

**CURRENCY SUBSTITUTION AND THE DEMAND
FOR MONEY IN THE EUROPEAN UNION**

**A thesis submitted to the University of Manchester for the Degree of PhD
in the Faculty of Economic and Social Studies**

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To my parents Semra and Ahmet

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ABSTRACT

This thesis is motivated by the argument that there is a considerable degree of currency substitution in the European Union countries, which could lead to instability in conventional national money demand functions, while an area-wide money demand function could be more stable. In recent years as international financial markets have become more integrated and exchange controls have been phased out, especially in the EU countries, it can be expected that EU residents will tend to allocate their portfolios across different EU currencies, in the form of cross-border deposits, and adjust their composition more frequently in the light of changing financial circumstances. Although there have been many studies investigating the implications of currency substitution in the literature, there is little agreement about precise definition and its measurement.

The thesis begins by discussing these issues and argues that national monetary aggregates should be redefined as extended monetary aggregates which include the relevant cross-border deposits. Even though the traditional monetary aggregates could exhibit instability due to currency substitution, the extended monetary aggregates are expected to be more stable as any switch from one currency-denominated deposit to another would be a shift within the extended monetary aggregate. An aim of this thesis is to define extended monetary aggregates and estimate the demand for them for five EU countries, namely France, Germany, Italy, the Netherlands and the United Kingdom. The empirical findings suggest that the demand for extended money in each country appears to be reasonably stable, as expected.

After determining the structures of national extended money demand functions, an area-wide demand for extended money is estimated. In the literature it is widely argued that the results of the area-wide money demand estimations are sensitive to the aggregation methods. In order to investigate this, two conversion methods are used in obtaining the area-wide variables: fixed base exchange rates and moving average current exchange rates. The empirical evidence indicates that our estimates seem to be largely insensitive to the conversion method. The estimated area-wide demand for extended money appears to be stable suggesting that there is a scope for monetary policy at the European level.

Declaration

No portion of the work referred to in this thesis has been submitted in support of application for another degree or qualification of this or any other university or other institute of learning.

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CHAPTER 1

INTRODUCTION

1.1 The Background

Currency substitution has become an important issue in recent years, as exchange controls have been abolished and international financial markets have become more integrated. Especially in the European Union (EU) countries, the issue of currency substitution is linked with the moves towards a monetary union. There is a worldwide trend towards the integration of national and international capital markets taking place alongside a rapid pace of innovation in these markets. Furthermore, financial markets have been deregulated in many countries, and this has promoted greater competition and efficiency. This market globalization and the progressive lifting of constraints on capital flows have increased international monetary inter-dependence and resulted in rapid transmission of monetary disturbances across the closely integrated European Union countries as well as across other Western countries.

Generally, optimal international portfolio management will usually take the form of holding assets in a number of different currencies. The technological improvements allow instant quotation of foreign-currency denominated deposit rates and exchange rates at minimal cost making currency substitution possible on a scale not previously feasible. There is not a general consensus about the definition of currency substitution, but it refers to substituting domestic currency and domestic monetary assets with foreign currency and foreign currency-denominated assets. Artis and Lewis (1991) suggest two motives for diversifying money holdings across several currencies: transactions-cum-precautionary and (depending on the definition of money in question) speculative.

Economic agents who buy goods invoiced in different currencies will have a corresponding need at the time of payment for the currency of the right denomination. Considering costs of exchange or of liquidating alternative assets, it may be optimal to hold a mixed portfolio of different currencies. As a result of

financial integration, some financial assets, including cash denominated in foreign currency have become capable of reducing transaction costs.¹ In that case economic agents may diversify their portfolios in order to be able to meet future transactions in different currencies at minimum cost, leading to a precautionary demand for foreign currency denominated money. In the world of international business, future payments in different currencies may be effectively hedged by holding corresponding monetary assets in the same currencies. The second motive, which is transactions-cum - speculative, relates to hedging the risk of exchange rate change if expenditures on foreign goods are planned in any case.

In addition to the transactions motive for holding different currencies, currency substitution as a store of value is likely to be one of the main motives, especially in the EU countries. The reasons behind the store of value substitutability can be attributed to uncertainty of the future level of prices, interest rates and exchange rates. In high inflation countries, as the store of value function of the domestic currency erodes, agents can be expected to hold more of their financial savings in terms of a stable foreign currency, generally the US dollar or the Deutsche Mark. The extreme case of currency substitution, where foreign money replaces domestic money, is called dollarization and is usually seen in less developed countries and transition economies. In the case of dollarization, currency substitution is asymmetric, and Gresham's law is reversed: good money tends to drive out the rapidly depreciating one as foreign currency is used in transactions as a medium of exchange. However, in industrialized countries, especially in the EU countries, currency substitution is more symmetric. In a financially integrating Europe, agents tend to hold different currencies on the basis of whether they yield superior characteristics to other currencies.

In a two-country world, if domestic currency is being substituted heavily for the foreign currency, an apparently expansionary monetary policy may turn out to be

¹In the case of hyperinflation, the real cost of holding domestic money becomes extremely high. Domestic currency is generally replaced by a foreign one, often the US dollar, thereby reducing transaction costs.

an unchanged stance of policy given the strong international demand to hold the domestic currency. When the domestic monetary authorities increase the money supply, rather than the entire increase remaining within the country and the price level adjusting to eliminate the domestic excess supply of real balances, some part of domestic money is redistributed through private markets to the foreign country. Hence, the effects of monetary policy are no longer internalized within the domestic country. Without any intervention by governments of either country, the nominal money supply also rises in the foreign country, leading possibly to a rise in the foreign price level. "Thus inflation is transmitted between countries without having to assume any government intervention in the foreign exchange market. Yet transmission of inflation is precisely the type of phenomenon from which flexible exchange rates are assumed to insulate a country."² Furthermore, the degree to which inflation is transmitted between countries will, other things being equal, be proportional to the degree of substitution between currencies, and the limiting case is equivalent of one world currency.

Accordingly, currency substitution can be seen as a source of loss of independence, and the domestic economy may no longer have monetary autonomy even under flexible exchange rates. Miles (1978) and McKinnon (1981, 1984) argue that although currency substitution may lead to instability in national money demand functions, a global money demand function could still be expected to be more reliable. The importance of the stability of the demand for money functions stems from the fact that if there is a stable relationship between money demand and a limited number of explanatory variables, then policy actions which alter the money stock can be expected to have predictable effects on ultimate goal variables. Otherwise, the ultimate response would be unpredictable and there may be no basis for monetary policy.

Therefore, McKinnon suggests that individual countries, which are financially closely linked, should give up controlling their own monetary aggregates, but should

²Miles (1978), pp.432.

pursue a joint monetary policy targeting an area-wide monetary aggregate. This issue has a great importance in the context of European Union countries. The increased degree of currency substitution between currencies of EU countries, due to the process of financial innovation and economic integration, together with international policy interdependence, strengthen the links between the monetary policies of EU countries, which may lead to unstable measures of national money demands and hence affect the usefulness of national monetary aggregates as policy indicators. Generally, the closer substitutes the European currencies become, the stronger the expected shifts in national money demand functions should be. Because when financial instruments become more identical, small changes in risk-return profiles or expected exchange rates will induce significant currency substitution effects. "So increased exchange rate stability among the ERM currencies, itself strongly desired and necessary to the final stage of the EMU, will certainly augment the instability of the national money demand ..."³ but an EU-wide money demand function could be stable.

The European Monetary System, which was established in 1979, aimed to create an area of monetary stability, with fixed but adjustable exchange rates, facilitating trade among participating countries and giving impetus to growth and employment. Even though it was not the first attempt of EU member states to stabilize their currencies (Artis and Lewis (1991)), the System has largely succeeded in its objective of stabilizing exchange rates, despite occasional realignments. Following the high inflation of the 1970s, most European countries felt that controlling inflation was a priority. The EMS aimed to provide a framework within which member countries could pursue counter-inflationary policies at a lesser cost in terms of unemployment and lost output. Furthermore, the requirements for a monetary union also included the liberalization of financial markets and removal of capital controls to increase efficiency of intra-EU resource allocation.

The Delors Committee Report, which was issued in 1989, offered a blueprint

³Sardelis (1993), pp. 24.

for moving towards a monetary union. The ratification of the Maastricht Treaty in December 1991 provided for intensified coordination of member states' monetary policies following the establishment of the European Monetary Institution (EMI) on 1 January 1994. The Treaty also contains an agreement to establish a European Central Bank (ECB) at the latest in 1999, which will issue European currency and possibly target an EU-wide monetary aggregate. However, the transition to this final stage of monetary union is made conditional on a number of convergence criteria.⁴ At this stage participating EU countries will pursue a common monetary policy, with price stability as the overriding objective.

With the phasing out of exchange controls in the EU, portfolio investment abroad and the holding of foreign currency-denominated bank deposits and loans became possible for many more people. At the same time, financial innovation gained momentum in EU countries. Sardelis (1993) argues that the financial innovation has been driven by the availability of new technologies and propelled by a strong demand for new assets. Developments in computer technology in recent years have lowered transaction and information costs, enhancing market transparency. Instruments, such as swaps and options, have come into day-to-day use with advances in computer technology which have reduced the calculation work to a simple routine. Furthermore, new information is now instantly processed in global markets. However, it is not only improvements in technology that initiate financial innovation. The needs of the authorities may also require issuing of new assets. For example, in France and Italy large budget deficits forced monetary authorities to issue new financial instruments with different maturities and varying interest rates, thus diversifying the portfolios of investors. Whatever the underlying forces are, financial liberalization and financial innovations influence the effectiveness of different monetary instruments and the efficacy of monetary policies in general.

The increasing degree of economic and financial integration within the EU has been associated with intensified portfolio diversification and currency substitution.

⁴See de Grauwe (1992).

The process of European integration can be expected to make EU residents focus their attention increasingly on other countries. Investors will come to see European currencies as closer substitutes and will tend to adjust the composition of their portfolios more frequently to changing financial circumstances. The spread of currency substitution has often been associated with the increased amount of cross-border deposits. This term refers to bank deposits for which there is no coincidence between the residency of holder, the currency of denomination and the location of the intermediary service. As capital markets have become more integrated and exchange controls have been phased out, the amount of deposits held by EU residents denominated in foreign currency, either held with domestic banks or banks abroad has increased dramatically. Such cross-border deposits can be regarded as reflecting currency substitution. The proportion of these deposits to national broad monetary aggregates has grown very fast for most EU countries.⁵

As mentioned above, in the absence of an understanding of currency substitution, monetary authorities may easily follow inappropriate policies. Since they operate in a context of imperfect information, they may not accurately identify the nature and extent of currency substitution, this may lead to instability in estimations of national money demands. If the only reason behind the observed instability in many national money demand functions were currency substitution, then the problem would disappear if national monetary aggregates were redefined, as extended monetary aggregates, so as to include the relevant cross-border deposits, since they reflect the extent of currency substitution. These new aggregates can be obtained using three different criteria: residency of holder, currency of denomination and location of the issuer. The extended monetary aggregate, which is obtained according to the residency of holder criterion is preferred in this thesis as it reflects residents' total demand for money, either in domestic or foreign currency. Furthermore, one cannot be a resident in more than one country, so that any double counting or omissions would, in principle, be avoided. If each EU country applied the same criterion to

⁵See respective country chapters for the evolution of these cross-border deposits.

obtain the extended monetary aggregate, adding up national monetary aggregates across countries would yield a consistent and comprehensive EU-wide measure. By extending the monetary aggregates the destabilizing effects of currency substitution could be internalized and the national as well as the area-wide extended monetary aggregates would, other things being equal, be expected to be stable.

Furthermore, harmonization of national monetary aggregates by using one criterion in obtaining the national extended monetary aggregates, has important implications for the conduct of an area-wide monetary policy when the European Central Bank is established. The one criterion principle ensures that double counting or omissions are avoided when obtaining a reliable area-wide monetary aggregate. Then the European Central Bank would be able to use this broad monetary aggregate for the EU as an intermediate target variable for a European money supply policy, if it chooses to do so. This thesis is motivated by the argument that there is a considerable degree of currency substitution in the EU countries which could lead to instability in national money demand functions, but that an area-wide money demand function could be stable. Thus pursuing an area-wide monetary policy, rather than pursuing national monetary policies, could be feasible, strengthening the case for a common European currency and a European Central Bank.

1.2 The Argument Summarized

The broad objective of this thesis is to define extended monetary aggregates for five EU countries namely France, Germany, Italy, the Netherlands and the UK according to residency of holder criterion and obtain an area-wide extended monetary aggregate, then investigate the economic properties and the stability of these aggregates. Even though a large number of EU countries was considered initially, the absence of data on cross-border deposits for other EU countries restricted our analysis to five countries. The process of financial innovation and liberalization in EU countries, in addition to greater exchange rate stability can be expected to lead EU residents to see EU currencies as close substitutes. They will allocate their portfolios

across different EU currencies, and this is reflected by the increased amount of cross-border deposits. These deposits can be expected to be sensitive to expected changes in exchange rates, foreign economic variables or banking regulations. For example an increase in withholding tax in one EU country is likely to result in the transfer of deposits from that country to another. Alternatively when a specific currency is expected to appreciate, agents will shift into that particular currency from other depreciating currencies. Thus national money demand functions could become instable, but the extended monetary aggregate obtained using residency of holder criterion is expected to be stable.

An estimated money demand function at an area-wide level may be stable even though national money demand functions show instability. This could be due to currency substitution or aggregation bias which may result from assuming the demand for money function has the same structure in each country under consideration. In that case assumption of a single money demand structure for all countries may lead to considerable bias in parameter estimates as well as in stability analysis. However, as financial integration in Europe progresses inflation and interest rates in EU countries are likely to come closer. This could result in national money demand functions of similar structure for these countries. At this point the importance of estimating national demand for money functions becomes evident. If the structures of the national money demand functions are found to be similar to each other then, the aggregation bias would be less likely to be large in this study, and the area-wide estimations would be more reliable in testing currency substitution indirectly.

The specific objectives of this thesis can now be listed.

1. To define for five EU countries an extended monetary aggregate which includes residents' foreign currency deposits with domestic banks and domestic and foreign currency deposits at banks abroad. As traditional monetary aggregates do not generally include these types of deposits, they may not reflect the true amount of money demanded and may be unstable due to currency substitution effects.
2. To estimate the demand for extended monetary aggregates for five EU countries

and investigate their economic properties and their stability. The demand for extended monetary aggregates is expected to be more stable than the traditional monetary aggregates as any switch from one currency-denominated deposits to another, reflecting currency substitution, would be a shift within the extended monetary aggregate. Furthermore, the structures of national extended money demand functions will be compared, and if there are considerable differences among them the reasons for that will be examined.

3. To estimate an area-wide demand for extended money, to see if its structure is similar to national ones and investigate its economic properties and its stability. If a stable, well behaved area-wide money demand is obtained, it would suggest that financial integration and currency substitution are such that an area-wide monetary policy would be more feasible.

1.3 The Structure of the Thesis

Even though the issue of currency substitution has attracted a lot of attention in recent years, there is no general agreement in the literature about its precise definition or its measurement. In Chapter 2, alternative definitions of currency substitution are discussed, in addition to some measurement issues. It is argued that currency substitution can be interpreted as usage of foreign money along with the domestic currency for transactions or store of value purposes. Its importance stems from the fact that the level of foreign currency balances will change in response to changes in domestic and foreign economic variables. As far as the measurement of currency substitution is concerned, it is argued that the sharp increase in foreign currency deposits of residents held either with domestic banks or banks abroad following the phasing out of exchange controls in the EU reflects the increased degree of currency substitution. However, the traditionally defined monetary aggregates do not generally include these particular cross-border deposits. Accordingly it is proposed to redefine national monetary aggregates as extended monetary aggregates by including the relevant cross-border deposits. Furthermore, the implications of currency substitution

for the stability of the demand for money, the conduct of monetary policy and exchange rate determination are also discussed. It is argued that currency substitution would lead to interdependence of national monetary policies even under flexible exchange rates and result in instability in national money demand functions. But an area-wide demand for money function would be expected to be more stable.

Estimation of an area-wide money demand function requires aggregation of the national variables. Cross-border monetary aggregation has both advantages and disadvantages, which are summarized in Chapter 3. On one hand the estimation of an area-wide function may overcome the specification bias caused by the omission of the within-area foreign variables as area-wide money demand function include variables of all countries. However, on the other hand, by assuming the same structure of national money demand functions, aggregation bias could be introduced. But this disadvantage may decline as financial integration progresses in the EU and inflation and interest rates in EU countries become closer.

Chapter 4 addresses empirical modelling of demand for money functions focusing mainly on the vector autoregressive model which is employed in this thesis. The econometrics of the vector autoregressive model (VAR), its linkage with cointegration analysis and the importance of hypothesis testing in this context are discussed. The estimated stationary long-run relationships, if any, between the non-stationary variables of the VAR model are obtained through cointegration analysis. Furthermore, a number of economic hypotheses about the behaviour of variables can be tested in this context and the short run dynamics of the system can be modelled. VAR modelling allows the data to determine the specifications of money demand functions given the set of explanatory variables, and if the structures of the national money demand functions are found to be similar then aggregation bias, mentioned in Chapter 3, would be less likely to be significant.

In Chapter 5 through to Chapter 9, estimates of the demand for extended money are presented for Germany, France, the United Kingdom, the Netherlands and Italy respectively. In each chapter a summary of economic developments and of the

evolution of cross-border deposits is given for the country concerned. Moreover, previous studies of the demand for money are reviewed in order to enable a comparison later between them and our own results. Empirical estimates are presented as well as a stability analysis.

