Goodhart and Hofmann (2001) argue, from the early 1990's many countries adopted explicit inflation targeting regimes as a response to the instability of the money demand function, which made monetary growth rates an unreliable proxy of monetary policy and future inflationary pressures. Simplified inflation targeting models include an aggregate supply and an aggregate demand equation and are used to derive optimal monetary policy reaction functions (see e.g. Svensson, 1997).

In chapter one, we presented some statistics describing the composition of households' wealth. Furthermore we presented the channel through which wealth and asset prices can affect the real economy. In this section we test the hypothesis that lagged asset prices have an effect on the level of the aggregate demand. Due to the inconsistencies between purely forward-looking models and actual output data, many researchers (see e.g. the references provided in Clarida, Galí and Gertler, 1999) suggest the employment of "hybrid" IS-curves, which include both backward- and forward-looking elements. Therefore we model the demand-side of the economy as a hybrid IS, that is consistent with dynamic optimising behaviour by the agents (micro-foundations[109]) and also allows for some persistence in output. Thus, our specification allows the output gap to be a function of past and expected future output, lagged real interest rate, and lagged values of a vector, **X**, of additional explanatory variables.

$$\tilde{y}_t = \lambda_0 + \lambda_1 \tilde{y}_{t-i} + \lambda_2 E_t[\tilde{y}_{t+n}] + \lambda_3 \bar{i}_{t-s} + \grave{\mathbf{U}}'\mathbf{X}_{t-k} + v_t \qquad (4.1)$$

where, $\bar{i}_t = (\frac{1}{12})\sum_{i=0}^{11}(R_{t-i} - \pi_{t-i})$ is the twelve-month average *ex post* real interest rate.

[109] Among the others see MaCallum and Nelson (1999).

As we already pointed out there are many channels via which, changes in equity prices and house prices affect consumer wealth. Direct effects include the change in consumption plans as a response to swings in asset prices (Modigliani, 1971), while indirect effects operate mainly via househo lds and firms' balance sheets. There is a growing consensus that, apart from the conventional explanatory variables, output is also determined by changes in consumption and investment demand induced by changes in the level of asset prices. Therefore, the aggregate demand function given by Eq. (4.1) is estimated with GMM including house price and stock price inflation.

$$\tilde{y}_t = 0.024 + 0.230\tilde{y}_{t-3} + 0.691\tilde{y}_{t+3} - -0.464\bar{i}_{t-12} + 0.017\pi^{SP}_{t-12} + 0.030\pi^{HP}_{t-12} + \hat{v}_{3t}$$
$$(0.00) \quad (0.03) \quad (0.03) \quad (0.07) \quad (0.00) \quad (0.00) \qquad (4.2)$$
$$SE = 0.008, \quad \text{J-stat} = 0.1638\ [0.8]$$

The results indicate that aggregate demand is more affected by its forward-looking component (expected future output) since $\ddot{e}_2$ is positive and significant and it has a higher magnitude than $\ddot{e}_1$. The one-year lagged real interest rate is negative and strongly significant, as expected. Finally, the magnitude of the wealth effect depends among other factors on the share of the respective asset in private sector wealth, with housing constituting the most significant asset in the households' portfolio in most countries. Indeed, we find that the magnitude of the wealth effect due to stock price increases is smaller than the effect due to house price increases. The coefficient of stock price inflation is smaller than the coefficient of stock price inflation a result that is in line with previous evidence by Goodhart and Hofmann (2001) for the UK. Using a panel of 14 developed economies Case, Quigley, and Shiller (2001) also find that the housing market appears to be more important than the stock market in affecting the real economy. Moreover our result is consistent with the IMF results (IMF, 2003) that housing wealth has a greater impact than other assets on consumption and consequently on output and unemployment.

Having demonstrated that movements in asset prices affect future aggregate demand and consequently also future inflation, in the next section we shall focus on the key empirical question of this chapter, that is, what has been the response of the monetary policy instrument to asset price inflation.

4.5. An Alternative Taylor Rule Specification

It is generally assumed that the monetary policy interest rate instrument responds with fixed, positive weights to deviations of inflation from a pre-specified target, and deviations of output from its potential level (Taylor, 1993). The past decade has seen a vast amount of empirical and theoretical work considering monetary policy reaction functions. McCallum and Nelson (1998) and Clarida, Gali and Gertler (2000) present econometric estimates of the Taylor rule coefficients for the United States. Nelson (2000) provides empirical evidence for the United Kingdom under alternative monetary policy regimes, over the period 1972-97, prior to the Bank of England (BoE) operational independence[110]. Focusing on the inflation-targeting period 1992-1997, Nelson's results suggest that a forward-looking looking Taylor rule outperforms a backward looking Taylor rule. His results contradict those of Kuttner and Posen (KP) (1999). In contrast with Nelson, who used quarterly data, KP employed monthly data over the period October 1992-December 1997 and found a coefficient of zero on inflation. Other important differences with the Nelson study include the use of the unemployment rate, instead of the real GDP for the construction of the output gap proxy, and the employment of the annualised month-to-month rather than annual inflation rate. As Nelson argues though, the use of annual inflation in the estimated rule is crucial for the results since the BoE's inflation target has always been expressed in terms of the annual (year-ended), rather than the monthly inflation rate.

Following Clarida *et al.* (1998) we assume that the Central Bank has an operating target for the nominal short term interest rate that is based upon the state of the economy. In the benchmark model the state of the economy is characterised by the

[110] See Section 2.3.

evolution of the output gap and expected inflation. This forward looking behaviour is consistent with a central bank that operates in the context of an inflation targeting regime (Kent and Lowe, 1997). In each period, the actual interest rate partially adjusts towards the target value. Svensson (1997) justifies the partial adjustment mechanism by including the change in interest rates in the Central Bank's loss function. Combining the target rule with the partial adjustment mechanism we obtain the empirical form of the monetary policy reaction function:

$$R_t = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\left\{a + \beta(E_t[\pi_{t+n}] - \pi^*) + \gamma E_{t-1}[\tilde{y}_t]\right\} + \sum_{i=1}^{l} \varphi_i R_{t-i} + u_t \qquad (4.2)$$

where $\sum_{i=1}^{l} \varphi_i \in [0,1]$ measuring the degree of interest rate smoothing, $\eth^*$ is the inflation target (2.5 %), and $\acute{a} = r^* - \hat{a}\eth^*$, with r^* denoting the long-run equilibrium nominal interest rate. Due to the fact that monetary policymakers cannot observe $\tilde{y}_t$ when setting R_t, we replace the actual value of the output gap with its expected level, $E_{t-1}[\tilde{y}_t]$; see McCallum and Nelson, 1999, and Orphanides *et al.*, 2000 for a further discussion of the uncertainties faced by the policymaker with respect to output. The error term, u_t, represents a white noise monetary policy shock. We consider an inflation forecast horizon of one year, therefore we set n equal to 12 in our monthly sample.

In order to estimate the model, unknown expected future variables are replaced with their ex post realised values. This leads us to Eq. (4.3):

$$R_t = \left(1 - \sum_{i=1}^{l} \varphi_i\right)\left\{a + \beta(\pi_{t+n} - \pi^*) + \gamma \tilde{y}_t\right\} + \sum_{i=1}^{l} \varphi_i R_{t-i} + \omega_t \qquad (4.3)$$

The disturbance term in Eq. (4.3) is a linear combination of the inflation and output gap forecast errors and the exogenous monetary policy shock u_t:

$$\omega_t = -(1-\sum_{i=1}^{l}\varphi_i)\{\beta(\pi_{t+n}-E_t[\pi_{t+n}])+\gamma(\tilde{y}_t-E_{t-1}[\tilde{y}_t])\}+u_t \quad (4.4)$$

Eq. (4.3) implies the following set of orthogonality conditions:

$$E_t\left[R_t-\left(1-\sum_{i=1}^{l}\varphi_i\right)\{a+\beta(\pi_{t+n}-\pi^*)+\gamma\tilde{y}_t\}+\sum_{i=1}^{l}\varphi_i R_{t-i}\middle|Z_t\right]=0 \quad (4.5)$$

where Z_t represents all the variables in the Central Bank's information set available at time t when the interest rate is chosen. Z_t is a vector of variables that are orthogonal to $\grave{u}_t$. These instruments are lagged variables that help forecasting inflation and output, and contemporaneous variables that are uncorrelated with the exogenous monetary policy shock, u_t. The benchmark reaction function given by Eq. (4.3) is estimated using the Generalised Method of Moments (GMM). The instruments employed in the estimation include a constant and six lags of the nominal short-term interest rate, inflation, output gap, and a world commodity price index (agricultural raw materials). Since the number of instruments is greater than the number of elements of the parameter vector *[öi, á, â, ã]*, we test for the validity of the over-identifying restrictions using the *J*-statistic. As pointed out by Clarida *et al.* (1998), failure to reject orthogonality implies that the Central Bank considers lagged variables in its reaction function, only to the extent that they forecast future inflation or output.

The GMM estimation results in Table 4.2, column 2, indicate that the benchmark specification satisfies the dynamic stability criterion since the estimated inflation coefficient, *â*, is greater than one (1.02). If â was smaller than the stability threshold of one, then this would imply a positively sloped aggregated demand, with output decreasing in response to an inflation shock (Taylor, 1999). The output gap coefficient, *ã*, is positive and statistically significant at the 1 % level, although quite modest in magnitude (0.03). Its estimate implies that, holding expected inflation constant, one-percent increase in the level of output gap induces the BoE to raise interest rates by 3 basis points. This result is consistent with those reported by Martin and Milas (2001) who employed quarterly UK data. Therefore, during the inflation-targeting period that we consider, U.K. monetary policy has put more weight on price stability than output stabilisation. The sum of the interest rate smoothing parameters is close to one (0.92) indicating a high level of persistence in short term interest rates. Finally, the *J*-statistic indicates that the over-identifying restrictions of the benchmark model are not rejected.