After determining the structures of the national money demand functions an area-wide demand for extended money is estimated in Chapter 10. First, an account of existing studies is presented. Then aggregation methods and their strengths and shortcomings are discussed. In this thesis the method of fixed base-date exchange rates is preferred. To test if the results are sensitive to the aggregation method, an alternative aggregation method is employed using moving averages of exchange rates. However, the models estimated using variables obtained by both aggregation methods give similar results and a stable area-wide demand for extended money is obtained.

Finally, Chapter 11 reviews and summarizes the findings from the earlier chapters and provides a conclusion.

CHAPTER 2

CURRENCY SUBSTITUTION AND ITS IMPLICATIONS

2.1 Introduction

Monetary theory traditionally assumes that economic agents hold domestic currency, and domestic and foreign currency denominated assets. They are not allowed to hold foreign currencies either for speculative or transactionary purposes; that is currency substitution is excluded. However, the widespread financial innovation, prompted by the adoption of new technologies, has made the movements of funds and transfer of information across markets more rapid and less costly. Moreover, the process of increasing liberalisation of international money and capital movements provide transactors easy access to a wider set of international financial instruments. As a result of international integration in the economic and financial sphere, and the process of financial innovation, some financial assets, which are denominated in foreign currency, have been included in the portfolios of economic agents. These developments have led to remarkable growth in capital movements and cross border deposits, indicating the increased degree of currency substitution. Furthermore, transactors have an incentive to hold foreign currency balances if they want to hedge against potential exchange rate changes. On the other hand, differential inflation rates among countries give an incentive to economic agents to hold the currency that depreciates less rapidly.

Currency substitution has important implications for the conduct of monetary policy, exchange rate determination and stability of demand for money functions. Although the determinants of currency substitution have not yet been precisely identified, the implications of currency substitution have been investigated extensively. Reallocation of currency by large international firms and/or by other economic agents, who shift between alternative currencies as there are changes in foreign economic variables, will lead to an unstable demand for money function (Monticelli and Papi (1996)). Furthermore, the independence of monetary policy

under a floating exchange rate will not be possible any more. As the degree of currency substitution increases, monetary policies will be more interdependent and conducting a joint international monetary policy could become feasible, rather than controlling national monetary aggregates (Miles (1978), McKinnon (1982)). Moreover, real and financial shocks on the nominal exchange rate are amplified, increasing its volatility, and exchange rates becomes indeterminate under the presence of perfect currency substitution (Girton and Roper (1981)).

In this chapter, an overview of the theoretical models and empirical work on currency substitution is presented. In section 2.2 alternative definitions and measurement issues of currency substitution are discussed. It is argued that the traditional monetary aggregates should be extended by including cross-border deposits according to residency of holder, denomination of currency or the location of the intermediary services. The theoretical models of currency substitution, which are employed by various studies, are reviewed in section 2.3. Among others, cash in advance models, money in utility models and portfolio balance models have been extensively utilized in exploring the effects of currency substitution on various policy issues. In section 2.4 the implications of currency substitution are surveyed as well as the empirical studies. It emerges that as the degree of currency substitution increases, monetary policies of countries become more interdependent. This could strengthen the links between the money demand functions of closely integrated countries, such as EU countries. In that case it could be feasible to pursue a joint monetary policy. Finally, section 2.5 concludes.

2.2 What is Currency Substitution?

2.2.1 Definition of Currency Substitution

Even though the implications of currency substitution have been investigated both theoretically and empirically, there is no agreement concerning the concept and the precise definition of currency substitution in the literature. The term currency substitution may be interpreted in two ways: Firstly, that foreign money is used along

with the domestic currency in transacting; secondly, that a change in relative cost of holding one currency induces a change in the ratio of domestic to foreign money holdings demanded. For instance suppose an increase in domestic money growth causes inflation and a real depreciation of domestic currency then domestic residents' demand for foreign currency can be expected to increase leading to a currency substitution. Under the presence of currency substitution, the level of foreign currency balances changes in response to domestic economic variables. The economic significance of currency substitution stems from the fact that there exists economic agents who, given the current value of economic variables, hold both domestic and foreign currency balances and are indifferent at the margin between holding more domestic or foreign balances (Miles (1978)). In that sense currency substitution refers to the substitution between two monies, which is due to any change in domestic and/or foreign economic variables, or institutional changes. This is consistent with the usage of the term in Cuddington ((1983), (1989)) and Miles (1978).

McKinnon ((1982), (1985), (1996)), on the other hand, distinguishes between direct and indirect currency substitution. Direct currency substitution means that people switch between two or more currencies which compete as a means of payment within the same commodity domain. Indirect currency substitution refers to investors switching between currencies and nonmonetary financial assets, such as bonds, denominated in different currencies, which in turn indirectly influences the domestic demand for transaction balances. Mizen and Pentecost (1996) illustrate these different kinds of substitution by employing the following Table 2.2.1. Direct currency substitution refers to switching between domestic and foreign currencies, C_D and C_F , which is a vertical movement in the Table 2.2.1. Indirect currency substitution takes place when domestic residents attempt to become more or less liquid. This horizontal movement in the Table 2.2.1 is not indirect currency substitution but it induces indirect currency substitution. Suppose international investors decide to shift their desired portfolios from B_D to B_F , in response to some political or economic news. Assuming that the governments are committed to defend exchange equilibrium,

domestic interest rates will tend to increase and foreign interest rates to decline. This will lead domestic residents to become less liquid and to buy domestic bonds, which in turn result in an incipient fall in the demand for non-interest-bearing domestic money, M_D . The excess supply of domestic money, will then, place new downward pressure on the domestic rate of interest, encouraging bond arbitrage. As economic agents shift to foreign bonds, there will be capital outflows from the home country which is exactly equal to the domestic residents' lower demand for currency. The foreign monetary authorities will expand the money supply under a fixed exchange rate. In summary, the shift from B_D to B_F in the international bond market has the effect of indirect currency substitution, as if private agents collectively were reducing their demand for domestic money and increasing their demand for foreign money. McKinnon (1996) argues that the process of indirect currency substitution suggests the need for greater international coordination of domestic and foreign monetary policies to stabilize their common price level.

Table 2.2.1 Types of Currency Substitution

	Currency	Bonds
Domestic	C_D	B_D
Foreign	C_F	B_F

Even though direct and indirect currency substitution can be distinguished in theory, in practise the two processes may occur simultaneously. Economic agents may hold domestic and foreign currency deposits as well as domestic and foreign currency denominated bonds in their portfolios at the same time, and shift between them according to exchange rate and interest rate expectations. In that case, it will be very difficult to distinguish between the concepts of capital mobility and direct and indirect currency substitution. Mizen and Pentecost (1996) argue that this practical ambiguity underlies McKinnon's definition of indirect currency substitution. Cuddington (1989) argues that the concept of currency substitution should focus on the transactions demand for monies, not solely assets and portfolio balances motives.

Only this feature of money makes the phenomenon of currency substitution separate from the more general phenomenon of capital mobility.

Giovannini and Turtelboom (1994) distinguish between currency substitution, which is a complete replacement of one currency with another, and currency substitutability, which is the process of one currency becoming a substitute for another. According to Giovannini and Turtelboom (1994) it is not clear from the term substitution whether it refers to a characteristic of currencies, in which case substitutability is to be preferred, or to an equilibrium outcome in which case substitution could be acceptable.¹

Mizen and Pentecost (1996) add further to the definitions of currency substitution by distinguishing between currency substitution as an equilibrium state, where one currency is substituted, either partially or completely, for another, and currency substitution as a dynamic process, which represents the adjustment of portfolios between equilibria. They argue that there are two ways in which currency substitution can exist: either as a stock of wealth in foreign currency held in the portfolio, or as a flow of wealth into the foreign currency as portfolios are adjusted. "The former takes into account currency substitution which has already taken place and the latter the currency substitution which is now taking place."²

2.2.2 Measurement of Currency Substitution

Along with the growing integration of European capital markets and abolition of exchange controls, there has been a sharp increase in cross-border deposits (CBDs), which reflects the increased degree of currency substitution as a stock of wealth between European currencies. The general term of cross-border refers to any banking instrument for which there is no coincidence between the residency of the non-bank holder, the currency of denomination, and the location of the bank that undertakes

¹ Giovannini and Turtelboom (1994).

² Mizen and Pentecost (1996), pp.13.

it. Angeloni, Cottarelli and Levy (1991) and Giucca and Levy (1992) summarize all possible combinations of CBDs according to the residency of holder, the currency of denomination or the location of the bank by means of an eight-cell diagram which is reproduced here as Table 2.2.2.

Table 2.2.2 CBDs in a Two Country Example

	Residents with domestic banks	Residents with banks abroad	Nonresidents with domestic banks	Nonresidents with banks abroad
In national currency	CBD1 AAA	CBD2 AAB	CBD3 BAA	CBD4 BAB
In foreign currency	CBD5 ABA	CBD6 ABB	CBD7 BBA	CBD8 BBB

In Table 2.2.2 A represents domestic and B foreign, so that the CBDs can be categorized. For example CBD1 (AAA) refers to the deposits held by residents of country A (first index), in their own currency (second index) and in their own country (third index); while CBD6 refers to the deposits held by residents of country A, in the currency of country B and in the foreign country. Deposits represented by CBD1 are always included in the money stock and normally are by far the largest component. Conversely, CBD8 is always excluded, since the corresponding deposits are money of the rest of the world. Thus, according to the previous definition, the term cross-border deposits refers to all deposits included in cells CBD2-CBD7 (Angeloni et al. (1991)).³

Generally, some traditional monetary aggregates include only holdings of foreign currency deposits by domestic residents in domestic banks (CBD5, ABA), which is one of six possible component parts of what could be considered currency substitution. But, they neglect other types of CBDs, which could reflect currency substitution, such as foreign currency deposits held by domestic residents in banks abroad (CBD6, ABB). One reason for considering a restricted number of CBDs

³ For exact sources of CBDs see Appendix 2.

could be concerning the availability of the data. However, the availability and reliability of CBD data have increased significantly since the late 1970s, and the virtual exclusion of CBDs from official monetary statistics cannot be justified anymore. The Bank for International Settlements (BIS), in its International Banking and Financial Market Developments, regularly publishes statistical information on cross-border deposits held by non-bank residents of European countries. The series are produced on a quarterly basis and provide for classification on the basis of country of residence of the holder, the country of location of the issuer and the currency of denomination.

The growing size of CBDs has several policy implications, one of which is related to the effects exerted on monetary aggregates. As mentioned above, the money stock statistics compiled by almost all central banks exclude CBDs. "The recent growth of these deposits, therefore, reduces the coverage, and may ultimately undermine the significance, of the monetary aggregates as indicators of policy. As CBDs became quantitatively important, failure to account for them may result in an inflationary bias."⁴ Therefore, we proposed to define extended monetary aggregates which include CBDs based on the currency of denomination, residency of holder or location of the intermediary service criteria. In the context of the European Union, the establishment of Economic and Monetary Union requires first the coordination of national monetary policies and then a common EU-wide monetary policy when a European Central Bank is established. An essential element in this respect is the definition of uniform and comparable monetary aggregates in the various EU countries. For the purposes of a unified monetary policy in the future, the national monetary aggregates should be harmonized. Wersch (1992) notes that the future European harmonized monetary aggregates should include the monetary deposits of residents held with money-creating institutions in the other EU countries, i.e. certain cross-border deposits.

The sum of different combination of CBDs in Table 2.2.2 gives rise to various

⁴ Angeloni, Cottarelli and Levy (1991), pp.2.

definitions of extended money based on the three different criteria mentioned above. If the extended monetary aggregate is defined on the basis of the criterion of the holder's residence, the relevant aggregate should include CBD1, CBD2, CBD5 and CBD6. The extended monetary aggregate based on the currency of denomination comprises of CBD1, CBD2, CBD3 and CBD4. Finally, the third extended monetary aggregate based on the bank's location should include CBD1, CBD3, CBD5 and CBD7.⁵ The application of the various criteria does not give rise to the same measure of money and each criterion identifies a particular component which is relevant only for that particular definition. Several empirical studies have considered the informativeness, the economic properties and the stability of demand for extended monetary aggregates in European Union countries, and compared them with the traditionally defined monetary aggregates.⁶

As regards the choice of the most significant concept of money with respect to currency substitution, aggregates defined according to currency of denomination and location of the intermediary service are not relevant (Giucca and Levy (1992), Monticelli and Papi (1996)). Although, the definition based on the issuer's location is easier to implement, it chiefly relates to the expansion of bank credit and is likely to be difficult to interpret from an economic point of view, especially when international financial centres attracting deposits from abroad are located within the country. But if we were studying the behaviour of banks, then the location of those banks might be important. The monetary aggregate based on currency of denomination criterion might be related to the potential pressure on the exchange rate of the country in question. It includes, in addition to the other components, non-residents' domestic currency deposits held with banks abroad which has little significance for the currency substitution in the domestic country. Furthermore, it excludes foreign currency deposits held by domestic residents with domestic banks, which reflects pure currency substitution. The monetary aggregate based on the

⁵ See Appendix 2, for the definition of CBDs and calculation of extended monetary aggregates.

⁶ The empirical survey of these studies are presented in Chapter 10.

residency of holder criterion, on the other hand, includes this component as well as foreign currency deposits of residents with banks abroad. This aggregate reflects residents' total amount of demand for money, either in domestic or foreign currency. Thus any currency substitution by domestic residents between domestic and foreign money will be accounted for, so that any change in expected interest or exchange rates, resulting in currency substitution, will not lead to fluctuations in this monetary aggregate. As a consequence, the EU central banks appear to be oriented in favour of adopting the definition of money based on the concept of residency of holder criterion (Giucca and Levy (1992)) as economic agents cannot be residents in more than one country and there is no risk of double counting of their holdings. Therefore, in this study the extended monetary aggregate based on residency of holder criterion is chosen as the appropriate monetary aggregate, when estimating demand for money for five EU countries as well as for an area-wide demand for money.

2.3 Models of Currency Substitution

The theoretical models which examine the implications of currency substitution are extensions of money demand models to a multicurrency economy where different currencies circulate in a country or several currencies circulate in different countries. The literature distinguishes five main theoretical approaches to model currency substitution: cash in advance models, transaction cost models, money in utility function models, portfolio balance models and ad hoc models where the demand for different currencies are specified a priori. The cash in advance models are basically used in order to examine what determines the substitutability of two currencies. Whereas, transactions costs models are employed to illustrate the liquidity services of money.⁷ Additionally, money in utility models and portfolio balance models have also been used in order to model currency substitution among others. In this section a discussion of the theoretical models of currency substitution, which are extensively used in the literature, is presented.

⁷ For a discussion of the services that money performs, see Chapter 3.

2.3.1 Cash in Advance Models

Lucas (1982) and Svensson (1985) introduce money in the macroequilibrium models through a cash in advance constraint (CIA henceforth), to study the pricing of assets. As goods can only be purchased by money, the transactions motive for holding money is underlined.

In general two-good, two-country CIA models, the representative consumer is assumed to derive utility from the consumption of both domestic and foreign goods, and from holdings of real domestic and foreign monetary balances. The consumer can hold four types of asset in his portfolio, domestic and foreign monetary balances and domestic and foreign currency denominated assets. It is assumed that holdings of money do not earn an interest income while bonds do. Since the opportunity cost of holding money is the foregone interest earnings, one plus the interest rate is the relative price of money.

Consider a consumer who seeks to maximize

$$E_t \sum \beta U(C^1, C^2) \quad (2.1)$$

where C^1 and C^2 denotes domestic and foreign goods and β is the discount factor.

Before considering the budget constraints of the representative consumer, it would be useful to explain the organization of trading in goods and financial markets. Each period t is assumed to consist of two subperiods, when different markets are open. In the first subperiod, the consumer can exchange currencies for one another and for the one period riskless bonds denominated in either of the two currencies. In the second subperiod, the consumer purchases goods in the two different markets.

Thus the individual seeks to maximize utility subject to three budget constraints. The first budget constraint is related to the transactions of the household in the first subperiod. It requires that the value of bonds and money balances held at the end of the first subperiod should be less than or equal to the value of wealth. So the budget constraint for the first subperiod, in terms of home currency, is

$$M^1_t + (1+r^1_t)B^1_{t+1} + e_t M^2_t + e_t(1+r^2_t)B^2_{t+1} \leq W^1_t \quad (2.2)$$

where e is the exchange rate expressed as P^2/P^1 , $r^1(r^2)$ denotes interest rate on bonds denominated in home (foreign) currency, $M^1(M^2)$ is the quantity of home (foreign) currency held at the end of the first subperiod, $B^1_{t+1}(B^2_{t+1})$ denotes the nominal value at maturity of bonds denominated in home (foreign) currency and W^1_t denotes the wealth in terms of home currency.

In the second subperiod, goods are purchased using currency, in two distinct markets, each with separate budget constraints. The two types of goods do not differ except in the kind of payment used to purchase them. Domestic goods are purchased by domestic currency, whereas foreign goods are purchased by foreign currency. Hence, substitution of goods in consumption results in substitution of currencies. Cash in advance constraints are

$$P^1_t C^1_t \leq M^1_t \quad (2.3)$$

$$P^2_t C^2_t \leq M^2_t \quad (2.4)$$

stating that expenditure on home (foreign) good must be less than or equal to the quantity of home (foreign) currency held at the end of first subperiod. The presence of this CIA constraint results in demand for different currencies in such models.