Table 4.2: GMM Estimates of Forward Looking Taylor Rule, 1992:10-2003:1

	Benchmark Model	$X_t = [\pi_t^{HP}]'$	$X_t = [\pi_t^{SP}]'$	$X_t = [\pi_t^{HP}, \pi_t^{SP}]'$
a	2.59 *	4.00 ***	2.51 ***	4.56 ***
β	1.02 *	1.60 ***	1.01 ***	1.82 ***
γ	0.03 ***	0.04 ***	0.08 ***	0.02 ***
$\sum_{i=1}^{l}\varphi_i$	0.92 ***	0.91 ***	0.91 ***	0.83 ***
θ_1	-	0.15 ***	-	0.12 ***
θ_2	-	-	0.06 ***	0.07 ***
S.E. of Reg.	0.0023	0.0022	0.023	0.0030
J- Stat.	14.10	17.38	21.19	15.51
Q(1)	1.7358	1.5502	0.0333	0.1292
Q(12)	19.482	17.897	14.613	17.555
$Q^2(1)$	0.4496	1.52346	0.1851	1.4029

As pointed out in the previous section, asset prices contain important information about future aggregate demand and consequently inflation pressures. Also, there are theoretical arguments in favour of including asset price inflation in the reaction function of the Central Bank. Cecchetti *et al*. (2000) find that, on the basis of simulations, it would be desirable to include asset inflation in the Taylor rule. Therefore, we proceed by considering alternatives to our benchmark specification, by allowing asset prices to enter in the Taylor rule. The augmented reaction functions we consider are of the form:

$$R_t = \left(1 - \sum_{i=1}^{l}\varphi_i\right)\left\{a + \beta(E_t[\pi_{t+n}] - \pi^*) + \gamma E_{t-1}[\tilde{y}_t] + \grave{\mathbf{E}}'\mathbf{X}_t\right\} + \sum_{i=1}^{l}\varphi_i R_{t-i} + \varepsilon_t \qquad (4.6)$$

where $\mathbf{X}_t = [x_{1t} \quad \ldots \quad x_{jt}]'$, and $\mathbf{\grave{E}} = [\theta_1 \quad \ldots \quad \theta_j]'$ denote the vector of j-additional explanatory variables, and the relevant coefficient vector respectively. In the cases that we will examine, X_t contains contemporaneous house price and/or stock price inflation. We use contemporaneous, and not expected, asset price inflation due to the well known difficulties involved in forecasting asset price movements. Also, weak form efficiency implies that the current asset price reflects all past history, thus there is no need to incorporate lags.

First, we allow annual house price inflation to enter the reaction function. The results are presented in Table 4.2, column 3. The house inflation coefficient, $\grave{e}_1$, is positive and highly significant. Monetary policy tightens in response to increases in house prices: a one percent rise in house prices increases interest rates by 15 basis points. The response to expected inflation is stronger than in the benchmark case, with a smaller standard error. The estimated inflation coefficient is 1.6 close to the theoretical value of 1.5, as suggested by Taylor (1993), thus ensuring that real rates increase in response to inflationary pressures. Second, we add stock price changes in the benchmark model. The estimated coefficient, $\grave{e}_2$, (Table 2, column 3) is still positive and statistically significant but its value (0.06) is much smaller as compared to house price coefficient. When both asset returns are included (Table 2, column 4), the magnitude of the coefficients confirms that house prices enter more significantly the monetary policy reaction function, since $\grave{e}_1 > \grave{e}_2$. As in the benchmark specification, the J-statistic cannot reject the overidentifying restrictions.

4.5.1. Accounting for independence

There is a wide consensus among academics and practitioners that central bank independence produces lower average inflation (Cukierman, 1992). Spiegel (1998) finds that the BoE independence on May 1997 had a significant negative impact on agents' inflationary expectations. In order to account for the change in the underlying regime and preferences we allow the expected inflation coefficient to be different post-independence. We therefore introduce a multiplicative dummy variable, D_t, in the reaction function, where $D_t = 0$ prior to independence and 1 onwards:

$$R_t = \left(1-\sum_{i=1}^{I}\varphi_i\right)\left\{a+(\beta+\mu D_t)(E_t[\pi_{t+n}]-\pi^*)+\gamma E_{t-1}[\tilde{y}_t]+\grave{E}'\mathbf{X}_t\right\}+\sum_{i=1}^{I}\varphi_i R_{t-i}+v_t \quad (4.7)$$

We would expect the dummy coefficient, ì, to be positive and significant indicating that the BoE becomes more inflation-averse, which leads to lower inflation expectations.

Table 4.3: Estimates adjusted for the Effect of Bank of England Independence,

	Benchmark Model	$X_t = [\pi_t^{HP}]'$	$X_t = [\pi_t^{SP}]'$	$X_t = [\pi_t^{HP}, \pi_t^{SP}]'$
a	4.53 **	5.85 ***	3.27 **	5.62 ***
β	1.81 **	2.35 ***	1.30 ***	2.25 ***
γ	0.03 ***	0.04 ***	0.02 ***	0.03 ***
μ	0.41 *	0.47 **	0.61 ***	0.40 *
$\sum_{i=1}^{I}\varphi_i$	0.92 ***	0.88 ***	0.89 ***	0.87 ***
θ_1	-	0.12 ***	-	0.13 ***
θ_2	-	-	0.04 ***	0.03*
S.E. of Reg.	0.0022	0.0024	0.0022	0.0025
J- Stat.	13.30	15.76	23.18	15.78
Q(1)	1.5358	1.5502	0.533	0.373
Q(12)	16.482	15.897	14.613	15.405
$Q^2(1)$	0.357	1.435	0.211	1.009

Note: 1. Estimates are obtained by GMM estimation with correction for MA(12) autocorrelation. Two-stage least squares estimation is employed to obtain the initial estimates of the optimal weighting matrix.

2. In the benchmark model the instruments used are a constant and lags 1 to 6 of the nominal short term interest rate, inflation, output gap, and a world commodity price index (agricultural raw materials). In the models that include asset price inflation, lags 1 to 6 of the relevant asset price inflation variable are also included.

3. *J*-stat denotes the test statistic for overidentifying restrictions.

4. *, **, *** indicate level of significance of 10%, 5%, and 1% respectively.

5. Q(n) and $Q^2(1)$ are the Q-stats. Derived from the correlogram of the residuals.

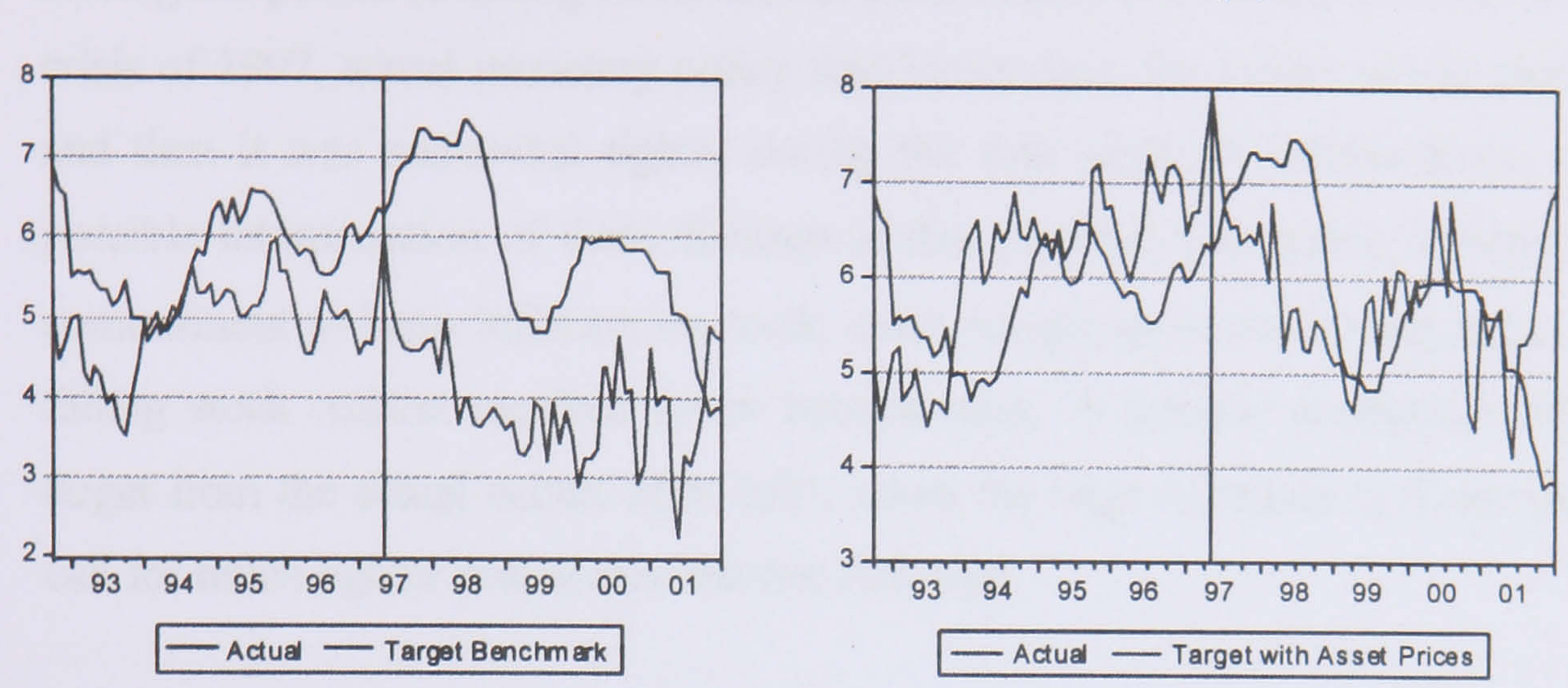
The results in Table 4.3 confirm our predictions. In the benchmark model, ì is equal to 0.41 suggesting that post-independence the BoE reacts to one percent increase in expected inflation by raising interest rates by an additional 41 basis points. Even when we control for the effect of asset prices, the dummy remains positive and significant, reaffirming a higher degree of inflation aversion as a result of independence. We notice that the magnitude of the estimated asset inflation coefficients does not change. The monetary policy response to house prices is always stronger than the one with respect to stock prices. For instance, in the case of both assets entering the reaction function, $\grave{e}_1$ is equal to 0.13 and significant at the 1% level, while $\grave{e}_2$ is equal to 0.03 and significant at the 10%.The coefficient of house price inflation in particular is almost double the coefficient of stock price inflation. This supports the findings in the previous section where we reported a strong link between house price inflation and aggregate demand which induces policy makers to track more closely developments in the housing market.