The third budget constraint shows how wealth denominated in terms of domestic currency at the beginning of period $t+1$ is determined.

$$W^1_{t+1} = (M^1_t - P^1_t C^1_t) + e_t(M^2_t - P^2_t C^2_t) + B^1_{t+1} + e_t B^2_{t+1} \quad (2.5)$$

where W^1_{t+1} is the real wealth at the beginning of period $t+1$. The representative consumer maximizes his utility, equation (2.1), subject to constraints equations (2.2), (2.3), (2.4) and (2.5). Optimization then requires,

$$\frac{U^1_t}{U^2_t} = \frac{P^1_t}{e_t P^2_t} \quad (2.6)$$

CIA are always binding and they do not allow any substitution between

currencies. But substitution of the commodities are allowed by the utility function. Thus the type of utility function determines the degree of substitution between currencies. Assume that the representative individual has a utility function, where home and foreign goods enter by weights of α and $(1-\alpha)$, respectively,

$$U = C_1^\alpha C_2^{1-\alpha} \quad (2.7)$$

where $(1-\alpha)/\alpha = \sigma$ is the substitution term. Then the nominal exchange rate is obtained as:

$$e = \sigma \frac{P_1 C_1}{P_2 C_2} \quad (2.8)$$

An increase in expenditure on consumption of the home good leads to an increase in demand for home currency relative to foreign currency, which in turn causes the appreciation of the home currency by σ . When there is an increase in substitution between currencies, as α decreases (hence σ increases), the relative price of foreign currency increases.

Solving equation (2.8) for C^1 and C^2 and substituting them in each CIA constraint with equality, we can obtain national money demand functions as follows:

$$M_d^1 = \frac{e P^2 C^2}{\sigma} \quad (2.9)$$

$$M_d^2 = \frac{\sigma P^1 C^1}{e} \quad (2.10)$$

Since transactors are allowed to substitute currencies, the national money demand functions are obtained as functions of exchange rate and substitution term. As there is an increase in substitution between the currencies, demand for domestic money decreases while demand for foreign money increases by the same amount, σ . Furthermore, substitutability of the two goods can be seen in money demand functions as well. As there is an increase in the price of the home (foreign) good, the

demand for the foreign (home) good increases. Since foreign economic variables affect demand for domestic money and currency substitution is allowed, instability in national money demand functions can be observed.

The key assumption of the CIA models postulates a perfect correspondence between the composition of goods and the currency composition of the money balances held for transaction purposes. This assumption rejects a priori the notion of substitutability between the currencies. To overcome this drawback, Woodford (1991) devises a model where the CIA constraint takes a parametric form. He models currency substitution as substitution between the types of goods purchased, rather than as a change in the degree to which same types of goods are purchased using different currencies.

CIA costs models originate from the transactions motive and emphasize the medium of exchange function of money. Agents need money only to purchase goods, there is not any other motive for holding money. In CIA models transactors can obtain the necessary cash by liquidating part of their portfolio of bonds or other assets without incurring any transfer costs. The CIA models assume the presence of legal and institutional arrangements that make the use of money for some payment indispensable, that is one must hold the monies of both countries in order to make purchases of their goods. However, in practice, one holds one money and then use the foreign exchange market to buy the other money when one wishes.

2.3.2 Transaction Cost Models

Although the simple cash in advance models explain substitutability of currencies when transactions services of money are considered, it does not explain how different monies work as a store of value. However, money still has a store of value role as transaction costs are incurred in transferring other assets into goods or into money.

Consider a model where economic agents consume domestic and foreign goods, have domestic and foreign currency denominated bonds in their portfolios as well as domestic and foreign currency. Each period t is assumed to consist of two

subperiods, when different markets are open. Transactors have to acquire the cash balances which could be used to purchase commodities in the next period. However, transferring bonds into money or into goods entails transaction costs. Every sub-period t , the individual chooses the amount of domestic and foreign bonds B^1_{t+1} and B^2_{t+1} maturing at next sub-period, and the domestic and foreign monetary balances, M^1_{t+1} and M^2_{t+1} , he wants to hold. Hence the representative agent maximizes his utility

$$E_t \sum \beta U(C^1, C^2) \quad (2.11)$$

subject to the budget constraint

$$\begin{aligned} & \frac{M^1_{t+1}}{P^1_t} + \frac{B^1_{t+1}}{P^1_t} + \frac{e_t M^2_{t+1}}{P^1_t} + \frac{e_t B^2_{t+1}}{P^1_t} \\ &= \frac{M^1_t}{P^1_t} + \frac{e_t M^2_t}{P^1_t} + \frac{B^1_t(1+r^1_t)}{P^1_t} + \frac{e_t B^2_t(1+r^2_t)}{P^1_t} \\ & - C^1_t - \frac{e_t C^2_t P^2_t}{P^1_t} - \phi(C^1_t, C^2_t, M^1_t, M^2_t) \end{aligned} \quad (2.12)$$

Where all notation as in previous section and ϕ represents the transaction costs, which are increasing in consumption of both goods and decreasing in stocks of real balances. The degree of substitutability between the currencies depends on the form of the ϕ function.

The first order conditions with respect to C^1 and C^2 yield

$$U^1_t = \lambda_t (1 + \Phi_{t,1}) \quad (2.13)$$

$$U^2_t = \frac{e_t P^2_t}{P^1_t} \lambda_t \left(1 + \frac{P^1_t}{e_t P^2_t} \Phi_{t,2} \right) \quad (2.14)$$

where λ_t represents the Lagrange multiplier associated with the budget constraint, which is marginal utility of wealth, and the subscripts to the symbol Φ_t denote partial derivatives of the Φ function, evaluated at time t , with respect to variables at the subscripts. These first order conditions show that when there are transactions costs in transferring bonds into money or into goods, the marginal rate of substitution of the goods is no longer equal to the relative price of the two commodities. If transaction costs were zero, that is when the partial derivatives were identical, then the two goods would be perfectly substitutable in the function Φ . However, when there are transaction costs, the partial derivatives would be different leading to a wedge between the marginal rate of substitution and the marginal rate of transformation of the two goods.

When derivatives with respect to the two monies and the stock of bonds are taken, the first-order conditions from asset pricing models are obtained as follows:

$$\frac{\lambda_t}{P^1_t} = \beta E_t \left[\frac{\lambda_{t+1}}{P^1_{t+1}} (1 - \Phi_{t+1, \frac{M^1}{P^1}}) \right] \quad (2.15)$$

$$\frac{e_t \lambda_t}{P^1_t} = \beta E_t \left[\frac{e_{t+1} \lambda_{t+1}}{P^1_{t+1}} \left(1 - \frac{P^1_{t+1}}{P^2_{t+1} e_{t+1}} \Phi_{t+1, \frac{M^2}{P^2}} \right) \right] \quad (2.16)$$

$$\frac{\lambda_t}{P^1_t} = \beta E_t \left[\frac{\lambda_{t+1}}{P^1_{t+1}} (1 + r^1_t) \right] \quad (2.17)$$

$$\frac{e_t \lambda_t}{P^1_t} = \beta E_t \left[\frac{e_{t+1} \lambda_{t+1}}{P^1_{t+1}} (1 + r^2_t) \right]. \quad (2.18)$$

The system can be solved after imposing a specific functional form on the function Φ and the demand for domestic and foreign monetary balances can be obtained. The structure of the demand for money equations will, then, be determined by the functional form of the liquidity function. The demand for domestic and foreign money is determined by the expected liquidity services that they offer, represented by the partial derivative of the liquidity function with respect to the real money

stocks. Agents trade off money and other assets in their portfolio by comparing their expected returns. If domestic money has a low expected return due to high inflation, then the demand for foreign currency increases as it becomes a significant liquid investment for domestic residents. In countries where the financial markets are not yet developed, agents may not easily perform their financial transactions. Then, the demand for money for store of value purposes increases since the liquidity services of money increases.

The liquidity models for currency substitution illustrate the demand for different currencies as stores of value. Giovannini and Turtelboom (1994) point out that the liquidity services of money are determined by the shares of the domestic and foreign money in the total stock of monetary balances in the economy. This follows from the fact that a particular currency becomes more acceptable, the more it is used as a medium of exchange and for store of value purposes. Hence as the aggregate share of the domestic money increases in the total holdings, more people will choose to use it in their transactions. Then it would be convenient to use the widely circulating currency as the medium of exchange. It can be argued that this is the mechanism underlying the establishment of the vehicle currencies.

Transaction cost models differ from CIA models in that they also emphasize the store of value function of money. This is achieved by introducing transfer costs incurred in transferring other assets into goods or money. Transactors cannot instantaneously acquire cash to purchase goods because of the transfer costs, which make money more liquid than the other assets. In countries where the financial markets are underdeveloped there would be a considerable amount of transaction costs involved, leading to an increase in the liquidity services of money, which, in turn, cause a rise in demand for money for store of value purposes. The demand for domestic and foreign money, hence the degree of currency substitution, will be determined by the expected liquidity services they offer. The share of a particular currency increases in the total holdings with an increase in its degree of liquidity and the more it is used as a medium of exchange and store of value purposes.

2.3.3 Money in Utility Function Models

In money in utility function models, it is assumed that transactors derive utility from liquidity services provided by holdings of domestic and foreign money. Hence they have domestic and foreign monetary balances as arguments in their utility functions, as well as the consumption of domestic and foreign goods. Engel (1989) argues that the presence of money balances in the utility function is a device which allows agents to hold money even when it is dominated in its risk and rate of return characteristics. For example, even though foreign bonds have a higher real interest rate and inflationary pressures discourage holding of domestic money, agents still have to hold the domestic money as it is necessary for government transactions.

Consider a representative agent who has domestic and foreign money, M^1 and M^2 , and domestic and foreign currency denominated assets, B^1 and B^2 , in his portfolio and who maximizes his utility function

$$E_t \sum \beta V(C^1, C^2, M^1, M^2). \quad (2.19)$$

If utility is assumed to be separable, we have

$$V = U(C^1, C^2) + F(M^1, M^2) \quad (2.20)$$

where C^1 and C^2 are the consumption of domestic and foreign goods.

The total financial asset holdings of the representative agent are given by

$$a = \frac{M^1}{P^1} + \frac{eM^2}{P^1} + \frac{B^1}{P^1} + \frac{eB^2}{P^1} \quad (2.21)$$

where e denotes the exchange rate. If ϵ is defined as the expected rate of depreciation of the domestic currency ($\epsilon = (de/dt)/e$), the asset accumulation equation is given by

$$\dot{a} = y - c^1 - \epsilon c^2 - \pi^1 \frac{M^1}{P^1} + (\epsilon - \pi^1) \frac{eM^2}{P^1} + (r^1 - \pi^1) \frac{B^1}{P^1} + [\epsilon(1+r^2) + r^2 - \pi^1] e \frac{B^2}{P^1}$$

where a dot indicates time derivative, π^1 is the domestic rate of inflation, r^1 and r^2 are domestic and foreign interest rates on bonds, y is real income, c^1 and c^2 are real consumption of domestic and foreign good.

The optimization problem faced by the representative agent is to maximize the utility function ($\delta > 0$ is the discount factor),

$$U = \int_0^{\infty} [V(C^1, C^2) + F(\frac{M^1}{P^1}, \frac{M^2}{P^2})] e^{-\delta t} dt \quad (2.22)$$

subject to the portfolio constraint (2.21) and the asset accumulation constraint. The Hamiltonian for the optimization problem is given by

$$\begin{aligned} H = & V(C^1, C^2) + F(\frac{M^1}{P^1}, \frac{M^2}{P^2}) \\ & + q(y - c^1 - ec^2 - \pi^1 a + \epsilon \frac{eM^2}{P^1} + r^1 \frac{B^1}{P^1} + [\epsilon(1+r^2) + r^2] e \frac{B^2}{P^1} \\ & + \lambda [a - \frac{M^1}{P^1} - \frac{eM^2}{P^1} - \frac{B^1}{P^1} - \frac{eB^2}{P^1}]. \end{aligned} \quad (2.23)$$

The variable q is the costate variable associated with the flow constraint and λ is the Lagrangean associated with the stock constraint. The first order conditions yields

$$U_1 = q \quad (2.24)$$

$$U_2 = eq \quad (2.25)$$

$$\frac{F_{M^1}}{P^1} = \frac{\lambda}{P^1} \quad (2.26)$$

$$\frac{F_{M^2}}{P^2} = \frac{e}{P^1}(\lambda - q\epsilon) \quad (2.27)$$

$$\frac{(qr^1 - \lambda)}{P^1} = 0 \quad (2.28)$$

$$\frac{e}{P^1} = [q(\epsilon(1+r^2) + r^2) - \lambda] = 0 \quad (2.29)$$

From equations (2.28) and (2.29) the uncovered interest arbitrage condition is obtained

$$r^1 = \epsilon(1+r^2) + r^2 \quad (2.30)$$

and from equations (2.26) and (2.27), using the uncovered interest rate parity condition we obtain

$$\frac{F_{M^1}}{F_{M^2}} = \frac{P^1}{eP^2} \left(\frac{r^1}{r^2(1+\epsilon)} \right) \quad (2.31)$$

which states that the marginal rate of substitution between the domestic and foreign currencies must be equal to the ratio of the opportunity cost of holding a unit of resources as domestic currency rather than as domestic bonds to the opportunity cost of holding a unit of resources as foreign money rather than foreign bonds. This analysis indicates that when there is currency substitution national money demand functions are affected by foreign economic variables, leading to instability in the national money demand functions. Furthermore, the real exchange rate influences the equilibrium value of the marginal rate of substitution between domestic and foreign monies.

If it is assumed that the money services function, F , is a constant elasticity of substitution model (CES) type such that

$$F = [\theta_1(\frac{M^1}{P_1})^{-\rho} + \theta_2(\frac{M^2}{P_2})^{-\rho}]^{-\frac{1}{\rho}} \quad (2.32)$$

then using the results above, equation (2.31) can be rewritten as:

$$\frac{\theta_1}{\theta_2} (\frac{M^1}{eM^2})^{-(1+\rho)} = (\frac{P^1}{eP^2}) (\frac{r^1}{r^2(1+\epsilon)}). \quad (2.33)$$

Taking logs this can be expressed as

$$\log(\frac{M^1}{eM^2}) = \sigma \log \frac{\theta_1}{\theta_2} - \sigma \log(\frac{P^1}{eP^2}) - \sigma \log(\frac{r^1}{r^2(1+\epsilon)}) \quad (2.34)$$

where $\sigma = 1/(1+\rho)$ is the elasticity of currency substitution. As with the Miles (1978) model, the coefficient on each of the explanatory variables is expected to be the same.

Equation (2.34) implies that the degree of currency substitution can be measured by either the real exchange rate or the uncovered interest parity differential. Since the uncovered interest parity is linked to capital mobility, currency substitution cannot be distinguished from capital mobility in this model. Although in equation (2.31) the purchasing power parity (PPP) and uncovered interest rate parity (UIP) conditions enter as a multiplicative term, by taking logs these two effects are split up in equation (2.34), where both of them have the same coefficient. "If, however, it is assumed that UIP holds, then the second term on the right-hand side will be equal to unity and relative money balances will depend only on relative prices. Similarly, if the real exchange rate is assumed to be constant then the degree of currency substitution is given solely by the interest rate differential term. If, however, in long-run equilibrium both PPP and UIP are assumed to hold, there is no scope for currency substitution: indeed it would be unnecessary, since both domestic and foreign goods and bonds are perfect substitutes."⁸ Furthermore, income does not appear in the final

⁸ Mizen and Pentecost (1996), pp.26.

equation as argued by Bordo and Choudhri (1982), although one would expect that income would be an important determinant of the demand for money. In empirical estimation, income (Bordo and Choudhri (1982)), or the trade balance (Ratti and Jeong (1994) and Milner, Mizen and Pentecost (1996)) variables are included to overcome this weakness.

Money in utility models are totally different from the other two micro-level models, cash in advance and transaction cost models, in that transactors derive utility from consumption and from the liquidity services provided by domestic and foreign money. Although it is true that holding money does not add to one's utility, this approach is useful for intuitive reasoning. Engel (1989) argues that inclusion of money balances into the utility function allows agents to hold money even when it is dominated in its risk and return characteristics. Transactors should hold domestic currency for transactions purposes as it is generally necessary for government transactions.

2.3.4 Portfolio Balance Model

The general portfolio balance model postulates that transactors are likely to hold a portfolio of currencies and non-monetary assets to maximize utility, which is assumed to depend on the rate of return and the riskiness of the total portfolio, as in Tobin (1958). Economic agents allocate their wealth among all assets in order to maximize the real return they get for a particular level of risk, hence permitting varying degree of substitutability between domestic and foreign currencies and non-monetary assets. Girton and Roper (1981), Cuddington (1983) and Zervoyianni (1992) have extended the general model to include the possibility of currency substitution.

Domestic investors are allowed to hold their wealth in the form of four different assets: domestic money M^1 ; domestic currency denominated non-monetary assets, that is domestic bonds, B^1 ; foreign currency, M^2 ; and foreign bonds, B^2 . The desired holdings of each asset in the portfolio depend on the vectors of expected real returns on currencies and bonds, income and wealth. It is assumed that an increase

in wealth leads to a proportional increase in desired holdings of each asset. Thus domestic investors' demands can be expressed as follows ⁹

$$M^1 = M^1(r^1, r^2 + \epsilon, \epsilon, I, W) \quad (2.35)$$

$$eM^2 = M^2(r^1, r^2 + \epsilon, \epsilon, I, W) \quad (2.36)$$

$$B^1 = B^1(r^1, r^2 + \epsilon, \epsilon, I, W) \quad (2.37)$$

$$eB^2 = B^2(r^1, r^2 + \epsilon, \epsilon, I, W) \quad (2.38)$$

where I denotes income, W denotes wealth and ϵ is the expected exchange rate change. $r^2 + \epsilon$ is the expected return on foreign bonds including expected exchange rate changes. Thus r^1 , $r^2 + \epsilon$, and ϵ represent the expected nominal returns on domestic bonds, foreign bonds and foreign money. Although the demand for domestic and foreign money depends negatively on nominal returns on domestic and foreign bonds, expected exchange rate changes have different effects on them. When domestic currency is expected to depreciate, the demand for domestic money is predicted to fall, and the demand for foreign money increase. It is important to distinguish the effects of changes in the return on foreign bonds from changes in the return on foreign money. The former is seen as presenting capital mobility while the latter is seen as representing currency substitution¹⁰ effects of expected exchange rate changes.