4.5.2. Historical Performance

In this section we examine the historical performance of our estimated Taylor rules against the actual policy setting of the BoE. In Fig. 4.2, we plot the implied target rates from the dummy augmented model versus the actual short term interest rate. As Clarida *et al.* (1998) point out, employment of the target rate as opposed to the fitted rate, that includes the lagged interest rate, allows for a better comparison of the alternative specifications. Fig. 4.2(a) uses the target interest rate implied by the benchmark model, while Fig. 4.2(b) uses the target rate implied by the asset price augmented policy rule[111].

[111] The target interest rate in Fig. 4.1(b) has been constructed considering both house price and stock price inflation.

Fig. 4.2: Actual and Target interest rate, 1992:10-2002:01.



It is clear that the benchmark target rate underperforms in capturing actual Central Bank behaviour. With the exception of two short periods at the beginning and the end of our sample, actual interest rates were consistently higher than the rule predicted value. Thus, the BoE was far tighter than the simple benchmark forward looking model would predict. When asset prices are allowed to be one of the state variables monitored by the Central Bank, the picture becomes clearer. As we notice in Fig. 4.2(b), the target rate tracks the general trend of the actual interest rate for most of the period under investigation. Indeed, summary statistics presented in Table 44 indicate that when asset prices are not considered, the target interest rate is on average more than 1 % lower than the actual rate. Thus, the benchmark Taylor rule does not seem to explain well interest rate setting in the UK. The alternative specification produces a target rate which is much closer to the actual behaviour in terms of both mean and variability.

Table 4.4: Descriptive Statistics of Actual and Taylor Rule Target Interest Rate, 1992:10-2002:1.

	Actual	Target Benchmark	Target with Asset Prices
Mean	5.83	4.42	5.92
Median	5.87	4.57	6.03
Maximum	7.46	6.04	8.24
Minimum	3.78	2.25	4.11
Std. Dev.	0.82	0.77	0.85

During the period of strong stock market performance prior to the Asian financial crisis of 1997, actual monetary policy was looser tha n the model would predict; and then it was somewhat tighter during the first years of independence. One possible interpretation of these findings is that the BoE was trying to signal its commitment to keep inflation on track, even though some would argue that the falling stock market required lower interest rates. A notable divergence of the target from the actual occurs after 2001, when the large increases in house prices call for much tighter policy than the one followed.

4.6. Conclusions

This chapter has examined the empirical reaction of monetary policy to asset prices using forward-looking Taylor rule models of interest rates. The intuition for monetary policy to consider asset prices lays on the fact that consumption wealth effects and investment balance sheet effects may destabilise aggregate demand and inflation, the two main variables of interest for the monetary authority. Furthermore, we argued that Central Bank as the objective to control financial stability along with monetary stability, where the achievement of the latter does not guarantee that the system would not move to a fragile state.

Changes in property prices and stock prices have significant impact on households' consumption and firms' investment; this could have severe consequences or the stability of the financial system. Using UK data over the period October 1992 to January 2003 we showed that movements in asset prices, especially house prices, have a significant positive impact on aggregate demand. Demand pressures feed into higher future inflation, thus there is scope for an inflation targeting Central Bank to consider a model of the economy which includes the direct and indirect effect wealth effects deriving from the asset markets.

The main contribution of this chapter is to find that policymakers in the UK appear to take into account both stock price inflation and house price inflation when setting interest rates, with the results suggesting that they are more concerned about developments in the property market. When the standard forward-looking Taylor rule is augmented by house prices and stock prices, the estimated coefficient of house price changes is always greater. The benchmark Taylor rule conditions short term interest rates upon expected inflation and the output gap and fails to provide an accurate characterisation of actual policy. When asset prices are included in the reaction function, the implied target rate describes the general trends of the actual interest rate much better. In addition, we model the effect of Central Bank independence on the policy preferences towards expected inflation. We find that the relationship between asset price inflation and interest rates is robust, and that inflation aversion increased post-independence.

Chapter 5

The Wealth Effect and the Conduct of Monetary Policy

5.1 Introduction

The role of asset prices in the monetary transmission mechanism has been the subject of a growing debate in recent literature. As we highlighted in the first chapter, broad money channel and broad credit view attribute a great role to asset prices in the monetary transmission mechanism. In chapter four we explained that one important question arising is that the achievement of price stability in the last ten years is not a sufficient guarantee of financial stability. An environment characterized by low inflation does not automatically preclude the build up of financial imbalances. This, of course, is an issue that has to be addressed by monetary authorities; consequently, a highly important question for central bankers and economists is if and eventually how monetary policy should respond to movements in asset prices. We showed[112] that interest rate settings by the Bank of England can be better explained by a rule which incorporates asset prices.

In fact, asset prices may serve as part of the objectives that monetary policymakers pursue, or as part of the information set that they employ (Vickers, 1999). The dominant view is that changes in asset prices should affect monetary policy only to the extent that they affect the central bank's forecast of inflation. Some authors favor a *pro*-active monetary policy response to asset price bubbles. Cecchetti *et al* (2000) suggest that the central bank can reduce long term inflation and output volatility by adjusting interest rates in response to asset price misalignments even when inflation remains on track. Filardo (2000) shows that if monetary policy ignores asset price inflation, both consumer price inflation and output becomes less stable. Other authors however take a contrarian view: asset prices are too volatile relative to their information content and any attempt to include them in a feedback rule for interest rates would worsen economic outcomes. Bernanke and Gertler (1999, 2001) allow for non-deterministic bubble processes and suggest that a too aggressive interest rate response increases inflation volatility.

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[112] See Chapter 4.

It is often argued that the forward-looking nature of asset prices makes them good proxies for the information left out of conventional inflation measures. Goodhart (2001) stresses that asset price inflation developments are closely associated with general inflation trends. Goodhart and Hoffman (2000) derive financial conditions indices that employ assets such as stocks and property in their calculation, and show that they are a useful indicator for future consumer price inflation. In any case, as Bäckström (2000, p.1) argues, "in a regime that explicitly targets inflation, asset prices are taken into account via the effects on aggregate demand. Rising share prices increase household wealth and that would raise consumption for a given level of income if these increases in wealth are considered to be of a permanent nature". Thus, the link between asset prices and aggregate demand is crucial in the context of the transmission mechanism of monetary policy. Expansionary monetary policy boosts asset prices leading to an increase in aggregate demand which feeds into future inflationary pressures.

This chapter examines the relationship between asset prices and monetary policy in the context of optimal policy rules. Monetary policy rules have been widely discussed in theoretical and empirical literature following the seminal work by Taylor (1993). The majority of previous studies use calibrated models to measure the effects on the variance of inflation and output from a *direct* response of monetary policy to asset prices. In essence asset prices are considered as one of the elements of the monetary authorities' reaction function. Departing from this line of research, we examine the case where asset prices enter indirectly the optimal policy rule. This chapter present a structural macro model where changes in asset prices affect future inflation indirectly, through wealth effects on aggregate demand. In this model asset prices are determined exclusively by the fundamentals. The optimal rule is obtained by optimizing intertemporally a loss function which includes inflation and output variance. The derived optimal rule conditions the current nominal interest rate instrument upon concurrent inflation and output, with the weight on inflation being lower than in the traditional case of no demand-wealth effect.

We extend our model the model to include a more realistic asset price dynamic. We allow asset prices to be positively influenced by their past rate of change allowing for potential bubble build-up, along with standard revision to fundamentals. Our results suggest that optimal monetary policy should respond to asset price misalignments from their fundamental value, with the aggressiveness of the response being a positive function of the impact of asset prices on aggregate demand. This result has important implications for the conduct of monetary policy and contributes crucially to the existing literature, as existing work on optimal rules considering asset prices, either fails to find a role for asset prices (Bean, 2003), or obtains complex, non linear rules (Bordo and Jeanne, 2002).

The chapter is organised as follows: in the next section we provide the theoretical background relating asset prices and real economy. Section 5.3 discusses different monetary policy approaches which incorporate asset prices. Section 5.4 and 5.4.1 are devoted to the construction of the structural macro model and its solution. In section 5.4.2 we derive the optimal monetary policy rule using stochastic control, while in Section 5.4.3 we discuss the results. Section 5.5 extends the model in order to account for momentum trading and revision towards the fundamentals in the asset prices, Section 5.5.1 show the solution to the model, discussion of the results are in Section 5.5.2. Conclusions are presented in Section 5.6.

5.2. The wealth effect and the real economy

In the last decade or so, it has been recognised that asset prices play an important role in determining business cycles conditions. Such a significant impact can be found in the role that capital markets play in the modern economic environment, they are not only the intermediary between surplus and deficit units but they are also creators of wealth.