In order to differentiate currency substitution and capital mobility properly and for estimation purposes equations (2.35) - (2.38) can be approximated in log-linear form as follows:

⁹ These demand functions can also be obtained by solving first order conditions of the optimization problem of the transaction cost model, equations (2.15), (2.16), (2.17) and (2.18), when the utility function is specified.

¹⁰ See Cuddington (1983).

$$\log\left(\frac{M^1}{P^1}\right) = \alpha_0 + \alpha_1 r^1 + \alpha_2 (r^2 + \epsilon) + \alpha_3 \epsilon + \alpha_4 \log I \quad (2.39)$$

$$\log\left(\frac{eM^2}{P^2}\right) = \beta_0 + \beta_1 r^1 + \beta_2 (r^2 + \epsilon) + \beta_3 \epsilon + \beta_4 \log I \quad (2.40)$$

$$\log\left(\frac{B^1}{P^1}\right) = \gamma_0 + \gamma_1 r^1 + \gamma_2 (r^2 + \epsilon) + \gamma_3 \epsilon + \gamma_4 \log I \quad (2.41)$$

$$\log\left(\frac{eB^2}{P^2}\right) = \delta_0 + \delta_1 r^1 + \delta_2 (r^2 + \epsilon) + \delta_3 \epsilon + \delta_4 \log I. \quad (2.42)$$

Cuddington (1983) argues that under the presence of currency substitution the coefficient of expected exchange rate change in domestic money demand function, α_3 , which is the coefficient representing currency substitution, will be negative. Hence, an expected depreciation of the domestic currency leads to a fall in the demand for domestic money by domestic residents, since they switch into foreign currencies in order to maintain the purchasing power of their money holdings. When α_3 is zero, it is argued that there is no currency substitution effect. The effects of capital mobility, on the other hand, is reflected with a $\alpha_2 < 0$. In either case expected exchange rate change enters domestic money demand equation with a negative sign. Furthermore, γ_2 and δ_1 measures substitution between domestic and foreign bonds, which McKinnon called indirect substitution.

There are two problems associated with the empirical work based on these equations: multicollinearity and partial adjustment. Firstly, in cases where there is high capital mobility, expected returns on domestic and foreign assets will be highly correlated. Therefore, the precise estimation of the parameters is difficult. Secondly, there is a question about whether the money market should be assumed to clear within one period or whether a partial adjustment specification is needed. The latter case requires the inclusion of a lagged dependent variable in the equation. But as Giovannini and Turtelboom (1994) indicates, the inclusion of a lagged dependent

variable is hard to justify, since it is difficult to identify costs of adjustment of private financial portfolios.

Even though it is assumed that all assets are available to economic agents who can choose a combination of assets according to the risk and return criteria, there is another strand of portfolio balance model where agents allocate their financial wealth in two stages. In the sequential or restricted portfolio balance approach agents have a restricted set of portfolio choices. The main characteristic of this approach is a two-stage decision process, in the first stage economic agents divide their wealth between liquid and non-liquid assets, and in the second stage divide each of these two independent portfolios between assets of their own class. As agents shift between different currencies when dividing their liquid asset portfolios, the process of currency substitution occurs, in the second stage. Thus, it is apparent that the phenomena of currency substitution and capital mobility are analytically separate, because the division of wealth between capital and money services is determined in the first stage.¹¹

Miles (1978) employs this approach and postulates that agents would maximize their production of money services, F , subject to the budget constraint. If it is assumed that the money services function, F , is a constant elasticity of substitution model (CES) type such that:

$$F = [\theta_1 \left(\frac{M^1}{P^1}\right)^{-\rho} + \theta_2 \left(\frac{M^2}{P^2}\right)^{-\rho}]^{-\frac{1}{\rho}} \quad (2.43)$$

where ρ is the elasticity of substitution. This function is maximized subject to the money constraint, M_0 , fixed at the first stage of the portfolio allocation process, which is given by:

$$M_0 = (1+r^1)\left(\frac{M^1}{P^1}\right) + (1+r^2)\left(\frac{M^2}{P^2}\right). \quad (2.44)$$

¹¹ Mizen and Pentecost (1994), pp. 1059.

Then, maximizing F subject to the constraint, gives the first order conditions:

$$\frac{\partial F}{\partial M^1} = \theta_1 \left(\frac{M^1}{FP^1} \right)^{-(1+\rho)} - \lambda(1+r^1) \quad (2.45)$$

$$\frac{\partial F}{\partial M^2} = \theta_2 \left(\frac{M^2}{FP^2} \right)^{-(1+\rho)} - \lambda(1+r^2) \quad (2.46)$$

$$\frac{\partial F}{\partial M_0} = \lambda[(1+r^1) \left(\frac{M^1}{P^1} \right) + (1+r^2) \left(\frac{M^2}{P^2} \right)] \quad (2.47)$$

Taking the ratio of the marginal products and assuming purchasing power parity (PPP) so that $P_1 = P_2 E$, gives:

$$\frac{\theta_1}{\theta_2} \left(\frac{M^1}{EM^2} \right)^{-(1+\rho)} = \left(\frac{1+r^1}{1+r^2} \right). \quad (2.48)$$

Taking logarithms gives

$$\log\left(\frac{M^1}{EM^2}\right) = \sigma \log\left(\frac{\theta_1}{\theta_2}\right) + \sigma \log\left(\frac{1+r^2}{1+r^1}\right) \quad (2.49)$$

where $\sigma = 1/(1+\rho)$ is the elasticity of currency substitution and expected to be positive according to this approach. The first term in the right-hand side of equation (2.49) is the ratio of the weight of domestic real money over the weight of foreign real money in the money services function. Miles (1978) argues that close substitution between the currencies can be reflected in two ways in this model: one way is to have a high elasticity of substitution between the two assets and another indication is to have similar values of θ_1 and θ_2 , which represent the efficiency of different money assets in providing money services. With perfect currency substitution σ goes to infinity, implying that ρ goes to -1 and the money services function (2.43) becomes the weighted sum of domestic and foreign real money.

Mizen and Pentecost (1996) note, however, that this model is subject to a number of limitations. Firstly, this model cannot distinguish between capital mobility and currency substitution. Secondly, the demand for money does not depend on income, as one would expect in demand for money functions. Thirdly, it is assumed that PPP holds always, which is empirically invalid and theoretically undesirable if currencies are substituted for transaction purposes.¹²

Numerous authors have employed this model. Bordo and Choudhri (1982) modify the model of Miles by adding output to the maximization problem, so that output also enters the equations to be estimated. Bergstrand and Bundt (1990) extend this model by considering an asymmetric case where domestic residents do not hold foreign currency, but foreign residents hold both currencies. Only foreign residents are allowed to switch between the two currencies. They note that the conditions describing optimal money demand are from production theory, not from financial theory. In this model the only opportunity cost variables influencing money demands are the home and foreign nominal interest rates, representing the marginal productivities of the home and foreign monetary inputs in the production of money services. In this asymmetric case, equilibrium in the home country money market requires:

$$\frac{M^1}{P^1} = [k_{11}(r^1)]I^1 + [k_{12}(r^1, r^2)]I^2 \quad (2.50)$$

where I^1 (I^2) denotes real income in domestic (foreign) country. To test for currency substitution, only the foreign residents' demand for home currency is estimated, which in logarithms is:

$$\ln\left(\frac{M^{12}}{P^1}\right) = \beta_0 + \beta_1 r^1 + \beta_2 r^2 + \beta_3 \ln I^2 + u_t \quad (2.51)$$

where u_t is the error term. The sign on β_2 denotes currency substitution. When there

¹² Mizzen and Pentecost (1996), pp.22.

is an exogenous increase in the foreign interest rate (r^2), foreign demand for foreign real money falls and foreign demand for home money (k_{12}) increases, since the relative opportunity cost of using home money as a monetary input is now lower. Since residents of home country are not allowed to hold both currencies, the rise in foreign interest rates has no impact on home money demands. The resulting excess demand for real home money causes the appreciation of the home currency. The home price level falls, and the real stock of home money increases. As a result of an increase in foreign interest rates, home currency flow to foreign residents, leading to currency substitution. Bergstrand and Bundt (1990) argue that this positive relationship between foreign interest rates and foreign demand for real home money can potentially erode the home country's monetary autonomy. Furthermore, this version of a restricted portfolio balance model explicitly includes real income as a determinant of the demand for money and does not impose PPP, as opposed to Miles' model.

Even though a rise in the foreign interest rates would result in the appreciation of the foreign currency in financial models, the opposite result is obtained by Bergstrand and Bundt (1990). This is because residents of foreign country compare the opportunity cost of using foreign or home money in their production services as in Miles (1978). As Bergstrand and Bundt (1990) note, in an expected utility maximizing model, the usual opportunity cost variables affecting portfolio asset demands in general, including expected exchange rate changes, fail to influence money demands in particular. The particular results of both Miles (1978) and Bergstrand and Bundt (1990) follow from the assumptions of the model. Although the assumptions are proper in their models, they produce implausible results. In that respect their models are quite restrictive and require strong assumptions.

The portfolio balance models originate from the speculative motive for holding money. Agents allocate their wealth among domestic and foreign currency and financial assets in order to maximize the real return they could obtain for a

particular level of risk. Therefore levels of domestic and foreign interest rates, price levels and expected exchange rate changes can affect the degree of currency substitution. In addition to the models discussed in this section, certain other macroeconomic models investigate the currency substitution issue in the context of both speculative and transactions motive for holding money, such as Spinelli (1983).

Finally, the last category of models include the dynamic models of Imrohoroglu (1991) and Bufrman and Leiderman (1992), which emphasize the demand for money as a medium of exchange. These authors do not directly estimate money demand equations. Instead they estimate a set of Euler equations, which are obtained from the first order conditions of the utility maximization problem, specifying the equilibrium dynamics for marginal utilities.

2.4 Implications of Currency Substitution and Empirical Evidence

2.4.1 Monetary Policy Implications

In traditional international economic models, it is widely argued that flexible exchange rates insulate a country's monetary policy from the developments occurring in the rest of the world. A system of flexible exchange rates would allow individual countries the liberty of using independent monetary policy for domestic purposes. Exchange rates that are allowed to adjust freely to market forces, provide an adjustment mechanism that insulates the domestic money supply from external influences, that would, under fixed exchange rates, dominate its own monetary policy decisions. It is assumed that, under flexible exchange rates, each domestic monetary authority controls the supply of its own currency that is not a substitute for others. When there is an excess demand for a currency, it will be eliminated by the exchange rate and price level changes, and purchasing power parity establishes the equilibrium relationship between the two. The balance of payments is always zero and there is no net flow of money between central banks. Thus under flexible exchange rates currencies are perfect nonsubstitutes on the supply side.

Under fixed exchange rates, on the other hand, differences among countries'

excess demands for money are generally eliminated through the balance of payments, changing the physical distribution of world money among countries. That is under fixed exchange rates monetary independence is impossible because by pegging the value of domestic currency to foreign currency, the domestic monetary authorities make foreign currency a perfect substitute for domestic money on the supply side. When there is an increase in the domestic money supply, money would immediately flow out through the balance of payments. The domestic balance of payments deficit would be matched by a balance of payments surplus abroad. Then, money supplies abroad must also increase and a common rate of inflation would be observed among the countries. Hence fixed exchange rates do not insulate a country's money supply from the monetary developments in the rest of the world.

Consequently it has been argued that elimination of the substitution of currencies on the supply side results in complete monetary independence. However, this monetary independence argument relies implicitly on the assumption that currencies are also nonsubstitutes. But in the world of global integration this assumption appears inappropriate. As explained in previous sections, economic agents have an incentive to hold foreign currency or foreign currency denominated deposits, both to facilitate transactions in different currencies and to earn the rate of appreciation of a particular currency vis-a-vis others. Once the assumption of currency substitution on the demand side is introduced, the conclusion that flexible exchange rates imply an independent monetary policy begins to weaken. In a two country world where currency substitution exists and uncovered interest parity prevails, when the foreign country employs an expansionary monetary policy and foreign interest rates fall, the foreign currency will depreciate against the domestic currency, leading to anticipated relative inflation in all prices in the foreign country. Then economic agents would like to hold the currency that is depreciating less rapidly and shift from foreign currency to domestic currency. This, in turn, would lead to an increase in demand for real balances in domestic currency, whereas that of foreign currency falls. Sharp deflation in prices in domestic currency could only be avoided

if the stock of nominal cash balances of domestic currency were increased. Under fixed exchange rates the relative supply of each currency would be adjusted automatically to the changes in relative demands. However, flexible exchange rates would not allow such an adjustment. Thus currency substitution on demand side produces flows of money and changes in price levels that are not consistent with the flexible exchange rate models.

Under flexible exchange rates the effects of the monetary policy are not internalized within the foreign country and affects the price level of the home country. "Thus inflation is transmitted between countries without having to assume any government intervention in the foreign exchange market."¹³ In that case, under perfect currency substitution, monetary authorities face similar types of constraints under both flexible and fixed exchange rates and the theory of how a flexible exchange rate system works needs to be altered. The degree to which inflation would be transmitted would be proportional to the degree of substitution between the currencies. If the currencies are perfect substitutes, it would be equivalent to a world of one currency, just as when monetary authorities make currencies perfect substitutes on the supply side by fixing exchange rates.

Rogers (1990) analyses the transmission effects of higher foreign inflation under currency substitution and flexible exchange rates. He employs a money in the utility function model. Both foreign and domestic money enter into the utility function assuming that the currencies are imperfect substitutes and foreign currency provides services that are not provided by domestic money. In a standard model where there is no currency substitution, an increase in foreign inflation would result in an equivalent depreciation of the nominal exchange rate. When currency substitution is introduced into the model, however, an increase in foreign inflation would produce real effects on holdings of foreign balances, on the demand for domestic real balances and domestic inflation. The transmission of foreign inflation to domestic inflation depends on the elasticity of demand for foreign currencies. If it is sufficiently elastic,

¹³ Miles (1978), pp.432.

an increase in foreign inflation would lead to an increase in demand for domestic money and a decrease in the demand for foreign money. With domestic money supply unchanged, this implies a rise in the domestic price level until the excess demand is eliminated. In that case there is a positive relationship between the domestic and foreign inflation. However, if the demand for foreign currency is inelastic, the foreign inflation may be transmitted negatively under flexible exchange rates and currency substitution. In that case, the accumulation of domestic real balances lowers the velocity of money, and with output and nominal money growth unchanged leads to a lower rate of domestic inflation. Thus, as the degree of currency substitution increases, the flexible exchange rate system becomes closer to a fixed exchange rate system in the sense that higher inflation is positively transmitted. His model implies that the domestic country could experience a diminished ability to insulate domestic inflation from foreign shocks in a flexible exchange rate regime under currency substitution. He reports that for a small open economy with flexible exchange rates a degree of insulation from foreign economic shocks could be lost in the presence of currency substitution.

Similarly, Brillembourg and Schadler (1979) argue that in the extreme case of perfect currency substitution, the relative attractiveness of the strong currency will eliminate the demand for the weak currency, which is expected to depreciate¹⁴, and the exchange rate between the two will be indeterminate. They assume that the international portfolio consists of three types of assets, currencies, bonds and commodities. The change in holding of any asset is assumed to be equal to the weighted average of the difference between the desired levels of assets and a proportion of change in wealth. Assuming the purchasing power parity holds among currencies, the value of all assets is expressed in terms of a common currency. After defining real assets in the portfolio, the general portfolio model is converted into an exchange rate determination model, where changes in exchange rate depends on

¹⁴ Gresham's law can apply where different currencies coexist in an integrated economy under fixed exchange rates. Fluctuations of their relative valuation affect their circulation, which could lead to instability in the demand for money functions.

changes in real domestic money supply, changes in holdings of currencies and changes in wealth. The model is estimated for eight industrialized countries and it is found that there is a close complementarity among European currencies and the US dollar is the substitute currency for them. The complementarity among European currencies implies that investors tend to view these currencies as a group. Thus, Brillembourg and Schadler (1979) conclude in favour of policy coordination among European countries on the grounds that any coordinated action on the part of European countries would be expected to have longer impact on each currency than the same action taken by an individual country.

McKinnon (1982) explores empirically and theoretically the phenomenon of international inflation transmission in a currency substitution framework. He questions how far one can define meaningful monetary aggregates in the presence of currency substitution and argues that this leads to a loss of monetary control with the result that the world money supply may be more relevant for the determination of the domestic price level rather than national money supply. Spinelli (1983), focusing on the work of McKinnon, investigates the proposition that individual countries should not pursue a monetary policy of their own, rather they should cooperate and conduct monetary policy at a 'world' level. He employs a rational expectations version of the Mundell - Fleming model of an open economy. The solution of the model points out that foreign nominal shocks affect domestic variables. Hence flexible exchange rates cannot insulate the domestic economy from developments which occur in the rest of the world. The adjustments in exchange rates to counter unexpected world price shocks result in shifts in money demand functions which, in turn, cause changes in output and price levels. This analysis shows that currency substitution can cause instability in domestic money demand functions. The domestic economy may no longer have full monetary autonomy. It is shown that an open economy can insulate itself from foreign nominal shocks under an extreme set of assumptions but that currency substitution leads to a link between domestic and world prices even under a flexible exchange rate regime. That is, currency substitution is seen as a source of

loss of monetary independence. His analysis shows that both domestic and world monetary variables appear in the price equation at the same time, and he argues that both domestic money and world money affect the domestic price level. Therefore, McKinnon's argument for solely controlling a world monetary aggregate and relinquishing national monetary policies is not supported. Yet cooperation between countries aiming to control a world aggregate is reasonable. However, when discussing the kind of possible coordination, Spinelli criticizes McKinnon's argument in that McKinnon assumes a stable world demand for money. But it is not clear that the stability of world money demand is a sufficient condition for monetary cooperation. McKinnon assumes that the main cause of the monetary interdependence is currency substitution. But there may be other reasons for monetary interdependence such as capital mobility.