In Chapter 1 we reviewed the role of asset prices in the monetary transmission mechanism. First of all, we showed how they can have a positive impact on firms' investment level *via* the Tobin's q theory of investment. Expansionary monetary policy which lowers interest rates makes bonds less attractive relative to stocks and results in increased demands for stocks that bids up their price. Combining this with the fact that higher stock prices will lead to higher investment spending via Tobin's q effect and via lower cost of capital we expect a positive relationship between real stock returns and aggregate spending. Morck, Shleifer and Vishny (1990) review five main theories concerning the causal direction of the underlying positive relationship between stock returns and the investment component of output growth. Empirical evidence also indicates that the impact of changes in stock prices on investment appears to have been particularly strong (see Barro (1990) for the US). Second, the higher the asset price level, the higher would be the investors' capital gains. Thus, expansionary monetary policy which raises stock prices, increases the value of household wealth, thereby increasing the lifetime resources of consumers which causes consumption spending to rise. Goodhart and Hoffman (2000) offer empirical evidence from 17 developed countries over the period 1972-98 indicating that it is important to control for the effect of changes in real stock prices on the aggregate demand equation in order to find a significant monetary policy effect[113]. Moreover, if we accept that the stock market influences real activity, then investor sentiment[114] such as fads and fashions that cause stock prices to diverge from their fundamental values could also indirectly affect real activity. There is extensive empirical evidence that asset price changes tend to lead output growth in industrial countries. Various empirical studies have found a positive correlation between lagged stock market returns and current output growth. Most of the studies in this area have employed U.S. data; see for instance Barro (1990), Fama (1990). Similar evidence was presented by Mullins and Wadhwani (1989) for Japan, Germany and the United Kingdom, by Choi *et al* (1999) for the G-7 countries, and by Asprem (1989) for several other European countries. Mauro (2000) employed a panel of emerging

[113] For a more general discussion see Poterba (2000).
[114] The term investor sentiment refers to beliefs held by some investors that cannot be rationally justified. Shiller (1984, 1987) was among the first to suggest that fads and fashions, as well as fundamentals, influence asset prices.

market economies and advanced economies. He finds that the correlation is as strong in emerging market economies as in advanced economies.

The third point is frequently referred to as the balance-sheet channel[115]. When the level of asset prices is low, firms have to sustain a risk premium if they want to recruit funds in the capital market. These premia depend decisively upon enterprises' balance sheet position. The lower the level of the net worth and collateral, the higher will be the asymmetric information problems (i.e. moral hazard and agency problem) and the corresponding risk premia. In such a framework, monetary policy may affect a firms' balance sheet in several ways. For instance, monetary tightening increases the interest payment for firms, reducing the level of cash flow and the net worth. Bank lending towards the firms then decreases, resulting in lower investment and aggregate spending[116].

Finally another mechanism linking the stock market with aggregate demand is the household liquidity effect: expansionary monetary policy boosts returns on stocks and leads to a decrease in the perceived level of financial distress of households which in turn increases consumption spending. Ludwig and Sløk (2001) provide empirical evidence supporting a positive link between changes in stock prices-house prices and consumption for both market-based and bank-based economies.

Although the forecasting power of asset prices with respect to output is not clear[117], the above analysis and the discussion in the first three chapters points in the direction of an increased importance of asset prices in the economic decision making process of households and firms. Both because an increasing part of households' wealth is locked into the stock market and at the same time the amount of firms' external financing is increased as never before[118]. With such a central role for asset prices, it is

[115] The Balance-sheet channel or broad credit view channel was extensively revised in Chapter 1. A theoretical model was presented in Chapter 3.
[116] Bordo (2000, p.2) speaks of *collateral trap*: 'following an asset market crash the economy may fall into a collateral trap where firms cannot increase labor and output because they are collateral constrained'.
[117] See for example Stock and Watson (2001) and Goodhart and Hofmann (2000).
[118] See Table 1.1 and 1.2 and Table 3.1 and 3.2

essential for monetary authorities that pursue an inflation target to take them into consideration. This does not assert that the Central Bank should target asset prices, but it rather implies that they should be considered for their effect on the aggregate demand. The next paragraph presents a review of the main studying relating asset prices and monetary policy.

5.3. Monetary Policy and Asset Markets

Following the extraordinary expansion of credit markets during the eighties and the boom and burst in asset prices in almost all economies, researchers have turned their attention to financial markets and their development. The broad credit channel and the asset price channel provide plausible explanations of how monetary policies propagate to the economy. Both channels emphasize that assets prices are likely to play an important role in how monetary policy is conducted. According to Bernanke and Gertler (2001) "assets booms and busts have been important factors in macroeconomic fluctuations in both industrial and developing countries".

The major debate is not on the role of asset prices in the economy, but rather if and eventually how policy makers (i.e. Central Banks) should take into consideration information deriving from the asset market. In the literature we can identify three views: the first states that assets prices should be considered but only as one of the variables used to forecast inflation. Bernanke and Gertler (1999) argue that when monetary policy operate within a logic of flexible inflation target, it should ignore movements in asset prices that do not appear to be generating inflationary or deflationary pressures. Changes in asset prices should affect monetary policy only to the extent that they affect the central bank's forecast of inflation; once the predictive content of asset prices for inflation has been accounted for, there should be no additional response of monetary policy to asset-price fluctuations. By focusing on the inflationary or deflationary pressures generated by asset price movements, a central bank effectively responds to the "*toxic*" side of asset booms and busts without getting into the business of deciding what a fundamental is and what is not. Bernanke and Gertler (1999, 2001) argue that the potential costs of responding to asset price can be quite large because asset prices can be too volatile relative to their information content. In fact, Bernanke and Gertler (2001) show that a too-aggressive response to a stock price bubble can create significant harm in the economy. Batini and Nelson (2000) find an analogous result for bubbles in the real exchange rate.

A second view is expressed by Goodhart (1999)[119]. He believes that the Central Bank should target a broader price index one that includes asset prices. This measure has the potential to improve macroeconomic performance if asset prices reliably predict future consumer price inflation. He explicitly writes: "My dictionary defines inflation as a fall in the value of money, not a rise in consumer price index. If I spend my money now on obtaining a claim on future housing services by buying a house , or on future dividends by buying an equity, and the price of that claim on housing or on dividends goes up, why is that not just as much inflation as when the price of current gods and services rises?" (Goodhart, 2001, p.3).The theoretical foundation of Goodhart's recommendation is based on the pioneering research on the theory of inflation measurement by Alchian and Klein (1973). They argue that since asset prices represent the current money prices of claims on future, as well as current, consumption, an accurate measure of inflation should include asset prices. They also argued that asset prices can serve as good proxies for the inflation information left out of conventional measures. Using a VAR methodology they find that the Financial Condition Index is a useful instrument to forecast in-sample future inflation[120]. If a central bank were to follow Goodhart's recommendation and use this broader measure of inflation, an increase in asset price inflation could prompt tighter monetary policy even if conventionally measured inflation were low and stable. As Filardo (2000) argued though, this policy implication depends on the strong

[119] Goodhart (2001) writes: "So long as asset price changes are not incorporated in the measure of inflation which the authorities are required to stabilize, the authorities are likely to express audible worries about 'exuberance' and 'sustainability', but in practice find themselves largely incapable of any (pre-emptive) action in response to asset price change themselves in advance of any (consequential) effects coming through onto current goods and services prices, paralysed in practice".
[120] Out-of sample results do not seem to provide satisfactory results.

assumption that asset price inflation accurately reflects future consumer price inflation.

The third view is that asset prices should be made an integral part of monetary policy, policy makers should try to act to stabilize their value around the fundamentals. Cecchetti, *et al.* (1999) argue that a central bank concerned in stabilizing inflation about a specific target level is likely to achieve superior performance by adjusting its policy instruments not only in response to its forecast of future inflation and the output gap as the traditional Taylor rule would suggest, but to asset prices as well. They demonstrate that monetary policymakers should react to perceived misalignments in asset prices to reduce the likelihood of asset price bubbles forming. More generally Cecchetti (2000, p.24) analyzing objectives and rule of monetary policy makers reach the conclusion that a *complex* rule is always more advisable than a *simple* Taylor rule. He states that "there is no reason to believe that information on output and inflation is always capable of adequately summarizing what policy needs to do to respond to the shocks hitting the economy". Bernanke and Gertler (2001) are very critical of the methodology used by Cecchetti *et al.* (1999). They argue that if Cecchetti *et al.* had accounted for stochastic, instead of deterministic, asset price bubbles, and also if they allow for the possibility that shocks other than a bubble may be driving asset prices, they would have found no useful role for asset prices beyond that which is reflected in expectations for future inflation[121]. Filardo (2001) shows that while there are benefits for the monetary authority to respond to asset price changes even when it cannot distinguish between the "bubble" and the "fundamental" part of the asset price inflation, the monetary authority's desire to respond to asset prices falls dramatically as its preference to smooth interest rates rises. He argues that even though asset prices contain useful information about inflation and output, the cost in terms of interest rate volatility can be so high as to cause the monetary authority to largely disregard the information. This result is consistent with Bernanke

[121] Cecchetti *et al.* "optimize" the policy rule with respect to a single scenario, a bubble shock lasting precisely five periods, rather than with respect to the entire probability distribution of shocks, including shocks other than bubble shocks. Effectively, their procedure yields a truly optimal policy only if the central bank knows with certainty that the stock market boom is driven by non-fundamentals and knows exactly when the bubble will burst, both highly unlikely conditions.

and Gertler's conclusion that by responding to stock prices, a central bank could worsen economic outcomes. In another paper Filardo (2000) concludes that a monetary authority generally benefits from responding to asset prices only as long as there is no uncertainty about the macroeconomic role of asset prices. If monetary authority is uncertain about whether asset prices have an independent role in the context of a macro-model or simply reflecting other economic fundamentals, then the expected costs in terms of economic volatility of responding to asset prices may exceed the expected benefits. The IMF (2000) also warns that since asset markets place greater reliance on information and are generally more competitive than some goods and labour markets, macroeconomic policy authorities should be extra cautious when pitting their judgment against those of the market. Another argument against asset price inflation targeting is that all asset pricing models empirical predictions are subject to wide margins of error, and they involve the modelling of non-directly observable expectations on the underlying determinants of asset prices.

To shed some light on the above discussion, in the next section we construct a structural dynamic model where macroeconomic aggregate demand is driven by asset prices. We extend and modify the model first presented in Kontonikas and Montagnoli (2003). We consider two distinct cases: in the first we allow the asset market to be exclusively driven by fundamentals. In the second we include the idea that asset markets are volatile and prices do not always reflect the value of the fundamentals; thus we model asset prices as dependent from their past rate of change and on the deviation from fundamental.