It is proposed by several writers that individual countries should give up the independent control of their own monetary aggregates, rather they should cooperate and seek to control a joint monetary aggregate (McKinnon (1982), Miles (1978), Brillembourg and Schadler (1979)). Miles (1978) states that although flexible exchange rates ensure a degree of monetary autonomy, this autonomy is lost in the presence of currency substitution. Most studies have been concerned with the bilateral relationship between the US and Canada. The first study on this issue was the pathbreaking study by Miles (1978), which is outlined in the previous section. Miles (1978) emphasized the instability of money demand under the presence of currency substitution. He regressed the relative demand for domestic and foreign currency by Canadian residents on the ratio of US to Canadian interest rates. His findings indicated that as the opportunity cost of holding US dollars rises, the demand for Canadian dollars rises. He concluded that there was evidence of currency substitution which could undermine monetary autonomy, even with floating exchange rates. Hence, he argued that the proper model for monetary policy should be one of monetary dependence even when perfectly flexible exchange rates are assumed.

Bordo and Choudhri (1982) criticize Miles (1978) arguing that the models

used are incorrectly specified. Instead, they add output to the maximization problem and specify domestic and foreign money demand functions, including real income as an explanatory variable. Currency substitution is measured by the cross elasticity of domestic money demand with respect to the rate of return of foreign money holdings. Their model is estimated for Canada. It is found, in contrast to Miles (1978), that the coefficient on the interest rate differential is insignificant with a wrong sign, implying that there is no currency substitution in demand for M1 and M2. Furthermore, Cuddington (1983) argues that the indeterminacy of exchange rates and the instability or misspecification of demand for money functions might be caused by capital mobility rather than currency substitution per se. He examines the US-Canadian relationship using the portfolio balance model. His results are generally supportive of currency substitution.

Imrohoroglu (1991) and Bufman and Leiderman (1992) employ a dynamic equilibrium model of a monetary economy. In a money in the utility function model, Hansen's Generalized Method of Moments estimator is applied to the orthogonality conditions implied by the Euler equations to estimate elasticity of substitution between currencies. Imrohoroglu (1991) finds modest currency substitution between the Canadian dollar and the US dollar. Bufman and Leiderman (1992) incorporate nonexpected utility to disentangle parameterization of behaviour toward risk and behaviour toward intertemporal substitution. They report that the evidence for Israel supports the notion that liquidity services produced by domestic and foreign money enter as arguments in the representative consumer's objective function. Rogers (1992) finds that dollarization in a high inflation economy such as Mexico is quite strong and significant.

More recently, Ratti and Jeong (1994) examine the dynamic evidence for currency substitution between the US and Canadian dollar, using the dynamic money services model, which was outlined in the previous section. They find, within the context of a cointegrated relationship, that if the real exchange rate value of the Canadian dollar falls then US dollar deposits of non-bank Canadians rise; confirming

the implications of their theoretical analysis. They also include the net trade balance between the US and Canada, as a scale variable and the uncovered interest rate differential. Their findings show that in the long-run the ratio of domestic to foreign money balances responds elastically to the changes in the real exchange rate, indicating the existence of currency substitution between the US and Canadian dollar.

The empirical literature on US and Canadian dollar substitution, suggests that there is evidence of currency substitution between the two currencies, even though its statistical significance is sensitive to the functional specification. However, all the alleged currency substitution is by Canadians and there is no evidence of US citizens substituting currencies.

2.4.2 Gresham's Law

Gresham's law considers the effects of the existence of different monies under a bimetallic standard, where gold and silver coins circulate. With a bimetallic standard the central bank freely exchanges at a fixed nominal price the two metals for money. Gold and silver are traded in the nonmonetary market as well, where the new supplies of both metals are sold. A condition for equilibrium between the monetary and nonmonetary markets is that the official parity that the central bank sets should equal the relative price of the two metals in the non-monetary market.

However, when there is, say, an increase in silver ore production, which makes silver cheaper in the non-monetary market, the relative price of two metals will differ from the official parity. Economic agents can make profit when they buy gold from the central bank at the official parity to resell it in the non-monetary market. Then, the bad money will drive out the good, as the superior coins, gold, are taken out of circulation.

In a world of fiat currencies, however, the opposite tendency would prevail. Stronger fiat currencies would tend to drive out weaker ones, which McKinnon (1996) terms as Gresham's Law II. The main implication of Gresham's Law II for fiat currencies is that, whenever different currencies coexist in an integrated economy

under fixed exchange rates, fluctuations in their relative value affect their circulation. "This in turn can give rise to instabilities, usually caused by the inability of monetary authorities and the banking system to accommodate these demand fluctuations fully: there is always a limit beyond which central banks cannot run down their reserves or cannot increase their borrowing from other central banks and the banking system."¹⁵

Several authors (Girton and Roper (1981), Kareken and Wallace (1981), Veil (1990)) have emphasized Gresham's Law II, while they investigate the determination of exchange rate under the presence of currency substitution. They find serious problems of exchange rate instability, when economic agents hold two different currencies, which circulate in parallel. A few examples to this unstable situation can be given: US dollars circulate in parallel with the domestic currency in certain Latin American countries such as Peru and Argentina, and did circulate in parallel with shekels in Israel in the late 1970s and early 1980s. The main reason for the dollarization in these countries has been the extremely high rates of inflation which has made the domestic currency unattractive as a store of value. The dollarization process generally begins when the foreign currency replaces the domestic currency as a store of value, as agents hold most of their financial savings in the form of foreign currency denominated deposits. In cases of hyper inflation the domestic currency is generally replaced by a foreign one, often the US dollar, which reduces transaction costs as the real cost of holding domestic currency becomes extremely high. At that stage many prices begin to be quoted in a foreign currency, making it a medium of exchange. Cuddington (1989) called this phenomenon currency displacement to distinguish it from currency substitution.

McKinnon (1996) argues that when governments pursue an inflation tax policy, dollars should not be permitted to circulate in parallel with the weak domestic currency as a medium of exchange. Because economic agents will tend to abandon the taxed domestic currency which is depreciating in favour of the untaxed foreign currency thereby reducing the inflation tax base. For any given level of inflation tax

¹⁵ Giovannini and Turtelboom (1994), pp.403.

rate, the revenue from the inflation tax would be lower in the presence of currency substitution as the demand for domestic currency would be sensitive to the inflation tax rate. Then the government would need a higher level of inflation tax in order to finance its otherwise uncovered fiscal deficit. McKinnon (1996) suggests that government should impose exchange controls to prevent such currency displacement and erosion of the government's tax base.

Alternatively, governments can institutionalize direct currency substitution by allowing domestic residents to hold foreign monies freely while standing ready to purchase the most important one at a fixed rate of exchange. In that case, the outstanding domestic money supply is endogenously determined, as domestic money is injected into the economy in response to private demand for it at a fixed exchange rate. Thus the monetary authorities give up pursuing an independent monetary policy and cannot rely on inflation tax to finance the fiscal deficit. Then the domestic economy can benefit from the operation of Gresham's Law II.

2.4.3 Exchange Rate Determination

Several models have been developed to analyse exchange rate determination capturing the effects of currency substitution. It is assumed that residents of any country can allocate their monetary holdings across various currencies. When a currency depreciates substantially, portfolio holders can be expected to replace it with a stronger currency, and this leads, in case of perfect currency substitution, to exchange rate indeterminacy. Furthermore, in the presence of perfect currency substitution, the response of the real exchange rate to changes in domestic and foreign monetary policy is not clear. As currency substitution increases, the exchange rate becomes unstable since the movements in the exchange rate necessary to maintain monetary equilibrium become larger.

Girton and Roper (1981) presented within the framework of an asset demand model the first comprehensive study of exchange rate determination under the presence of currency substitution. The model of currency substitution contains two

money demand functions which, together with exogenous money supplies, are used to analyse the exchange rate. Currency substitution can be modelled by the inclusion of real returns on both monies in both money-demand functions. Defining r^1 and r^2 as the anticipated real returns on monies one and two, the demand for real balances can be expressed as

$$\frac{M^k}{P^k} = L^k(r^1, r^2, r, w), \quad (k=1,2) \quad (2.52)$$

where M^k is the money supply of currency k , P^k is the price level in terms of currency k , r is the anticipated real return on nonmonetary asset and w is the wealth. They assume that the money demand functions of home and foreign country have exponential specifications. The equilibrium condition for currency one is,

$$\frac{M^1}{P^1} = \theta_1(w) \exp[\alpha_1(r^1 - r) + \sigma_1(r^1 - r^2)], \quad \alpha_1, \sigma_1 > 0, \quad (2.53)$$

where σ^1 is the coefficient of substitution between the two monies and α_1 is the coefficient of substitution between money one and the nonmonetary asset. The monetary equilibrium conditions in logarithmic form are

$$\ln M^1 - \ln P^1 = \ln \theta_1 + \alpha_1(r^1 - r) + \sigma_1(r^1 - r^2) \quad (2.54)$$

$$\ln M^2 - \ln P^2 = \ln \theta_2 + \alpha_2(r^2 - r) + \sigma_2(r^2 - r^1). \quad (2.55)$$

The implications of currency substitution can be obtained by focusing on the relative values of the two monies. To find the expression determining the relative value of the monies, subtract equation (2.55) from equation (2.54), and rearrange terms to obtain

$$\ln\left(\frac{P^1}{P^2}\right) = \ln\left[\left(\frac{M^1}{\theta_1}\right) / \left(\frac{M^2}{\theta_2}\right)\right] - \alpha(r^1 - r^2) - 2\sigma(r^1 - r^2) \quad (2.56)$$

where the following restrictions are imposed: $\alpha = \alpha_1 = \alpha_2$ and $\sigma = \sigma_1 = \sigma_2$.

By using the PPP assumption that $e = \ln(P^1/P^2)$, equation (2.56) can be represented as

$$e = e^* - (\alpha + 2\sigma)(r^1 - r^2) \quad (2.57)$$

where e is the logarithm of exchange rate. The exogenous money supplies and demand factors are contained in term $e^* = \ln[(M^1/\theta_1)/(M^2/\theta_2)]$. Assume that the real anticipated returns are the differences between nominal returns, i^1 and i^2 respectively, and anticipated inflation rates; and that the rate of change in exchange rate, x , equals, in accordance with PPP, the differential between the anticipated inflation rates of the two monies. Then equation (2.57) can be rewritten as

$$e = e^* - (\alpha + 2\sigma)(i^1 - i^2 - x). \quad (2.58)$$

Equation (2.58) implies that currency substitution causes exchange rate instability and perfect currency substitution leads to indeterminacy of the exchange rate. Firstly, the changes in supplies of monies have a proportionate effect on exchange rates for all finite degrees of currency substitution. As $\partial e / \partial e^* = 1$ indicates. Furthermore, when the effect of a change in the anticipated rate of change of the exchange rate is considered, $\partial e / \partial x = \alpha + 2\sigma$, which means that as the degree of currency substitution increases, the change in the exchange rate to maintain equilibrium also increases. Currency substitution increases the impact of the rate of change in exchange rate, x , on the exchange rate, e , but leaves the impact of money supplies on the exchange rate unaffected, so that exchange market intervention in order to offset the shifts in the anticipated changes in the exchange rate becomes less effective. That is currency substitution is found to produce instability because changes in the expected rate of depreciation of the currency lead to larger movements in exchange rates.

Following this line of argument, Calvo and Rodriguez (1977), Engel (1989), Guidotti (1989), Weil (1991), Woodford (1991) and Canzoneri, Diba and Giovannini

(1992) investigate theoretically the effects of currency substitution on exchange rates. Calvo and Rodriguez (1977) show that the real exchange rate depends on the rate of monetary expansion in the short run but it is determined by real variables in the long run. They demonstrate that an increase in domestic money growth causes an immediate real depreciation of the currency. Weil (1991) argues that the likelihood of hyperinflation will increase with perfect currency substitution. He also shows that high currency substitution can lead to multiple rational expectations equilibria. Canzoneri, Diba and Giovanini (1992) report that with perfect currency substitution, a perfect foresight equilibrium would be indeterminate, and equilibrium would not exist under either a fixed or a flexible exchange rate regime. Moreover, they agree with Weil in that the likelihood of hyperinflation increases as the degree of substitution between currencies increases, because then no currency will ever be essential for transactions.

2.4.4 The Demand for Money

The concept of currency substitution first attracted attention in the late 1970s. Although, money demand functions had been assumed to be stable, this had seemed to break down in the 1970s as empirical evidence which exhibited instability in the demand for money functions was obtained both in the UK and in the US. Instability refers to three interrelated features. First, errors of prediction occurred when the data for the 1950s and 1960s were used in predictions of money demand in the 1970s (Artis and Lewis (1974), (1976)). Secondly, in partial adjustment models¹⁶, when data for the 1970s were included in the sample, the coefficient of the lagged dependent variable changed, implying that there had been some change in the nature of the adjustment process. Finally, in order to accommodate additional data from the 1970s, some studies resorted to including variables which were not previously included in similar studies, or adding dummy variables (Grice and Bennett (1984) and Taylor (1987)).

¹⁶ See Chapter 4 for a brief discussion of partial adjustment models.

For the US, the instability in the money demand function first emerged in the years 1972-1974 when the demand for money began to grow much more slowly than would have been expected on the basis of previously satisfactory formulations of the demand for money functions. This development was termed as the case of missing money where instability in previously satisfactory specifications of demand for money functions were observed, and it was followed by an upward shift of the demand for money in 1981-1982. In the UK, there was a large expansion of money in 1972-1973 (and subsequently in the late 1980s), which was termed as the great velocity decline. The decline in velocity in the early 1970s coincided with the release of lending controls and alterations to the required reserve ratios.

There have been several attempts to explain the instability in the demand for money functions. One line of argument was misspecification of the demand for money functions. Some authors attributed the observed instability to the inadequacy of the available techniques to cope with the data generated in the 1970s and 1980s. Others suggested that, although the relationships might have been properly specified in the 1950s and 1960s, there had been institutional changes in the 1970s and 1980s which should have been taken into account. Some authors, like Brittain (1981) and McKinnon (1982), on the other hand, attributed this instability to currency substitution and called for co-operation to target a 'world' monetary aggregate rather than focussing solely on national aggregates.

In the 1980s, especially in ERM countries, financial innovations and deregulations accelerated, increasing both the liquidity of and the returns on financial assets. Information and transaction costs were lowered due to the strong development in computer technology during the last two decades. As international integration increases, economic agents can hold their money balances across various currencies. "The exchange rate stability ensured by the ERM, together with the progress towards EMU, enhances the scope for currency substitution within the area. Apart from the limited use of foreign currency to carry out domestic transactions (currency substitution *stricto sensu*), exchange rate stability fosters the holdings of

transaction balances in foreign currencies for spending abroad and, more generally, the holding of (monetary) assets denominated in foreign currency".¹⁷

Additionally, financial integration results in foreign economic variables, such as foreign interest rates or money, affecting domestic money demand functions, and making policy interdependence among countries more important. Thus currency substitution and increased policy interdependence strengthen the links between the money demands of closely integrated countries, and will tend to make estimated national money demand functions unstable as national money demands are influenced by foreign economic variables which are seldom included in the money demand specifications.¹⁸ Monetary authorities operate in a context of imperfect information and thus cannot precisely identify the nature and the extent of currency substitution, which would become a source of instability in national money demand functions. However, as shocks caused by currency substitution are negatively related, while individual money demands are more unstable, the total or area-wide money demand should not be affected by the shocks and will become more stable relative to individual country money demands.

Several empirical studies have investigated currency substitution in the context of policy coordination in EU countries. The indirect measurement of currency substitution through the relative stability of supranational versus national monetary aggregates has attracted a lot of attention recently. Among others, Angeloni, Cottarelli and Levy (1991), Kremers and Lane (1990), Lane and Poloz (1992), Monticelli and Strauss-Kahn (1993), Artis, Bladen-Hovell and Zhang (1993) and Cassard, Lane and Masson (1997) have investigated whether in the light of currency substitution an EU wide money demand function could be more stable than the national money demand functions. An account of these studies is given in Chapter 10 where an EU-wide demand for money function is estimated. Rather than going into the details of these studies, we just report here that most conclude in favour of a

¹⁷ Monticelli and Strauss-Khan (1993), pp. 347.

¹⁸ This issue is examined in Chapter 3.

stable and well-specified European money demand function. Then, if the currency substitution hypothesis is true, the case for EMU, which requires the adoption of a common monetary policy by a European Central Bank and provides a basis for an EU wide policy targeting, will be strengthened.

A second line of literature argues that as traditionally defined monetary aggregates neglect cross-border deposits, EU-wide monetary aggregates ignore a potentially large source of currency substitution which may exist. It is argued that the exclusion of CBDs may introduce misspecifications and constitutes a major difficulty in the investigation of regionally broader definitions of money. The empirical studies of Angeloni et al (1991), Giucca and Levy (1992) and Monticelli (1993) examine the informativeness of extended monetary aggregates compared to traditional monetary aggregates, for EU countries. They argue that the increasing degree of currency substitution between European currencies could produce higher volatility in aggregates which may impair the usefulness of monetary aggregates as policy indicators. Angeloni et al. (1991) examine empirically whether CBDs affect the role of monetary aggregates as policy indicators. They argue that CBDs are relevant for the stability of money - income relationship, since currency substitution leads to the instability of traditional monetary aggregates. Therefore, they suggest to redefine the traditional monetary aggregates so as to include CBDs. However, Giucca and Levy (1992) report that it is difficult to discriminate between traditional and extended monetary aggregates on the basis of their informational content. Furthermore, Monticelli (1993) investigated the economic properties of extended monetary aggregates and compared them with traditional ones within the context of EU countries. He found that extended monetary aggregates perform differently according to the definition. Very broad measures are found to be poorly linked with EU income. On the other hand, extended aggregates defined on the basis of currency of denomination performed well. However, none of the extended aggregates outperformed the traditional monetary aggregate, contrary to the findings of Angeloni et al. (1991).

Although empirical studies give contradictory results about the importance of CBDs, it still seems reasonable to include them in the definitions of monetary aggregates to avoid double counting or exclusion of some items when monetary aggregates are summed. Furthermore, the extended monetary aggregates can be expected to become stable when compared to the traditionally defined monetary aggregates as they include foreign currency deposits of residents which tend to fluctuate when there is a change in the foreign economic variables. This issue is explored in Chapter 3, where the advantages and disadvantages of cross-border monetary aggregation are investigated.

2.5 Conclusion

The concept and definition of currency substitution and some measurement issues are addressed in this chapter. Furthermore, after giving an account of the theoretical models of currency substitution the implications of currency substitution on the conduct of monetary policy, exchange rate determination and the stability of money demand are surveyed. It emerged that there is little consensus about the definition of currency substitution, but it is generally agreed that certain categories of cross-border deposits, which could represent currency substitution, should be included in the traditional monetary aggregates in order to prevent any misspecification.

As far as policy implications are considered, under the presence of currency substitution, flexible exchange rates do not insulate the domestic monetary policy from developments occurring in the rest of the world, and the independence of monetary policy becomes impossible. In terms of exchange rate determination, currency substitution will cause exchange rate instability and perfect currency substitution will lead to indeterminacy of exchange rates. Furthermore the likelihood of hyperinflation increases as the degree of currency substitution increases.

Currency substitution and financial integration, especially among EU countries, strengthens the links between the money demand functions of closely related EU countries, affecting both the specification and the stability of money

demand functions. In the context of EU countries, since currency substitution brings instability to national money demand functions, a common EU - wide money demand function could be stable. Therefore, a common monetary policy for EU countries could be reasonable as financial markets integrate and financial liberalisation takes place.

CHAPTER 3

CURRENCY SUBSTITUTION and CROSS-BORDER MONETARY AGGREGATION

3.1 Introduction

The issue of currency substitution has attracted a lot of attention in recent years, as the intensity and rapidity of the transmission of monetary impulses across countries has increased due to the high degree of economic integration within the EU, and progressive lifting of constraints on capital flows. Moreover, the financial innovations and adoption of new technologies have made the movements of funds and transfer of information across markets more rapid and less costly. These developments have led economic agents to have access to a wider set of financial instruments, allowing rapid portfolio shifts at low cost.

Since exchange controls have been eliminated in a majority of EU countries, it is relatively easy for people to switch from one currency to another if they find foreign interest rates more favourable, or they expect a depreciation of their own currency. Thus, if there is currency substitution in any economy, monetary policy will be affected by foreign economic variables, which may lead to the loss of monetary independence and instability in the national demand for money functions. In the context of EU countries, this implies that individual EU countries can not have independent monetary policies if people tend to switch between currencies when there is a change in the economic policies of another EU country. In that case, conducting a common monetary policy could be a feasible alternative and the area-wide monetary aggregate would be expected to be more stable than national aggregates. Then the European Central Bank would be able to use this broad monetary aggregate for the EU as an intermediate target variable for a European money supply policy.

In this chapter the issue of currency substitution and the reasons which may lead to it will be discussed. Since the discussion of the theoretical underpinnings of

currency substitution is just a discussion of the theory of money demand in an economy where different currencies coexist, it could be useful to begin by asking what is money, what are its functions and why it is held. The outcome of this investigation, then, could shed some light to why people hold different currencies in their portfolios.

The chapter is organized as follows: in section 3.2 the definition of money is discussed. Section 3.3 investigates why money is held. Some basic approaches to the determinants of money demand are discussed in section 3.4. In section 3.5 the reasons for currency substitution are analysed, and the concept of the extended monetary aggregate is introduced. It is argued that an EU-wide extended monetary aggregate would be stable and worth estimating using aggregated data. Accordingly, the advantages and disadvantages of aggregation are analysed in section 3.6. Finally section 3.7 concludes.

3.2 What is Money?

The proper definition of money has been a controversial issue in monetary economics and views have changed over time as financial markets and institutions have developed. In Walrasian general equilibrium analysis, where a central authority facilitates the trading plans of the agents and determines the exchange rate for each commodity, money can be defined as any commodity which could be exchanged for any other. It is assumed that there exists an organized market where all commodities are acceptable in exchange. The real Walrasian system has all prices determined at once, and the umpire and the auction replace money. Hence, there seems little reason to hold a specific money of the conventional kind.

When generalizing from Walrasian analysis to the real world of sequential trading, transactions take time and there is considerable uncertainty. The system requires a double coincidence of wants of agents as well as the timing of the transaction. It is possible to overcome the double coincidence of wants if the Walrasian general equilibrium system is substituted by an economic system with

independent markets in each of which units of one particular commodity is designated as a means of payment. Hence, in this context, money can be defined as all classes of commodities that serve as a means of payment in organized markets. In such systems people tend to use one good as a common means of payment or more widely accepted goods, which have a broader and more stable market than others.¹ However, the transactions may still take a long time as an individual would go to more than one market and would have to use more than one means of payment in order to achieve his final transaction. Such barter arrangements would be too complicated and they could restrict the opportunity for exchange so severely that little progress could be made towards a complex exchange economy without the introduction of a medium of exchange.

One solution to the difficulties of this system could be the introduction of one common commodity which could be used as a means of payment in all organized markets. Once such a medium is introduced the double coincidence of wants in a barter economy is eliminated. The single transaction of barter is decomposed into two separate transactions of sale and purchase. Furthermore the introduction of the common means of payment separates transactions in time. The common commodity can be held over time, which follows from its general acceptability. Hence this common commodity has to be a store of value by virtue of its use as a medium of exchange, which creates an asset function of money. Moreover, the use of a common commodity also solves the uncertainty problems to some extent. Agents no longer worry about the acceptability or the qualities of the means of payment in their transactions.

It can be argued that all exchangeable commodities could be defined as media of exchange since they serve to pay for at least one commodity. But money is the only means of payment for all commodities, because it is accepted in every exchange transaction. As Clower (1967) suggests "money buys goods and goods buy money, but goods do not buy goods". So we can define anything which functions as a

¹See Goodhart (1989).

medium of exchange as money. Newlyn (1962) notes that the necessary condition for the performance of this exchange function is general acceptability in settlement of debts. In a modern economy a great part of payments is facilitated by credit and/or debit cards. The payment is not made by the transfer of some physical entity, but by the alteration of a financial relationship.

Credit and debit cards are generally used in transactions, but their use does not complete the payment, they are only a part of a payment transaction. With a debit card there is a transfer of deposits and it is the deposits which are the means of payment. With a credit card, the vendor receives deposits from a bank which extends credit to the purchaser; the purchaser subsequently repays the credit with deposits or currency. Therefore the transaction could not be completed unless the deposits are transferred to the vendor's account in the case of a debit card, and purchaser repays the credit to the bank in case of a credit card. However, when cash is paid in a transaction, it is complete.

As transfers of bank deposits are accepted in settlement of a debt, and credit and debit cards can be used as a means of payment, bank deposits should also be included in the category of money. Although it is generally agreed that demand deposits should be included in the money definition, there has been some consideration as to the inclusion of time deposits in the money definition. Laidler (1969) argues that the crucial point is the costs involved in transformation of time deposits into demand deposits. If these costs are too great to make time deposits suitable for use as a temporary means of purchasing power, then they could not be included in the money definition. However, it can be argued that these costs have been decreased to a low level as financial innovations take place. Hence, time deposits could also be included in the money definition.

3.3 Why People Hold Money

One of the main problems of monetary economics has been the use and the holding of money. It has been questioned over time why people hold money which adds

neither to utility nor to wealth. Brunner and Meltzer (1971) argue that the solution of this problem is central to understanding of the difference between the monetary and nonmonetary, barter, economy. It can be argued that holding money depends on expected price and interest changes, uncertainty or liquidity services that money provides. Alternatively, one can approach the issue by looking at different motives for holding money and these motives will depend on the functions that money performs. Our previous analysis indicates that money serves as a medium of exchange and a store of value. Another function generally performed by money is that of acting as a unit of account in transactions. But it is neither necessary nor sufficient that the unit of account corresponds with the monetary unit, it is possible to have a unit of account which does not exist in a monetary form, such as guinea².

Keynes put forward three motives for holding money:

- i) Transactions motive: Agents need money for their current transactions of personal and business expenditure,
- ii) Precautionary motive: a) Economic agents hold money to provide for contingencies which require sudden expenditure and for unforeseen opportunities of advantageous purchases,
b) Agents hold an asset the value of which is fixed in terms of money.
- iii) Speculative motive: the agents hold money in order to secure profit or avoid losses, according to their expectations about price and interest rate changes.³

Brunner and Meltzer (1971) argue that Keynes bases his motives for holding money on the principal arguments advanced by previous studies. "The main arguments, used alone or in combination, invoke 1) time, 2) uncertainty, 3) lack of synchronization of receipts and expenditures, 4) costs of transaction, and, 5) the existence of nonpecuniary returns".⁴ Gilbert (1953), on the other hand, proposes that

²A guinea is formerly the sum of twenty-one shillings (now £1.05) which was used in stating prices of goods professional fees, charges and subscription, etc.

³See Newlyn (1962).

⁴Brunner and Meltzer (1971), pp.785.

the demand for money is determined by three causes, in order of importance, 1) uncertain foresight, 2) costs of investment and 3) desire for leisure.

It appears that time and uncertainty are the key elements in both lists. As every action takes time, which is limited, people would like to spend the minimum possible amount of time for their transactions and gathering information about the market prices, asset prices and availability of commodities. Additionally, there are investment and information costs involved in this process, which are a function of uncertainty. Furthermore, since we do not live in a static timeless economy, the synchronization of receipts and expenditures would not be possible. Thus in this section uncertainty and time are analysed.

3.3.1 Uncertainty

One of the most important functions of money is that, it acts as a specialized means of payment and it is used for the settlement of the transaction. Goodhart (1989) distinguishes the functional definition of money as a "means of payment" from the concept of an asset as a "medium of exchange". In order for an asset to be medium of exchange its transfer to the seller should allow a sale to proceed. However, when a medium of exchange which is not a means of payment is given to the seller, the transaction would not be complete as the seller would think that he still has a valid claim for future payment against the buyer or against a third party. The medium of exchange in any economy exists with time dimension. Transactions do not necessarily take the form of contemporaneous exchanges of commodities, but a medium of exchange could be accepted with which the current goods could be exchanged for future claims of payment.

In a world of certainty where every individual has perfect knowledge about all relative prices, quality of the goods and services, and it is assumed that all transactors are honest and all debts are paid in the certain future, there would be no need for a means of payment as all transactions would be conducted through a medium of exchange which would then become the means of payment. Thus all

market activity would simultaneously be arranged in the initial period.

However, transactors could not possibly have perfect knowledge about markets, commodities, relative prices and honesty of all market participants. There is uncertainty about the future paths of relative prices of commodities, about the identity and location of the other transactors and the quality of the goods offered. In order to obtain information about relative prices and quality of the commodities one has to collect information before making transactions; this is shopping. But this involves time and resources, and thus is costly. If we assume that the individual divides his time between production, consumption, shopping and executing transactions, the more time he spends with information gathering, the less he will be able to produce, consume or make transactions. Hence, "the use of a medium of exchange permits the household to economize on the amount of resources absorbed by these activities and enjoy a larger and more diversified basket of goods and more leisure".⁵

Furthermore, people hold money simply because they do not have perfect foresight. It can be argued that the store of value function of money depends upon uncertainty about future events. Since it serves as a temporary abode of purchasing power, it enables economic agents to delay transactions, and helps them to be prepared for the future. Hence money is stored to meet unforeseen contingencies. In that sense money is held for convenience and security, which is entirely related to the precautionary motive that Keynes proposed. He suggests that people find it prudent to hold some cash in case they are not able to realize other assets quickly enough to be of use to them for those classes of payments that cannot be considered regular and planned, such as paying unexpected bills, making purchases at unexpectedly favourable prices, and meeting sudden emergencies caused perhaps by accidents or ill health. People could hold financial assets instead of money for precautionary purposes. But money is liquid, whereas they have to transfer assets into money in

⁵Brunner and Meltzer(1971), pp.786.

case of an emergency. This process could be costly and could involve time. Therefore, agents are likely to hold a part of their wealth as money for precautionary purposes, although they can diversify their holdings by dividing their wealth among money and other financial assets according to the risk and return associated with each of them.

One of the reasons why people hold money when rates of interest are positive, could be the existence of uncertainty as to the future capital value of interest bearing assets. People are likely to hold money as a precaution against uncertain capital values of all financial assets other than money, which is the second element in Keynes' precautionary motive. In order to understand why people hold money, it is worth examining how asset-price uncertainty affects the portfolio distribution between risky assets, such as bonds, where the return over the holding period is uncertain, and a safe asset, such as money, which has a certain return. Uncertainty of the money value of bonds presents an investor with the prospect of capital gain or capital loss. Following Tobin, it can be argued that the investor is concerned with the mean and the standard deviation of the risk and return which act as proxy for a subjective probability distribution of the likely returns. Furthermore, expectations of the transactors play an important role at this point, such that they choose between money and a risky asset according to the expected risk and return criteria. Assuming that the expectations are neutral, a positive yield would be enough to induce investment in risky assets. The greater the yield the more investment would be made, suggesting that demand for money is negatively related to the interest rate. Goodhart (1989) notes that the great advantage of Tobin's reformulation of the theory of liquidity preference is that he linked it firmly to uncertainty about future asset prices, and thus provided a rationale for portfolio diversification, beyond transaction costs. Furthermore, this analysis can be extended to a broader analysis of portfolio choice where the investor can hold a range of risky assets and possibly one safe asset (Goodhart (1989)).

Although this analysis could be valid for large companies, generally agents

could not switch from money to other risky assets easily. This process involves time and there are switching costs. Firstly, since a great part of the population receive incomes on a regular basis, they have to arrange their expenditures and then their investments in that period of time, which is generally a month. In such a short period of time it would be difficult to switch to a risky asset. There are intermediary costs as well as personal costs involved. However, if the switching costs between money and alternative assets, that is the marginal cost of investment, are lower than the additional interest which could be obtained, then transactors would hold assets rather than money. Furthermore, transactions costs could become relatively less important, if the intended period for holding assets is long. Thus people would tend to hold that amount of money which would enable them to make their transactions with minimum cost. This approach forms the basis for the transactions demand for money that Baumol (1952) constructed.

Although the return from the risky asset would not be known and exactly predicted, people can form an expectation about it by examining mean and variance of expected return.⁶ Economic agents' decision as to which assets they should invest in depends on their attitudes towards risk. Depending on whether they are risk averters or risk lovers their actions differ. This analysis relates the decision of holding money or an alternative asset to the uncertainty about future asset prices. Keynes proposes that the uncertainty of the future rate of interest is the basis for the speculative motive for holding money. He argues that the necessary condition for holding money as a store of value is the existence of uncertainty as to the future rate of interest. Investors, who were treated as holding completely confident expectations about the future yield on the risky assets, hold money because they wish to avoid an expected loss on bonds. This approach is contrary to Tobin's reformulation of the liquidity preference theory where investors have no specific expectations but wish to avoid the uncertainty of return.

In every economy there is always uncertainty about the future pattern of

⁶See Goodhart (1989).

relative prices, quality of the commodities and honesty of the transactors. The use of money as a medium of exchange reduces time allocated to search and to obtaining information. Agents reduce the number of transactions in which they engage in order to exchange commodities and services. Money provides a security for unforeseen events, reducing uncertainty.

3.3.2 Time

It can be argued that one of the fundamental reasons for holding money is the existence of time. Money as a medium of exchange could not exist in a model of timeless static equilibrium. In Walrasian general equilibrium models, exchange of commodities take place instantaneously and costlessly. Since any good can be traded directly for another good, all commodities are perfect substitutes as means of payment, there is no need for money as a medium of exchange and means of payment, although one or more commodities could serve as a unit of account.

In a barter economy, where the deals take the form of contemporaneous exchanges of goods and services, money as a medium of exchange can overcome the inconveniences that would exist in this economy. Any series of barter transactions, a transaction chain, could be long and would involve uncertainty. Thus in practice the process of exchange requires the existence of a medium of exchange, generally money, through which goods will be exchanged for future claims to payment. The double coincidence of wants of seller and buyer is removed with the introduction of money, leading to the ease of the transaction process and a reduction in uncertainty.