5.4. The Theoretical Framework

We use a structural model of the economy that allows for the effect of changes in asset prices on aggregate demand. The model is given by the following equations:

$$\pi_{t+1} = \pi_t + a_1 y_{t+1} + \varepsilon_{t+1} \tag{5.1}$$

$$y_{t+1} = \beta_1 y_t - \beta_2(i_t - E_t[\pi_{t+1}]) + \beta_3 q_t + \eta_{t+1} \tag{5.2}$$

$$q_{t+1} = -\gamma_1(i_{t+1} - E_{t+1}[\pi_{t+2}]) + \gamma_2 y_{t+1} + u_{t+1} \tag{5.3}$$

where y_t is the deviation of (log) output from its steady-state level (output gap), $\pi_t = p_t - p_{t-1}$ is the inflation rate (strictly, the deviation from target), p_t is (log) price level, i_t is the monetary policy instrument (one-period nominal interest rate), q_t denotes (log) real asset prices. Different interpretations of q_t are possible (e.g. house prices, stock prices or the value of a portfolio containing both housing and equity investment), in what follows though we mainly treat it is an equity index. η_t, ε_t, u_t represent exogenous random shocks to aggregate demand, inflation, and asset price fundamentals. For simplicity, we assume that they are mutually uncorrelated *i.i.d.* processes with zero means and constant variances. The structural parameters can be interpreted as partial elasticises with the following properties: $0 < \beta_1 < 1$; a, β_2, γ_1, γ_2; β_3 □ 0. Similar specification has been used by Svensson (1997) and Rudesbusch and Svensson (1999), with the difference that their model exhibits a two-periods control lag for inflation. This allows us to compare our results with a model which is standard in the literature. Furthermore the adoption of a backward-looking model instead of a forward-looking one gives us the possibility to solve the model analytically.

Eq. (5.1) is an accelerationist (or backward-looking NAIRU type) Phillips Curve where the change in inflation is a positive function of the current output gap and the inflation shock. The presence of inflation inertia in the inflation equation implies that disinflations will be costly in terms of output losses, thus there is a short-run trade-off between inflation and output. However, since lagged inflation enters Eq. (5.1) with unity coefficient, this specification implies a vertical long-run Phillips curve. Eq. (5.1) posits no role for expected future inflation in the inflation adjustment equation[122]. Fuhrer (1997) employed US inflation data and argued that forward looking expectations are unimportant empirically. The parameter a is a positive constant which measures the sensitivity of inflation to excess demand.

The demand side, as given by Eq. (5.2), is consistent with the specification employed by Walsh (1998), Ball (1997), and Svensson (1997), with one important difference: aggregate demand depends positively on the past level of asset prices via consumption wealth effects and investment balance sheet effects. For example, a persistent increase in the level of asset prices decreases the perceived level of households' financial distress causing a boost in consumption spending. The balance sheet channel implies a positive relationship between the firms' ability to borrow and their net worth which in turn depends on asset valuations. There is a vast amount of empirical evidence indicating that stock and house price movements are strongly correlated with aggregate demand in most major economies[123]. Parameter $\hat{a}_3$ in the aggregate demand equation is of crucial interest since it indicates the magnitude of wealth effects. If there are no wealth effects then $\hat{a}_3 = 0$ and Eq. (5.2) resembles a traditional dynamic IS curve. In our model, the central bank takes into account the effect of wealth on aggregate demand; that is, it is fully aware of the effect of q_t on y_{t+1} and its magnitude.

The third equation describes the behaviour of the stock market. Fundamental real equity returns are negatively related to current real interest rate and positively to current output. This is supported by the majority of empirical studies examining the effect of macroeconomic variables on the stock market[124]. Financial theory posits that stock prices equal the expected present value of future net cash flows[125]. Holding everything else equal, higher interest rates are associated with lower stock prices, given the higher discount rate for the expected stream of cash flows. The

[122] Rudebusch (2002) considers the hybrid Phillips curve: $\pi_{t+1} = \mu_\pi \pi_t + (1-\mu_\pi)E_t[\pi_{t+1}] + ay_{t+1} + \varepsilon_{t+1}$, and points out that the accelerationist Phillips curve (ìð □ 1) can be derived from well-known models of price-setting behavior (see e.g. Roberts, 1995).
[123] See the estimate of Eq. 4.1.
[124] See among others Fama (1981), Conover Jensen and Johnson (1999).
[125] It is assumed that capital gains in the stock market are positively related to expected future dividends which are themselves proportional to current output.

conventional view suggests that a restrictive monetary policy environment serves as bad news for the stock as it is generally associated with higher future interest rates and lower level of economic activity. In contrast, an expansive monetary environment signals higher average real equity returns, as these periods are usua lly associated with lower future interest rates and increases in economic activity The stochastic error term, u_{t+1}, represents the non fundamental component of stock returns. Here, for simplicity, it is assumed to be zero mean and constant variance, $ó_u^2$. In other words, in the context of this study we do not allow for asset price bubbles.

The structure of the model implies that monetary policy affects the stock market contemporaneously, and inflation and output with one period lag. At time t the central bank chooses the optimal i_t which affects current period's real returns and next period's inflation and output; contemporaneous inflation and output, $\eth_t$, y_t are predetermined.

5.4.1 Solution of the model with perfect capital market

Substituting for lagged real stock returns, R_t, in the aggregate demand Eq. (5.2) and using the expectational version of Eq. (5.1) to eliminate $E_t[\pi_{t+1}]$ we get:

$$y_{t+1} = (\beta_1 + \beta_3\gamma_2)y_t - (\beta_2 + \beta_3\gamma_1)(i_t - \pi_t - a_1 E_t[y_{t+1}]) + v_{t+1} \tag{5.4}$$

where $v_{t+1} = \beta_3 u_t + \eta_{t+1}$

Taking expectations on both sides, conditional upon time t information, gives:

$$E_t[y_{t+1}] = \delta_1 y_t - \delta_2(i_t - \pi_t) \qquad \text{where } \delta_1 = \frac{\beta_1 + \beta_3\gamma_2}{1 - \alpha_1(\beta_2 + \beta_3\gamma_1)}, \ \delta_2 = \frac{\beta_2 + \beta_3\gamma_1}{1 - \alpha_1(\beta_2 + \beta_3\gamma_1)}$$

Using the above expression to eliminate $E_t[y_{t+1}]$ from Eq. (5.4) and rearranging, yields:

$$y_{t+1} = [(\beta_1 + \beta_3\gamma_2) + (\beta_2 + \beta_3\gamma_1)a_1\delta_1]y_t - (\beta_2 + \beta_3\gamma_1)(1 + a_1\delta_2)(i_t - \pi_t) + v_{t+1}$$

Following Walsh (1998), since δ_t , y_t are predetermined when i_t is chosen we can define φ_t as the control variable of the central bank, where φ_t is given by:

$$\varphi_t = [(\beta_1 + \beta_3\gamma_2) + (\beta_2 + \beta_3\gamma_1)a_1\delta_1]y_t - (\beta_2 + \beta_3\gamma_1)(1 + a_1\delta_2)(i_t - \pi_t) \qquad (5.5)$$

Using the definition of φ_t the Phillips Curve and the AD Eqs. (5.1) and (5.2) can be re-written as:

$$y_{t+1} = \varphi_t + v_{t+1} \qquad (5.1')$$

$$\pi_{t+1} = \pi_t + a_1\varphi_t + \omega_{t+1} \qquad (5.2')$$

where $\omega_{t+1} = \varepsilon_{t+1} + a_1 v_{t+1}$

5.4.2 Optimal interest rate rule

The central bank objective is to solve the following stochastic control problem: choose an infinite sequence of controls to minimise the expected discounted value of the intertemporal quadratic loss function:

$$\min_{\{\varphi_t\}_{t=0}^{\infty}} \frac{1}{2} E_t \sum_{i=1}^{\infty} \beta^i \left[\pi_{t+i}^2(\varphi) + \mu y_{t+i}^2(\varphi)\right]$$

subject to the transition Eq.s (4.1') and (5.2') where ì ≥ 0 is the relative weight attached by the central bank on output stabilisation for notational simplicity, we assume zero to be the target values of inflation and the output gap. â is the discount factor, 0 < â <1. It is evident from (5.2) that at time t, when the interest rate (and consequently ö$_t$) is chosen the only state variable is $ð_t$. Therefore, the value function is defined in terms of $ð_t$ only.

$$V(\pi_t) = \min_{\{\varphi_t\}_{t=0}^{\infty}} \frac{1}{2} E_t \sum_{i=1}^{\infty} \beta^i \left[\pi_{t+i}^2(\varphi) + \mu y_{t+i}^2(\varphi)\right] \tag{5.6}$$

Bellman's dynamic programming principle then implies that:

$$V(\pi_t) = \min_{\varphi_t} E_t[\tfrac{1}{2}(\pi_{t+1}^2 + \mu y_{t+1}^2) + \beta V(\pi_{t+1})] \tag{5.7}$$

If we substitute the 2 constraints (5.1') and (5.2') in (5.7) we get:

$$V(\pi_t) = \min_{\varphi_t} E_t\{\tfrac{1}{2}[(\pi_t + a_1\varphi_t + \omega_{t+1})^2 + \mu(\varphi_t + v_{t+1})^2] + \beta V(\pi_t + a_1\varphi_t + \omega_{t+1})\} \tag{5.8}$$

The first order condition that yields the optimal response is:

$$\frac{\partial}{\partial \varphi_t} V(\pi_t) = 0 \Leftrightarrow (a_1^2 + \mu)\varphi_t + a_1\pi_t + \beta a_1 E_t V'(\pi_{t+1}) = 0 \tag{5.9}$$

Employing the envelope theorem and re-arranging we obtain[126]:

$$(a_1^2 + \mu)\varphi_t + a_1\pi_t - \mu\beta E_t[\varphi_{t+1}] = 0 \Leftrightarrow \varphi_t = -\left(\frac{a_1}{a_1^2 + \mu}\right)\pi_t + \left(\frac{\mu\beta}{a_1^2 + \mu}\right)E_t[\varphi_{t+1}] \tag{5.10}$$

[126] See Appendix A.1 for more details.

Since we have a linear-quadratic structure in the stochastic control problem the optimal policy rule will be of the form

$$\varphi_t = c\pi_t \tag{5.11}$$

Thus the optimal control will be linear function of the state variable. Updating one period ahead and taking expectations at time t of (5.11) yields:

$$E_t[\varphi_{t+1}] = cE_t[\pi_{t+1}] = cE_t[\pi_t + a_1\varphi_t + \omega_{t+1}] = c(\pi_t + a_1\varphi_t) = \varphi_t + ca_1\varphi_t \Leftrightarrow$$
$$E_t[\varphi_{t+1}] = (1 + ca_1)\varphi_t \tag{5.12}$$

Substitution of (5.11) and (5.12) in (5.10) yields the following quadratic whose solution gives the optimal c value:

$$(\mu\beta\alpha_1)c^2 + (\mu\beta - \alpha_1^2 - \mu)c - \alpha_1 = 0 \tag{5.13}$$

The solution we accept has to fulfil the inflation process stability criterion. This condition implies that only the negative c-root is accepted[127]. Finally, we obtain the optimal interest rate, i_t, by using Eq.(5.5) and Eq. (5.11), and substituting for $ä_1$ and $ä_2$:

$$i_t = f_\pi \pi_t + f_y y_t \tag{5.14}$$

where: $f_\pi = 1 - \dfrac{c}{\beta_2 + \beta_3\gamma_1} + ca_1$ and $f_y = \dfrac{\beta_1 + \beta_3\gamma_2}{\beta_2 + \beta_3\gamma_1}$

Eq. (5.14) resembles a conventional Taylor rule where the nominal interest rate is a linear function of inflation and output gap.

[127] See Appendix A.2 for more details.

5.4.3. Discussion of the results

In the standard case of the no wealth effects, β_3 is equal to zero in Eq. (5.2) and the system would be formed by a typical AS/AD model. In such specification the optimal weights on inflation and output would be:

$$f_\pi^* = 1 - \frac{c}{\beta_2} + ca_1 \quad \text{and} \quad f_y^* = \frac{\beta_1}{\beta_2}$$

Comparing the standard case with our results, we notice that the optimal response of monetary policy to inflation should be smaller ($f_\eth < f^*_\eth$ since c < 0). The intuition underneath is that the negative effect on inflation from a monetary tightening would be more amplified when the there are significant wealth effects. With respect to the output coefficient we notice that the final result depends upon the relative effects of real interest rates and output on the stock market, (respectively γ_1 and γ_2). If $\gamma_1 > \gamma_2$ and $\beta_1 > \beta_2$ then $f_y < f_y^*$; This implies a weight on output lower than the benchmark case. On the other hand, if $\gamma_1 < \gamma_2$ and $\beta_1 < \beta_2$ then $f_y > f_y^*$; When the asset prices are more sensitive to output rather than interest rates, the model suggests that the central bank should adopt more aggressive interest policy with respect to output.

We now examine the effect of the underlying structure of the model on the policy parameters, by calculating he partial derivatives of f_π and f_y with respect to γ_1; γ_2; β_3

Table 5.1. Partial Derivatives

	γ_1	γ_2	β_3
f_π	$\frac{c\beta_3}{(\beta_2+\beta_3\gamma_1)^2} < 0$	0	$\frac{c\gamma_1}{(\beta_2+\beta_3\gamma_1)^2} < 0$

f_y	$-\frac{(\beta_1+\beta_3\gamma_2)\beta_3}{(\beta_2+\beta_3\gamma_1)^2} < 0$	$\frac{\beta_3}{\beta_2+\beta_3\gamma_1} > 0$	$\frac{\gamma_2}{(\beta_2+\beta_3\gamma_1)} - \frac{(\beta_1+\beta_3\gamma_2)\gamma_1}{(\beta_2+\beta_3\gamma_1)^2}$

The results presented in Table 5.1 lead to the following propositions:

Proposition 1: *The higher the elasticity of asset prices to real interest rate,* γ_1, *the smaller is the optimal interest rate weight on both inflation and output.*

This result can be interpreted on the basis that Central Bank actions exert a double effect on real economy. This happens because an increase in interest rates not only will have a direct negative impact on the firms' level of investment but will also depress consumption *via* a reduction in realised capital gains, leading to a greater-than-before decrease in aggregate demand and inflation.

Proposition 2: *The higher the response of asset prices to output,* γ_2, *the higher is the weight that the Central Bank attaches to output.*

The intuition behind is that, according to the model, output expansion is associated with asset price increases that feed into even higher future output. Therefore, when asset prices are strongly pro-cyclical a stronger response is required by the Central Bank in order to achieve output stabilisation.

Proposition 3: *The stronger the wealth effect,* β_3, *the smaller the optimal weight on inflation.*

Therefore, when the role of capital markets as creator of wealth and collateral is taken into account, the magnitude of the interest rate adjustment should be smaller. This does not imply that the Central Bank intervenes less frequently. In fact, if the true data generation process for output is given by the augmented IS (Eq.5.2), then monetary policy may have to be more frequently readjusted. Proposition 3 suggests that a too aggressive interest rate change might be beneficial in the short-run, but as wealth effects build up, this policy may threaten the medium-long run objective of stable prices[128].

[128] On the other hand no clear result emerges on the weight attached on output since $\frac{\partial f_y}{\partial \beta_3} > 0$ if $\beta_2\gamma_2 > \beta_1\gamma_1$ and $\frac{\partial f_y}{\partial \beta_3} < 0$ if $\beta_2\gamma_2 < \beta_1\gamma_1$.

5.5 Accounting for misalignments in asset prices

The specification adopted above in Eq. (5.3) was a process derived from standard dividend theory. The approach is appealing for it straightforwardness, but its practical application is quite limited, in fact, asset prices do seem to be characterised by high periods of volatility and "irrationality"[129].

In this section we account for potential bubble build-up in the dynamic of the asset prices. The model would be then given by the following equation:

$$\pi_{t+1} = \pi_t + ay_{t+1} + \varepsilon_{t+1} \tag{5.15}$$

$$y_{t+1} = \beta_1 y_t - \beta_2(i_t - E_t[\pi_{t+1}]) + \beta_3 q_t + \eta_{t+1} \tag{5.16}$$

$$q_t = b\Delta q_{t-1} - (q_{t-1} - q_t^*) \tag{5.17}$$

$$q_t^* = -\delta_1(i_t - E_t[\pi_{t+1}]) + \delta_2 E_t[y_{t+1}] + u_t \tag{5.18}$$

Eqs. (5.15) and (5.16) describe the aggregate supply and demand and are identical to Eqs. (51) and (5.2). As before the structural parameters can be interpreted as partial elasticises with the following properties: $0 < \beta_1 < 1$; a, β_2, δ_1, δ_2, $b > 0$; β_3 □ 0.

The main contribution of this section lies within Eqs. (5.17). With Eq. (5.18) it represents the dynamic evolution of asset prices and their underlying fundamentals, respectively. We assume a partial adjustment mechanism of actual asset prices towards their fundamental value that allows for the appearance of a bubble build-up. As Eq. (5.17) indicates, if asset prices have increased in the past (Ä$q_{t-1} > 0$) there is a positive 'momentum' effect on their current level ($b > 0$). In essence, investors bid up the demand for asset holdings in expectation that past capital gains will persist in the future. The higher the value of b, the stronger the effect from past asset price changes and therefore q_t can diverge significantly from its fundamental value, q_t^*, albeit not

[129] See Chapter 3 for a brief description of the irrationality underlining the asset market boom and crash in the UK in late eighties early nineties.

permanently[130]. But once asset prices revert, at an unknown future date, the downward effect on aggregate demand could be large. We allow for reversion to fundamentals since if there is an decrease in the fundamentals ($q_t^* < q_{t-1}$) there is a negative pressure on q_t.

As before Eq. (5.18) describes fundamental asset prices in line with the standard dividend model of asset pricing. There is a positive effect from expected future dividends (assumed to depend on expected output) and a negative effect from real interest rates. This is supported by the majority of empirical studies examining the effect of macroeconomic variables on the stock market[131].

5.5.1. Optimal interest rate rule with asset prices misalignments

Substituting for fundamentals, q_t^*, in Eq. (5.17) we get an alternative expression for real asset prices:

$$q_t = b\Delta q_{t-1} - \{q_{t-1} + \delta_1(i_t - E_t[\pi_{t+1}]) - \delta_2 E_t[y_{t+1}] - u_t\} \qquad (5.19)$$

Then, following the same methodology applied in Section 5.4.1, we obtain the following solutions:

$$\pi_{t+1} = \pi_t + a\zeta_t + \omega_{t+1} \qquad (5.15')$$

$$y_{t+1} = \zeta_t + v_{t+1} \qquad (5.16')$$

where $\omega_{t+1} = \varepsilon_{t+1} + av_{t+1}$ and $v_{t+1} = \beta_3 u_t + \zeta_{t+1}$.

The control variable, $\ddot{o}_t$, is now:

[130] We do not regard the divergence of q_t from q_t^* as an explicit bubble because we do not assign any probabilistic structure to its evolution.