Furthermore, there is a lack of synchronization between the receipts of income and its outlay, which gives rise to a need for holding cash balances. Since human action takes time, the complete synchronization between income and expenditures is impossible. Transactors generally receive periodic incomes, such as wages paid monthly. But they do not spend their incomes as soon as they receive them, rather they spread their expenditures through time, often over a week or a month. They can use money to even out the differences between income and

expenditure streams. They have to hold money in order to pay their expenses, although holding money involves an opportunity cost in terms of interest foregone. However, if the opportunity cost of holding money is very high, agents may alter their expenditure habits and reduce their holdings of money. Examples of this situation have been seen in high inflation countries, where people have chosen to spend their incomes on goods and services as soon as they receive their incomes, rather than holding depreciating money balances.⁷

However, Brunner and Meltzer (1971) suggest that this argument is valid only in the simple barter economy of the textbooks. Lack of synchronization does not necessarily imply that money is used or held. If there were no costs of information in an economy which does not have money, verbal promises would be enough to adjust the differences between receipts and expenditures, assuming that everyone is honest. In a modern economy, however, it would be impossible to bridge the gap between income and expenditures by promises and commitments. But a system of credit transfers could be carried out and there would be no need to hold cash balances, if the costs of investment were low. Then this credit becomes money.

Moreover, there are costs of exchange which prevent agents from spending or lending money as soon as they receive their incomes and force them to hold money. If an individual has a certain amount of money which is not required for an uncertain future expenditure, he can either lend his money to someone else or he can buy other assets. But these transactions take time, and in a limited time period he cannot quickly switch between money and other assets as there are considerable transfer costs which can be called investment costs. In addition to the individual's time and trouble costs, the intermediary organization which carries out these transactions would incur costs and charge a price for its services. As there are subjective costs which are not priced, such as leisure lost, as well as costs which have market prices, he is likely to hold this money for some minimum period.

⁷Alternatively, people would switch to a more stable foreign currency when switching costs are reasonably low.

"Furthermore if it is assumed that money can be loaned for infinitely short periods of time with certainty of repayment and there are no costs of investment and disinvestment, money will not be held either for certain or uncertain future payments".⁸ Hence periodicity of receipts and expenditures and unforeseen expenditures, which stem from time and uncertainty, explains why people hold money when interest rates are positive.

3.4 The Proximate Determinants of the Demand for Money

Two of the most common justifications for holding money were mentioned the previous section: Money held as a medium of exchange, giving rise to the transactions demand for money; and money held as one of the several possible assets, leading to speculative demand for money.⁹ But in practice agents' demand for money depends on both factors. We can distinguish three approaches to the economic theory of demand for money: One based on the application of the general theory of demand (Friedman's approach); the second is the approach where demand for money arises from its functions (Keynesian Theory) and the third approach treats money as one of the possible alternatives of investment which could be seen as an hedge against the risks in holding other assets (Portfolio Balance Approach). But they are neither incompatible nor contradictory with one another. They are complimentary. Since all theories of demand for money rest on the considerations having to do with uncertainty and the passage of time, these various models could be regarded as leading to one general theory of the demand for money.

Keynes argues that the demand for money arises because of the functions it performs which stem from the motives for holding money, which were outlined in the previous section. The transactions motive for holding money arises to bridge the gap between receipts and planned regular payments, that is to even out differences

⁸Gilbert(1953), pp.151.

⁹For a discussion of determinants of money demand, see Laidler (1993), Goodhart (1989).

between the income and expenditure streams. Since the level of transactions conducted by an individual can be expected to bear a stable relationship to the level of income, the transactions demand for money can be expected to depend on the level of income. Furthermore, Keynes suggested that the demand for money arising from the precautionary motive can also be expected to depend on the level of income. Thus, it can be argued that the aggregate real quantity of money demanded, which is nominal money demand divided by the appropriate price level, is an increasing function of some measure of real transactions. Income and wealth are two common scale variables which are assumed to reflect the volume of transactions. In empirical analysis Real Gross National Product (GNP) and Total Final Expenditure (TFE) are generally used for this purposes.¹⁰

Although agents hold money for transaction purposes, they may trade-off the convenience from holding money against the return from holding other assets, hence making the transactions and precautionary demands for money functions of interest rates. Assuming that agents can choose between holding money, which has a zero or low return, and a bond, which is an asset carrying with it the promise to pay its owner a certain income per annum, fixed in money terms, the decision to buy bonds is a decision to buy a claim to such future stream of income. Changes in the rate of interest involve changes in bond prices and thus result in capital gains or losses for the bond holder, even though the value of money remains unchanged. When the interest rate is expected to fall, bond holders expect to make capital gains in addition to their interest income, which may lead to a relatively low demand for money. Alternatively, when the interest rate is expected to rise, a relatively high demand for money is probably obtained as agents seek to avoid capital losses by holding bonds. Thus as the opportunity costs of holding money increase money demand declines.

Friedman's approach, on the other hand, is to treat the demand for money not as a special matter, but as a particular application of the general theory of demand

¹⁰See Laidler (1993) for a discussion of measuring the variables of the demand for money function.

where money is seen as similar to a commodity. Friedman does not provide any detailed analysis of the motives for holding money, but analyzes what determine how much money people want to hold under various circumstances. He argues that money is held because it yields a flow of services to people and these services become less valuable relative to the services of other assets, as more money is held. The basic concern of this approach is to establish the relevant variables to measure the opportunity cost of holding money and to analyze the nature of the budget constraint. The budget constraint in demand theory defines the maximum amount of the commodity in question that a consumer can buy. In the case of demand for money, the budget constraint determines the maximum amount of an asset which could be held. Friedman argues that wealth is the appropriate constraint on asset holding.¹¹ As in any other application of the demand theory, the demand for money increases when there is a relaxation in the budget constraint, that is there is a positive relationship between wealth and demand for money. The demand for money in the long run is expected to have a unit wealth elasticity, as people cannot hold an amount of assets which exceeds their wealth. Furthermore, the opportunity cost of holding money is defined as the income to be earned from holding bonds, equity and human wealth. The principle of diminishing marginal rate of substitution between money and other assets postulates that if the return on any of the other assets rises the demand for money will fall.

In the portfolio balance approach, money is one of many alternative assets for holding wealth. One of the best known portfolio balance models for money is Tobin's (1958) model, which builds on Keynes's idea that holding money provides a hedge against interest rate fluctuations. The main difference of Tobin's model from that of Keynes is that agents are allowed to hold a diversified portfolio in Tobin's model whereas in Keynes's model they hold either money or bonds, but never hold a combination of the two. Tobin argues that different assets have different expected returns and different degrees of uncertainty associated with their return. But since the

¹¹He provides also a distinction between human and nonhuman wealth.

price of money is assumed not to vary with the rate of interest, it can be seen as a secure asset which protects its holder from risks associated with fluctuations in the rate of interest. Transactors choose a combination of risky assets and money so as to maximize the return they expect from that portfolio, given the rate of interest and riskiness attached to holding different assets. Transactors are expected to choose their portfolio to balance more certain but lower returns with higher but riskier ones, depending on their attitudes towards risk. This approach incorporates wealth rather than income as a scale variable. However, partly because of the difficulty of measuring wealth, the demand for money function in the economy is usually expressed as a function of income. Furthermore, money demand functions contain some measure of the volatility of the alternative assets in addition to their expected returns.

Since the rate of return on holding money is not constant, that is the price level varies, the real value of holding money changes. As rising or falling price levels provide a return on money holdings, the expected percentage rate of change of the price level could be interpreted as an expected own rate of return to money holdings. Then, other things being equal, the higher the expected rate of inflation, the less money will be held. A higher rate of inflation may encourage a substitution into real assets such as housing, consumer durables and capital equipment. "Since money is held for the services it provides its owners, and since these services arise from its being an abode of purchasing power, it follows that the demand function for money we have been discussing is one that determines the demand for money measured in units of constant purchasing power, for real money balances".¹² Since the flow of services from money depends upon real money balances held, a doubling of the price level requires a doubling in demand for money. Thus, Friedman's theory requires homogeneity of degree one in nominal money balances when there is a change in the price level. In summary, a higher rate of inflation would lead to decrease in the demand for money. But when there is an increase in the price level people need to

¹²Laidler (1993), pp. 60.

hold more nominal balances for their transactions.

From this analysis it follows that the demand for money depends positively on a scale variable such as GDP or wealth, but is negatively related to the returns on alternative assets and the rate of inflation. Thus we have:

$$\frac{M^d}{P} = f(I, R, \dot{P}) \quad (3.1)$$

where M^d denotes money demand, P price level, I scale variable, R a vector of interest rates on the alternatives of money, and dot denotes the percentage change in the variable. $f(\cdot)$ is increasing in W and decreasing in inflation, and the elements of R . If we rewrite equation (3.1) in logarithms (lower case variables denote the logarithms), it reduces to a linear form:

$$m^d - p = \alpha + \delta i + \gamma' R + \eta \Delta p \quad (3.2)$$

where Δp denotes inflation. The parameters γ are negative, whereas $\delta=0.5$, under certain assumptions, in Baumol and Tobin's transaction demand theory, or $\delta=1$ in Friedman's quantity theory of money.¹³ There have been controversies in the literature over the magnitude of the income elasticity of demand for money. Goodhart (1989) notes that various econometric studies of the demand for money show a lower income elasticity of demand for a narrow definition of money than for a broad definition including time deposits. Particularly, the estimates of income elasticity of demand for narrowly defined money are frequently lower than unity implying some economies of scale, whereas estimates of income elasticity for broadly defined money are frequently in excess of unity. Alternatively, this could be due to financial innovations and introduction of new financial instruments. However, there is no convincing reason why the income elasticity of broad money should be so high. "If wealth and interest rates were constant, while transactions and incomes in real terms were higher, there would presumably be a greater demand for time deposits as a second line precautionary balance, but it is not immediately obvious why this second

¹³See Baumol (1952), Tobin (1956) and Friedman (1956) for detailed analysis of these models.

line precautionary balance should show a greater elasticity than demand deposits. The greater likelihood is that the estimated higher income elasticity of time deposits really is a reflection of a much higher wealth elasticity, and that the basic income elasticities of both monetary definitions are less than unity".¹⁴ It can be argued that the wealth elasticity of safe assets which dominate non-interest-bearing money balances may be greater than unity. As no crucial point of macroeconomic analysis rest on this issue, monetary policy can be equally effective whether that income elasticity of demand for money greater or less than unity, as long as the functional relationship is stable and predictable.

3.5 Currency Substitution

Up until now, we implicitly considered a domestic economy where there has been no foreign influence. Economic agents were presumed only to hold domestic currency, and the possibility of holding foreign currencies was not considered. But in many economies large companies, banks and some persons tend to use different currencies in their transactions and hold different currencies and assets denominated in several currencies in their portfolios. This phenomenon, that is holding different currencies or the replacing of domestic currency by foreign currencies is called currency substitution. The concept of currency substitution, its alternative definitions and the measurement issues are discussed in Chapter 2. This section, on the other hand, examines the reasons for currency substitution, emphasizing the motives for holding money, which are discussed in the previous sections.

When the reasons for currency substitution are investigated it is useful to start from the functions that money performs and the motives for holding it which were discussed in the previous sections. It is argued that anything which functions as a medium of exchange could be used as money. For this it is necessary that the asset in question should be a store of value, that is it maintains purchasing power. It does not necessarily mean that it maintains 100 per cent value, but needs to be store of

¹⁴Goodhart (1989), pp.90.

value to some extent at least in the short run. Hence, it carries value across both time and space. It is convenient that it acts as a unit of account, thus easing the calculation of prices. Keynes proposed the three motives for holding money of transactions, speculative and precautionary motives. Although these can be seen as stemming from the existence of time and uncertainty, it will be useful to keep these motives in mind when starting to discuss why currency substitution takes place.

The degree of substitutability of different currencies in investors' portfolios will depend on the differences in the services of transactions, store of value and unit of account services that the currencies provide. Accordingly, in this section the determinants of currency substitution will be examined by distinguishing the possible differences in the three traditional functions that each currency provides.

The degree of transaction services provided by a currency is determined by the degree to which this currency is used as a medium of exchange or means of settlement. A particular currency becomes more acceptable as more economic agents use it as a medium of exchange. But the question is what makes the transaction services of a currency different from those of another currency. Residents of a country would tend to use the national currency, since most purchases of goods and services are made locally by the residents of the same country, and exchanging one currency for another is generally costly. Furthermore, agents are often forced by governments to use domestic currency, which is the legal tender, for paying taxes.

Hence, it can be argued that the combination of habit and national restrictions make currencies imperfect substitutes. However, there may be exceptions. When local markets are limited relative to the volume of international trade, it would be convenient to use a widely-circulating medium of exchange. Then the more a currency is used, the more it will be acceptable.¹⁵ This follows from the fact that the more a currency is used, uncertainty about the acceptance of this currency will diminish. In that sense currency substitution reduces uncertainty, and also the time and resources allocated for information gathering. The use of the US dollar in world

¹⁵This is the mechanism underlying in the establishment of vehicle currencies.

trade can be given as an example.

People can hold foreign currency and foreign currency denominated assets, as well as domestic ones, in their portfolios as stores of value. In order for different currencies to be included in portfolios together with other assets, the currencies should provide liquidity services. Portfolio balance models start from the proposition that agents hold different assets in their portfolios according to rates of return and riskiness of the total portfolio. The degree to which a currency provides liquidity services varies from country to country, depending on the degree of financial sophistication and capital market liberalization in each country. Hence the currency of the country the financial system of which provides competitive rates on deposits and charges competitive rates on loans, and offers a diversified range of services, is likely, *ceteris paribus*, to be substituted for the domestic currency of a country where these things do not prevail.

It can be argued that the reasons behind the store of value substitutability can be related to the uncertainty of future levels of prices, interest rates and exchange rates. Transactors tend to substitute currencies if they want to hedge against potential exchange rate changes. If they expect favourable foreign interest rates in the future, they would hold foreign currency deposits. They may also want to reduce the adverse effects of inflation in their country by using foreign currency in their domestic transactions.

Economic agents' habits could be the only determinant of the substitutability of the unit of account, as little is known about the unit of account function of monies. "The more people are used to operating in different currencies to settle transactions, the more these currencies' unit of account services will be substitutable".¹⁶ Furthermore, a currency could become substitutable as a unit of account when the stability of the price level is not strong. In countries where inflation is very high, agents could use another, more stable, currency as a unit of account. Since there are uncertainties about the future levels of inflation, it may become convenient to express

¹⁶Giovannini and Turtelboom (1994), pp.393.

prices in another currency instead of adjusting prices continually. The most informative and less risky unit of account is the currency whose purchasing power is stable in terms of the basket of goods and services which the agents want to buy or sell.

Although in theory we distinguish between the motives of holding different currencies, in practice it is quite difficult to distinguish between store of value, unit of account or medium of exchange substitutability. Unit of account substitutability is often distinguishable, but, on its own, has no great immediate policy purposes for currency substitution. Moreover, if store of value substitutability is the only reason for currency substitution, there would be no reason to hold non-interest bearing currencies in portfolios. However, if the money provides liquidity services, it will be included in portfolios together with interest-bearing assets.

Looking at the functions of money is a complementary way not an alternative way to investigate the determinants of currency substitution. When people choose to hold different currencies in their portfolios they probably do not think about the functions that these different monies perform, but rather they take domestic and foreign economic situations into account. Since people do not have perfect foresight, they may choose to seek to protect themselves against the adverse effects of future changes in price levels, interest rates and exchange rates by holding different currencies. Furthermore expectations about exchange rate changes or institutional changes such as banking regulations could also lead people to hold different currencies. When they expect the depreciation of the domestic currency they could switch to foreign currencies and could deposit their money in the form of cross border deposits in a bank abroad.

Furthermore differential inflation rates among countries will, other things being equal, lead transactors to hold the less depreciating currency. In high inflation countries national currencies are often partially replaced by one strong currency, generally the US dollar, both as a medium of exchange and as store of value. This phenomenon is called Dollarization, which is a widespread currency substitution,

gone from involving just a store of value for big companies to a situation where many economic agents hold the foreign currency. Moreover expectations also play an important role in store of value substitutability. When agents expect a devaluation of the domestic currency, the store of value services of the foreign currency increase relative to the national one. The domestic currency is likely to be exchanged for the foreign currency. Thus, good money drives out the bad money¹⁷ from monetary circulation.

Then the decision of how much foreign currency to hold depends on firstly expectations of exchange rates, foreign and domestic inflation and interest rates. This implies that the demand for money function in equation (3.1), does not contain all the determinants of the money demand when there is currency substitution in the economy. In that case the foreign economic variables such as inflation, interest rates and the exchange rate should also be included in the arguments of the money demand function, which would yield

$$\frac{M^d}{P} = f(I, R, \dot{P}, R^*, \dot{P}^*, e) \quad (3.3)$$

where * denotes the foreign variables and e denotes the exchange rate.

People may choose to allocate their monetary balances across several countries' currencies taking the economic situations in each country in to account, as well as their expectations about exchange rate changes or any relevant legislative change. This allocation of money balances usually takes the form of cross border deposits. Since traditionally defined monetary aggregates have usually excluded most cross border deposits, they could not fully reflect the effects of currency substitution and could not assess the true amount of money demanded. Hence, it was proposed in Chapter 2 to redefine the monetary aggregates, as extended monetary aggregates,

¹⁷Which is the reverse of Gresham's Law. For a discussion of Gresham's Law and currency substitution see Chapter 2.

so that they include the relevant cross border deposits¹⁸, which can be denoted by M_c .

As mentioned in Chapter 2, currency substitution has important implications for the stability of the demand for money function. Since foreign economic variables are likely to enter into the demand for money function of the domestic country, whenever there is a change in monetary policy in an important foreign country which changes expectations about inflation, interest rates, or the exchange rate, this in turn will affect the domestic demand for traditionally defined money, denoted by M_t . Assuming a two country world, when the foreign country employs a tight monetary policy, the exchange rate, (defined as domestic currency per unit of foreign currency), will increase, that is domestic currency will depreciate.¹⁹ Hence people may choose to hold the foreign currency rather than holding the depreciating domestic currency.