[131] See among others Fama (1981).

$$\zeta_t = \lambda_1 y_t - \lambda_2 (i_t - \pi_t) + \lambda_3 (b\Delta q_{t-1} - q_{t-1}) \tag{5.20}$$

where:

$$\lambda_1 = \frac{\beta_1}{1-\left[a(\beta_3\delta_1 + \beta_2) + \beta_3\delta_2\right]}, \quad \lambda_2 = \frac{\beta_3\delta_1 + \beta_2}{1-\left[a(\beta_3\delta_1 + \beta_2) + \beta_3\delta_2\right]},$$

$$\lambda_3 = \frac{\beta_3}{1-\left[a(\beta_3\delta_1 + \beta_2) + \beta_3\delta_2\right]}$$

Again we define the central bank loss function in terms of inflation and output volatility, what changes here are the constrains that the authorities have to face:

$$\min_{\{\varphi_t\}_{t=0}^{\infty}} \frac{1}{2} E_t \sum_{i=1}^{\infty} \beta^i \left[\pi_{t+i}^2(\zeta) + \mu y_{t+i}^2(\zeta)\right]$$

subject to the transition Eqs. (5.15') and (5.16').

Solving the dynamic optimisation problem[132], using Eq. (5.20), substituting for λ_1, λ_2, λ_3, and re-arranging we obtain the optimal path for the interest rate:

$$i_t = \left(1 - \frac{c[1-A]}{\beta_3\delta_1 + \beta_2}\right)\pi_t + \left(\frac{\beta_1}{\beta_3\delta_1 + \beta_2}\right)y_t + \left(\frac{\beta_3}{\beta_3\delta_1 + \beta_2}\right)(b\Delta q_{t-1} - q_{t-1}) \tag{5.21}$$

where $A = a(\beta_3\delta_1 + \beta_2) + \beta_3\delta_2$

The solution that we accept should satisfy the inflation process stability criterion. This condition implies that only the negative c-root is accepted[133].

Eq. (5.21) can be transformed into a more intuitive expression by recalling that according to the asset price Eq. (5.17):

$$q_t = b\Delta q_{t-1} - q_{t-1} + q_t^* \Leftrightarrow b\Delta q_{t-1} - q_{t-1} = q_t - q_t^* \tag{5.22}$$

[132] We apply the same methodology as presented in Section 5.4.2.
[133] See Appendix A.2 for more details.

Hence, via Eq. (5.2), the final expression for the optimal interest rate rule is:

$$i_t = f_\pi \pi_t + f_y y_t + f_{q-q^*}\left[q_t - q_t^*\right] \tag{5.23}$$

where $f_\pi = 1 - \frac{c[1-A]}{\beta_3\delta_1 + \beta_2}$, $f_y = \frac{\beta_1}{\beta_3\delta_1 + \beta_2} > 0$, $f_{q-q^*} = \frac{\beta_3}{\beta_3\delta_1 + \beta_2} \geq 0$, are the respective interest rate weights on inflation, output and asset price misalignments from fundamentals. The 'Taylor principle' implies that the inflation coefficient, f_π, should exceed the value of one, to ensure a real interest rate response that will lead to lower inflation[134].

5.5.2 Discussion of the results

The rule for adjusting nominal interest rates shown in Eq. (5.23), signifies a fundamental new result in the interest rates rules literature, since we show that the central bank should not only take into consideration inflation and output when setting interest rates, but should also react to asset price misalignments. Bean (2003) also assumes that the aggregate demand is augmented by wealth effects, but the results that he obtains for optimal policy differ significantly from the ones presented in this section. In particular, he finds no role for asset prices in the commitment and discretionary equilibrium. Bean's optimality conditions contain neither the policy instrument, nor anything to do with the demand side of the economy.

In our results, the aggressiveness of the reaction to asset price misalignments depends upon the impact of wealth effects in aggregate demand. If there are significant wealth effects, $\beta_3 > 0$, then the central bank should raise interest rates in response to increasing asset price misalignments ($f_{q-q^*} > 0$).Such a pro-active response has also

[134] As we show in Appendix A.3, this condition is consistent with $A < 1$.

been advocated by Cecchetti et al (2000) using the Bernake and Gertler (1999) new Keynesian sticky wages – financial accelerator model.

A common feature in the aforementioned studies is that they assume, rather than derive, a rule for interest rate setting and then examine the effects on macroeconomic volatility fom reacting or not reacting to asset prices. Our main focus however, was to show that in the context of optimal central bank behaviour, asset price misalignments should be an element in the monetary authority's feedback rule. Hence, this chapter extends the literature that obtains analytical expressions for interest rates based upon optimization of the central banks' objectives. The augmented Taylor rule depicted by Eq. (5.23) points out explicitly that the financial instability associated with growing financial imbalances should not be tolerated by the central bank.

It is easy to show that the standard Taylor rule (Taylor, 1993) can be obtained as a special case of our augmented rule. In the absence of a link between aggregate demand and asset prices, i.e. $\beta_3 = 0$, there is no scope for monetary policy to react to asset prices ($f_{q-q^*} = 0$), and the feedback rule which implements the optimal policy takes the form of a Taylor rule with interest rates being an increasing function of inflation and the output gap.

$$i_t = f_\pi^* \pi_t + f_y^* y_t \tag{5.24}$$

where the inflation and output gap weights are given by: $f_\pi^* = 1 - \frac{c}{\beta_2} + ca$, $f_y^* = \frac{\beta_1}{\beta_2}$.

In order to examine the impact of asset prices on the interest rate setting behaviour of the central bank, we calculate the partial derivative of the reaction coefficients in Eq. (5.23) with respect to the magnitude of wealth effect, β_3. The results, presented in Table 5.2, lead to Propositions 4 to 6.

Table 5.2: Partial derivatives of interest rate reaction coefficients with respect to wealth effect parameter, β_3.

f	f_π	f_y	f_{q-q^*}
$\partial f/\partial\beta_3$	$\frac{c(\delta_2\beta_2+\delta_1)}{(\beta_3\delta_1+\beta_2)^2}<0$	$-\frac{\beta_1\delta_1}{(\beta_3\delta_1+\beta_2)^2}<0$	$\frac{\beta_2}{(\beta_3\delta_1+\beta_2)^2}>0$

Proposition 4: *The stronger the wealth effect, β_3, the smaller is the optimal interest rate weight on inflation.*

Proof: Since δ_1, $(\beta_3\delta_1+\beta_2)^2>0$ and $c<0$ it is implied that: $\partial f_\pi/\partial\beta_3<0$.

Proposition 5: *The stronger the wealth effect, β_3, the smaller is the optimal interest rate weight on output gap.*

Proof: Since β_1, δ_1, $(\beta_3\delta_1+\beta_2)^2>0$, it is implied that: $\partial f_y/\partial\beta_3<0$.

Thus, when the role of capital markets as creator of wealth and collateral is taken into account, the magnitude of the inflation related-interest rate adjustment should be smaller. This does not imply that the Central Bank intervenes less frequently. In fact, if the true data generation process for aggregate demand is given by the augmented IS, Eq. (5.16), then monetary policy may have to be more frequently adjusted. Proposition 1 suggests that as wealth effects build up, a too aggressive interest rate response to inflation will lead to recession and will threaten the price stability objective. In addition, Proposition 5 calls for a less pronounced response to the output gap in the presence of significant correlation between asset prices and aggregate demand.

Proposition 6: *The stronger the wealth effect, β_3, the larger is the optimal interest rate weight on asset price misalignments from fundamentals.*

Proof: Since β_2, $(\beta_3\delta_1 + \beta_2)^2 > 0$, it is implied that: $\partial f_{q-q^*} / \partial \beta_3 > 0$.

The intuition and policy implications of Propositions 4 and 5 become clearer when considered in combination with Proposition 6 In essence, if aggregate demand is affected by the evolution of asset prices then monetary authorities should include asset price misalignments in their optimal feedback rule and there should be a change in the distribution of the relevant interest rate weights. Particularly, the interest rate weight on inflation and output decreases while the weight attached to asset price misalignments increases. This allows asset prices to be considered as an element of the authorities' reaction function without necessarily implying overall tighter, than before, policy since the response to inflation and output will be less aggressive. In other words, our optimal analysis results imply that first, asset price misalignments should have an independent role and not only be considered as instruments to help forecast output and inflation; and second, there should be a shift in the magnitude of reaction, away from the traditional variables, i.e. inflation and the output gap, and towards a direct response to financial imbalances.

5.6. Conclusion

Although there is no agreement among economists whether central banks should target asset price inflation, there is a vast consensus that the asset prices channel plays an important role in the transmission of the monetary policy. Starting from these considerations, in the first part of this chapter we builds a backward looking structural macro model where capital gains have an impact on aggregate demand and consequently on inflation. Here the level of asset prices is determined entirely by the level of the fundamental, namely current real interest rate and current output. The central bank solves a stochastic control problem in order to minimise intertemporally the variance of output and inflation. Comparing our results with the standard Taylor rule, we find that the optimal policy in the presence of wealth effects attaches less weight on inflation in setting interest rate. Furthermore, the higher the sensitivity of asset markets to interest rates, the lower should be the monetary authorities' response to deviations of output and inflation from their long term trends. This is believed to be the result of the double effect of monetary policy on the real economy. In essence, along with the traditional interest rate channel, monetary policy affects aggregate spending *via* changes in asset prices. In the optimal interest rate feedback rule, the inflation coefficient is negatively related to the magnitude of the wealth effects and to the preference for output stabilisation.

In the second part of the chapter we extend the model to account for momentum treading and revision toward the fundamentals to affect asset prices. The derived optimal policy rule conditions the monetary policy instrument not only on inflation and demand pressures, as standard in the Taylor rule literature, but also on financial imbalances, as represented by asset price misalignments from fundamentals. The magnitude of the interest rate reaction depends, among other factors, on the relative importance of wealth effects for aggregate demand. The response to asset price deviations from fundamentals becomes more aggressive as wealth effects build up, hence when the risk of financial instability increases, while the reaction to inflation and the output gap becomes less pronounced. Thus, our main contribution is to extend the optimal monetary policy literature towards recognizing that, in the presence of wealth effects, monetary authorities should grant an independent role to asset price misalignments and not only regard them as instruments to forecast inflation and output. Future work should consider an open economy model, where the firms' financing and the households' capital gains derive not only from domestic but also from foreign capital markets.

In the end we recognize that our result could be criticized by those who do not believe that Central Banks have superior advantage in identifying a bubble in the financial markets and equilibrium asset value are difficult to estimate. This, however, should not stop monetary authorities to try to identify misalignment in asset prices. Equilibrium levels in other variables (i.e. GDP) are also difficult to estimate, and inflation forecasts are notoriously imprecise, but they are constantly check and estimated by Central Banks.

Appendix A1

We employ the envelope theorem in order to derive an expression for $E_t V'(\pi_{t+1})$ in Eq. (8):

$$dV(\pi_t) = E_t \frac{\partial}{\partial \pi_t}\left[\tfrac{1}{2}(\pi_{t+1}^2 + \mu y_{t+1}^2) + \beta V(\pi_{t+1})\right] d\pi_t \;\Leftrightarrow$$

$$V'(\pi_t) d\pi_t = E_t\left[\pi_{t+1}\frac{\partial \pi_{t+1}}{\partial \pi_t} + \mu y_{t+1}\frac{\partial y_{t+1}}{\partial \pi_t} + \beta V'(\pi_{t+1})\frac{\partial \pi_{t+1}}{\partial \pi_t}\right] d\pi_t \;\Leftrightarrow$$

$$V'(\pi_t) = E_t\left[\pi_{t+1} + \beta V'(\pi_{t+1})\right]$$

Using (2)′ we obtain:

$$V'(\pi_t) = \pi_t + a_1\varphi_t + \beta E_t V'(\pi_{t+1}) \tag{A1.1}$$

Multiplying (A1.1) by $\acute{a}_1$ and adding it to (8) we get:

$$a_1 V'(\pi_t) = -\mu\varphi_t\,. \tag{A1.2}$$

If we multiply this expression by $\hat{a}$ lead it by one period and take expectations based in information at time t we get: $\beta a_1 E_t V'(\pi_{t+1}) = -\mu\beta E_t[\varphi_{t+1}]$.

Thus, (8) can be re-written as:

$$(a_1^2 + \mu)\varphi_t + a_1\pi_t - \mu\beta E_t[\varphi_{t+1}] = 0 \Leftrightarrow \varphi_t = -\left(\frac{a_1}{a_1^2 + \mu}\right)\pi_t + \left(\frac{\mu\beta}{a_1^2 + \mu}\right) E_t[\varphi_{t+1}] \tag{A1.3}$$

Appendix A2

The quadratic equation whose solution gives the optimal c value is:

$$(\mu\beta\alpha_1)c^2 + (\mu\beta - \alpha_1^2 - \mu)c - \alpha_1 = 0 \tag{A2.1}$$

The two roots of (A2.1) are given by

$$c = \frac{-\mu\beta + \alpha_1^2 + \mu \pm \sqrt{\mu^2\beta^2 + 2\mu\beta\alpha_1^2 - 2\mu^2\beta + \alpha_1^4 + 2\alpha_1^2\mu + \mu^2}}{2\mu\beta\alpha_1} \tag{A2.2}$$

Recalling that according to Eq. (2)′ inflation is given by:

$$\pi_{t+1} = \pi_t + a_1\varphi_t + \omega_{t+1} = \pi_t + a_1(c\pi_t) + \omega_{t+1} \Leftrightarrow \pi_{t+1} = (1 + a_1 c)\pi_t + \omega_{t+1}$$

Therefore, stability of the inflation process requires that

$$|1+a_1c|<1 \Leftrightarrow -1<1+a_1c<1 \Leftrightarrow \frac{-2}{a_1}<c<0 \qquad \text{(A2.3)}$$

Since $\acute{a}_1 > 0$ it implies that only the negative
e c-root is accepted.

Appendix A3

The inflation parameter in the interest rate reaction function, f_π, has to be greater than one in order to satisfy the stability condition that real rates increase in response to inflation, with higher values implying a more aggressive response:

$$f_\pi = 1-\frac{c[1-A]}{\beta_3\delta_1+\beta_2}>1 \qquad \text{(A3.1)}$$

This condition can be re-expressed as:

$$\frac{c[1-A]}{\beta_3\delta_1+\beta_2}<0 \qquad \text{(A3.2)}$$

As we showed in Appendix A2, only negative values of parameter c are accepted. Since $\beta_3\delta_1+\beta_2>0$, it is implied that:

$$1-A>0 \quad \Leftrightarrow A<1 \qquad \text{(A3.3)}$$

Conclusion

Given the recent expansion in financial markets and new developments in macroeconomic analysis, the purpose of the thesis was twofold:

- First we wanted to explore the role of Industrial and Commercial Companies flow of funds in the monetary transmission mechanism and in the business cycles.
- Second we wanted to investigate the link between asset prices and monetary policy.

We now present a synopsis of our findings and the main contributions of the thesis. In Chapter 2 we investigated if firms' external funds are important in determining the short-run response or inflation following a monetary policy shock. In order to identify the unexpected change in the monetary policy instrument we define a vector of three variables: the non-policy variables were Retail Price index and Real GDP defined as difference from its long-run trend. We underline that the inclusion of these variables in levels would have not produced the correct policy innovation since the Central Bank loss function is defined in term of deviation from a trend (when it exists) and this specification should be preserved when a VAR study is employed. The short term interest rate was the monetary policy instrument. This ordering of the variables implied that the Central Bank instrument reacts within the quarter to the non-policy variables while it does affect output and inflation only in the following quarter. We ordered last a variable identifying the monetary transmission mechanism. The main result and contribution to the existing literature is that monetary policy has not only an effect on the demand side of the economy but also on the supply side. This suggests that an increase in the short term interest rate has an immediate positive impact on the level of inflation; the reason for this is not, as frequently referred to in the literature as a puzzle or the result of a misspecification, but rather the result of a squeeze in the amount of internal funds available to Industrial and Commercial Companies. They, therefore, need to borrow in order to carry on production; this, in turn, increases firms' marginal costs and consequently the price level. This result is quite striking, although not entirely surprising, and can have important policy implications. The first is that the financial stability of the whole economy could be at risk in the presence of prolonged unexpected rises in interest rates. In fact our results suggest that a positive shock in the monetary instrument weaken the firms' balance sheets reducing the assets and increasing the liabilities, via an increase in the cost of capital. This creates in the short-run a cost-push inflation, which persists for roughly a year after the shock occurs.

In Chapter 3 we suggested that in the presence of asymmetric information capital markets are themselves a source of financial instability. We made use of the Kalman Filter technique to estimate the contribution of firms' external finance to investment. Data of flow of funds of Industrial and Commercial Companies in the United Kingdom in the last thirty years were employed. Our results support Mayer's (1988) idea that internal funds are the most important source of financing for UK companies. The most important result emerging from the analysis is that Minsky's financial instability hypothesis could explain the dynamic of the 1990-92 recession. In fact we have found that most of the external capital was used to finance "speculative" investment rather than "productive" investment for the period antecedent (to) the economic downturn.

The objective of the second part of the thesis was to find a relation between asset prices and interest rate settings. Such a relation is important since wealth deriving from return in the asset market could be an important factor of households demand and firms' investment, which in turn might create pressures on output and inflation.

We approached the analysis from two different perspectives. In Chapter 4 we empirically test the link between asset markets and monetary policy reaction. We start testing the relation between returns in the financial markets and output; this is an essential preliminary test, because a positive relation would signify the presence of wealth effect in the economy. Indeed our results indicate that in the United Kingdom wealth is an important determinant of the national output. We then proceed examining the policy-makers reactions to movements in the asset markets. We employed forward looking Taylor rules to test if the Bank of England has taken into consideration movements in the housing market and in the stock market over the period 1992:10-2003:1; other studies have focused their attention on other variables, namely exchange rate and monetary aggregates, but none addressed this specific point. The results support the hypothesis that policymakers in the UK appear to have taken into consideration both stock price inflation and house price inflation when setting interest rates. When the Taylor rule was augmented by house price inflation and asset price inflation, we found a positive and highly significant response of these two indicators, with the former showing a coefficient always greater than the latter. This result was robust even when Central Bank independence was taken into consideration; furthermore we showed that after the independence monetary authorities have become more inflation adverse. We pointed out that the positive impact of asset returns on the risk free interest rate should be attributed to the fact that Central Bank not only has the objective of price stability, but also of financial stability; where the latter is not necessarily guaranteed with the achievement of the former.

Chapter 5 started from the result obtained in Chapter 4 that the aggregate demand equation is positively affected by changes in the asset market (wealth effect). We developed a macroeconomic model given by three equations: a Phillips Curve, an augmented IS and an equation describing the behaviour of the asset market. This particular theoretical framework departed from the traditional analysis. A dynamic optimization problem was then solved to identify the optimal interest rate. We derived an augmented Taylor rule where the monetary policy instrument reacts not only to squared deviations of output and inflation, but also to asset prices misalignments. The results deriving from the analytical solution suggested that the weight on inflation and output in the optimal level of interest rate decreases while the weight attached to asset price misalignments increases. An important point from these results is that financial imbalances should have a separate role in the formulation of the optimal interest rate.

Finally one important policy implication emerges from the thesis: financial markets matters. They appear to be important because: 1) they determine how a monetary policy shock is transmitted to the economy; 2) financial markets can be a source of financial instability and consequently a cause of an economic downturn; 3) they contribute to the consumers' and firms' wealth therefore they have a direct effect on the level of the aggregate demand.

There are two issues which will more than likely be considered by researchers in future years. Firstly not to only consider reflecting sustainable movements in the underlying economic fundamentals, but to consider how to measure credit expansion and increases in asset prices which are determined by the developments of underlying imbalances which is prone to future corrections. Secondly, improving our understanding of how monetary authorities should react in presence of a wealth effect which is not the result of an increasing in the economy fundamentals but rather of a period characterized by financial markets *euphoria*. Of particular interest would be the case where the real side of the economic system and the financial side call for different monetary policy actions.

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