In the case of an extended definition of money (M_e), changes in foreign interest rates (adjusted for expected exchange rate changes) will only influence the location and composition of the cross-border deposits, not their volume (Von Riet (1992)). Moreover, changes in banking regulations, such as the introduction of the withholding tax in Germany, may cause relocation of the cross-border deposits. When there is a change in exchange rate expectations, one would expect substitution between different currencies. Although these changes cause instability in traditionally defined monetary aggregates, M_t , they would have no consequences for an extended monetary aggregate which includes all the foreign currency holdings of residents. The currency substitution takes place entirely within the extended monetary aggregate in the form of shifts from one type of cross-border deposit to another, and it cannot here be regarded as a destabilizing factor. "The volume of the traditional monetary aggregate (M_t) will only change insofar as residents, besides changing the currency

¹⁸For the definition of cross border deposits and the calculation of extended monetary aggregates, see Chapter 2.

¹⁹See McKinnon (1982) or Miles (1978) for a formal exposition of implications of currency substitution in a two country world.

composition of their portfolios, also change the location of their balances".²⁰

The national demand for money may be influenced by changes in the yields on non-monetary long-term foreign assets including both financial assets and real assets. The increased degree of financial integration of EU countries has contributed to the freedom of international capital movements²¹, leading to greater scope for the inclusion of foreign long-term assets in the portfolios of the economic agents as an alternative to domestic assets. Thus, under fixed exchange rates, changes in the opportunity costs of these assets may lead to substitution, which, in turn, would affect the domestic money stock, regardless of whether M_1 or M_2 is chosen. When there is a differential between the returns of domestic and foreign bonds, the international bond market quickly adjusts to new exchange rate expectations and capital outflows may occur from the domestic country. McKinnon argues that since this indirect channel causes a potentially larger amount of currency substitution, it may be more important.²²

The previous analysis indicates that factors affecting real yields on monetary balances abroad, such as foreign interest rates or inflation, together with institutional changes may cause instability in the traditionally defined monetary aggregate M_1 . The volume of an approximately extended monetary aggregate, on the other hand, would not change when there is a fluctuation in these variables. However, indirect currency substitution and changes in the yield on non-monetary long-term foreign assets may lead to instability in both traditionally defined and extended national monetary aggregates. Thus the domestic monetary authorities should not try to control the domestic monetary aggregate independently, but should accommodate the changes which occur due to the actions of important foreign monetary authorities. The same

²⁰Von Riet (1992), pp.37.

²¹Within the EU, freedom of capital movements has been introduced across the entire community as a consequence of the Single European Act of 1986.

²²See Chapter 2, for a discussion of McKinnon (1982, 1996)'s argument of direct and indirect currency substitution.

could be true for the foreign country as well. Hence in a two country world each economy's demand for money function will be affected by the others' decisions. Neither of them could have an independent monetary policy. In that case monetary authorities in both countries lose their independence. Thus, as mentioned in Chapter 2, several authors argue that when there is significant currency substitution individual countries should give up pursuing their own independent monetary policy, but rather should cooperate and conduct a joint monetary policy.

The last issue is particularly important for the European Union countries. A recent line of research argues that as exchange rates between EU currencies become increasingly stable, together with liberalized capital movements within the EU area, the substitutability both of money and other assets denominated in EU currencies is likely to be increasing. Economic developments in one EU country may easily affect the demand for money function of the others. As a result of these developments and the increasing degree of integration of EU economies the traditionally defined national money demand functions may become more unstable. But an extended monetary aggregate may produce more reliable results, since currency substitution is expected to affect only the location and composition of the cross-border deposits but not the volume.²³

Although currency substitution may create a problem of instability in traditionally defined money demand functions and limit the independence of the monetary authority, it could provide one particular advantage for the EU. An EU wide monetary aggregate could be more stable, enabling the European Central Bank (ECB) (when it is established) to use a broad monetary aggregate for the EU as an intermediate target variable for a European money supply policy. To be effective this requires the existence of a stable demand for money relationship at the EU level.

A recent line of research investigating the stability of an EU-wide demand for money function uses aggregated data. But for the estimation of an area-wide demand for money relationship, aggregation across countries has both advantages and

²³ Angeloni et al. (1991) reports empirical results confirming this point.

disadvantages. Von Riet (1992) notes that the balance of the two determines whether aggregation to an area level will produce a better estimate of the parameters than demand for money estimations for individual countries. The next section explores the advantages and disadvantages of aggregation.

3.6 Theoretical Aspects of Aggregation

Since national money demand functions generally do not allow for cross-country links, specification errors may arise which could adversely affect the estimates.²⁴ However these specification errors, which may occur if there are omitted variables, measurement errors of the explanatory variable, or other errors in the equation's specification, could be avoided by aggregating national monetary variables across a group of countries, such as EU countries, with strong economic and financial links, and by estimating an area wide demand for money function.²⁵ If the specification bias reflects the omission of foreign variables from the individual country equations, aggregation could reduce the specification error. One of the potential sources of specification bias could be the existence of currency substitution in the countries under consideration. Incomes and interest rates, as well as other economic variables affecting demand for money in national countries, are automatically included in an aggregate money demand estimation, which may reduce the specification errors and improve the estimation.

In order to demonstrate the specification bias, consider a standard long run money demand function,

$$m^d - p = \alpha + \delta(a_1 i_t + b_1 i_t^A + c_1 i_t^*) + \gamma(a_2 R_t + b_2 R_t^A + c_2 R_t^*) \quad (3.4)$$

where $\delta > 0$, $\gamma < 0$, $a_i \leq 1$, $b_i + c_i < 1$, $a_i + b_i + c_i = 1$, $i = 1, 2$

²⁴Von Riet (1992) distinguishes traditionally defined monetary aggregate and an extended monetary aggregate and investigates the foreign influences on both of these aggregates.

²⁵For a discussion of econometrics of aggregation see Monticelli and Papi (1996), Von Riet (1992).

Equation (3.4) shows that the demand for real money depends on a weighted average of domestic, area-wide and the rest of the world income (denoted by i , i^A , i^* , respectively) and the interest rates on alternative assets which are treated in the same way as income. If currency substitution does not occur and there are no policy interdependence between the countries which have a high degree of economic and financial integration, then $a_i = 1$ and $b_i = c_i = 0$, $i = 1, 2$. But if these assumptions do not hold, then, $0 < b_i + c_i < 1$ and equation (3.4) can be rearranged as follows:

$$\begin{aligned}
 m^d - p = & \alpha + \delta i_t + \gamma R_t \\
 & + \delta b_1 (i_t^A - i_t) + \gamma' b_2 (R_t^A - R_t) \\
 & + \delta c_1 (i_t^* - i_t) + \gamma' c_2 (R_t^* - R_t)
 \end{aligned} \tag{3.5}$$

The first line of equation (3.5) is a standard money demand function. The remaining part of equation (3.5) indicates the specification bias which could occur if foreign economic variables are omitted when they are relevant. There can be two sources of specification bias: the omission of variables regarding the other countries in the area, and the omission of variables concerning the rest of the world. Equation (3.5) also indicates that two distinct components contribute to the specification bias: the weight of the foreign variables and the difference between the foreign and domestic variables. Monticelli and Papi (1996) report that, as regards the countries of the area, the importance of these two components move in opposite directions as integration within the area intensifies. Although the weight of foreign variables, and thus the specification bias, increases, integration could bring convergence leading to the reduction of the differential between the domestic and foreign interest rates and thus reduce the specification bias.

Since area-wide money demand functions include variables of all countries in the area, the estimate of an area-wide function may overcome the specification bias caused by the omission of the within area foreign variables. Furthermore, shocks affecting national demands for money, in so far as they are negatively correlated, may

partly offset each other at the aggregate level. Monticelli and Papi (1996) note that the extreme case of offsetting shocks is that of currency substitution between the two countries in the area, when there is perfect negative correlation. When there is high economic integration between countries, shocks in one country are likely to be offset, at least partially, by opposite shocks in the rest of the area. One of the advantages of estimating an area-wide money demand function is the efficiency gain with respect to national money demand estimations, which makes the standard error of the area-wide equation smaller than the sum of the standard errors of the national equations. Several studies report lower standard errors in EU-wide demand for money estimates than the national ones, implying that forecasts for an EU-wide monetary aggregate could be more reliable than those for the national monetary aggregates.

One of the disadvantages of the procedure is aggregation bias, which may result from assuming the demand for money function has the same structure in each country under consideration. But different countries in the area could have different money demand relationships. In that case aggregate estimates may not converge to a true money demand specification in any one country, or even to an appropriately weighted average. Income and interest rate elasticities may differ from one country to another, implying that income and interest rate elasticities of an EU wide demand for money relationship cannot be uniformly interpreted for each country. Angeloni et al. (1991) and Artis et al. (1993) report that there are substantial differences across countries in the coefficient values and the error structure of the relationship. Thus the assumption of a single money demand structure for all countries may lead to considerable bias in parameter estimation.

In order to show the implications of the aggregation bias consider an area of two countries where the money demand of each country depends on a number of variables of both countries taking international policy interdependence into account. Considering equation (3.2), denote all the domestic explanatory variables included in the national money demand function by x which comprises domestic income (i) and interest rates (R) and similarly denote the variables of the other country with an

asterisk x^* . Then the money demand functions for both countries can be expressed as follows:

$$m^d_t - p = \sum_i \gamma_i x_{it} + \sum_i \lambda_i x^*_{it} \quad (3.6)$$

$$m^{d*}_t - p^* = \sum_i \gamma^*_i x^*_{it} + \sum_i \lambda^*_i x_{it} \quad (3.7)$$

The money demand function for the area is defined as the sum of equations (3.6) and (3.7)

$$(m^d_t - p + m^{d*}_t - p^*) = \sum_i \Lambda_i (x_{it} + x^*_{it}) . \quad (3.8)$$

When the demand functions of two countries are compared with the area-wide money demand function, it can be observed that the parameters of equation (3.8) are not the same as those of the country equations. Furthermore, the aggregation imposes the following restriction:

$$(\gamma_i + \lambda^*_i) = (\gamma^*_i + \lambda_i) = \Lambda_i \quad \forall i. \quad (3.9)$$

A sufficient, but not necessary condition for these restrictions to hold exactly is that the money demand functions in each equations have the same parameter values, that is,

$$\gamma_i = \gamma^*_i \quad \lambda_i = \lambda^*_i \quad \forall i.$$

Monticelli and Papi (1996) report that if the restrictions shown in equation (3.8) do not hold, the aggregation procedure entails a specification bias. "The possibility of such a specification error arising does not necessarily imply that the standard specification of a national equation that omits foreign variables is preferable from an econometric point of view, since the omitted variable bias might well be more severe than that coming from the invalid restriction".²⁶ Moreover comparison of the area-wide equation with those for the countries indicates that the parameters of the area-wide equation are not the same as those of the national equations. In this case it is not possible to identify the parameters of national money demand functions from an area-wide money demand function.

²⁶Monticelli and Papi (1996), pp.126.

Von Riet (1992) argues that the aggregation bias problem would be less relevant for income if a long run unit income elasticity were found for every country. Although narrowly defined monetary aggregates may have unit income elasticity, as the monetary aggregate gets broader, the income elasticity tends to be greater than one.²⁷ Empirical studies of national money demand functions also find mixed results on this issue.²⁸ It is argued that the aggregation bias concerning the coefficient estimates of interest rates and inflation will gradually decline as the exchange rates of EU countries stabilize against those of the core countries of EMS. "Moreover, a change in interest rates induced by European monetary policy (or more generally any interest rate shock) will increasingly be distributed evenly over the EC countries. Its influence on the demand for money may continue to differ from country to country, but this will be less important than the effect on the demand for money in the EC as a whole".²⁹ For an EU wide monetary policy coordination, it is necessary to find a stable demand for money relationship at the EU level, so that differences in the estimates of the countries' money demand functions will be of lesser importance for the monetary authorities. This would mean a too tight or a too easy monetary policy for an individual country, but as von Riet (1992) reports this is the price which must be paid for a common monetary policy.

Additionally, national monetary aggregates cannot be readily added up, as the definitions of monetary aggregates of individual countries do not coincide with each other. This could lead to less reliable estimates. Since national monetary aggregates also do not contain cross-border holdings of residents, simple aggregation of national monetary aggregates would result in underestimation of the monetary aggregate at the EU level. In this study national monetary aggregates of each of the five countries are examined and the broadest monetary aggregate for each country is chosen.

²⁷For a discussion of income elasticity of different monetary aggregates see Goodhart (1989).

²⁸See Artis et al. (1993), Cassard et al. (1994) for some EU countries' money demand estimations.

²⁹Von Riet (1992), pp. 42.

Moreover, in order to prevent the underestimation of an EU wide monetary aggregate, among other reasons explained in Chapter 2, cross-border deposits of residents are also included in the monetary aggregates.

It can be argued that some sources of instability of national monetary aggregates may largely be removed by aggregating the demand for money across a group of countries with strong economic links. However, the assumption of the same structure for the national money demand functions constitutes the major disadvantage of aggregation. Thus the choice between area-wide equations and national equations depends on the actual implications of these two types of error. Von Riet (1992) notes that the advantage of aggregation should be weighed against the disadvantage of parameter bias resulting from the stringent a priori assumption of a uniform demand for money function for all countries considered. As this disadvantage may decline further as financial integration progresses, the aggregate money demand estimates could be more reliable. In order to reduce the significance of this problem, a general to specific modelling strategy is employed in this study. This method allows data to determine the long-run and short-run specifications of money demand functions given the set of explanatory variables. Thus aggregation bias is less likely to be large in this study.

3.7 Conclusion

In this chapter we have argued that the theories analysing currency substitution are extensions of the theory of money demand in a multi-currency world. The services that money provides and the motives for holding money are examined, because it is argued that these basic arguments help to explain why transactors hold different currencies in their portfolios. It is suggested that time and uncertainty are the two principal factors which lead transactors to hold money for transaction, speculative and precautionary motives. Money provides store of value and medium of exchange services and is also used as a unit of account.

It is argued that currencies become substitutes in the store of value sense as

there are inflation differentials between currencies. As far as medium of exchange substitutability is concerned, the most widely-circulating currency in the world or a regionally strong currency, such as the Yen, would be substituted for domestic currencies when the local markets are limited relative to the volume of international trade. In general, the substitutability of a currency as a store of value and unit of account depends largely on the behaviour of the price level. The most stable and less risky money would be substituted for domestic currency in transactors' portfolios. The lower inflation rate and a wide circulating area are the basic elements of a currency which substitutes for domestic currency. These elements decrease the uncertainty about the future price level, exchange rate and the acceptability of the currency, thus reducing the time and resources which would be allocated for information gathering.

When currency substitution occurs in any economy, its demand for money will be influenced by the foreign economic variables. Expected changes in the exchange rate, inflation rate or interest rate of the foreign country could prompt agents to shift from domestic currency to the foreign currency or vice versa. In that case, traditionally defined monetary aggregates would become unstable. However, the extended monetary aggregate, defined to include foreign currency deposits wherever held, would not show such instability as fluctuations in the foreign economic variables would only influence the location and composition of the deposits but not their volume. This suggests that an extended monetary aggregate is likely to produce a more reliable estimation result than a traditional one.

When the increased degree of financial integration and currency substitution in the EU is considered, it seems reasonable to aggregate the demand for money across the EU, so that some sources of instability of national monetary aggregates may largely be removed. However, there is a disadvantage of EU-wide aggregation which stems from the stringent a priori assumption of a uniform demand for money function for all countries considered. In section six, it was indicated that this disadvantage may decline in importance as integration progresses.

CHAPTER 4

ECONOMETRIC MODELLING OF THE DEMAND FOR MONEY FUNCTION

4.1 Introduction

This chapter gives an account of the approach to econometric modelling that is employed in this study. General to specific modelling has played an important role in recent applied econometrics, although it has been criticized heavily and alternative modelling frameworks have been proposed. Cuthbertson et al. (1992) term this approach as the LSE tradition, as this approach has been developed largely by individuals associated with London School of Economics. Starting from a general data specification, the aim is to simplify this formulation by imposing a set of restrictions. Economic theory guides the researcher in selecting variables of interest and provides knowledge about the restrictions that should be imposed. Restrictions are also imposed as a result of insignificant estimated coefficients. Thus, this approach can be seen as an interaction of economic theory and econometrics.

In section 4.2 the conceptual approach of the LSE tradition is reviewed. Several econometric approaches to the modelling of the demand for money and specific hypotheses that should be imposed on money demand functions are summarized in section 4.3 and a brief discussion is given as to why the VAR modelling is preferred to others. Section 4.4 focuses on modelling dynamic systems especially VAR processes. Cointegration analysis is examined in section 4.5, and tests of some important economic hypotheses are discussed. Section 4.6 discusses modelling issues in a stationary space. Finally, section 4.7 concludes.

4.2 General to Specific Modelling

The main proposition of general to specific modelling could be expressed as follows: a good, meaningful empirical econometric model can be developed by starting from a large, general model and by gradually reducing its size and transforming the variables through the testing of various linear and nonlinear restrictions. The concept of the data generating process (DGP) lies at the centre of this modelling process which can be defined as the mechanism underlying the observable phenomena of interest. Although it is too general to have any direct practical use, it provides a benchmark against which more simple models may be measured and allows the researcher to formalize the assumptions and steps which are needed when constructing actual models for estimation.

Hendry and Doornik (1994) discuss ten interrelated reasons for starting econometric analysis of economic time series from the joint density function. Since they constitute the main reasons for our selection of this approach, some of them are briefly noted here. First of all, the economy is a system and all variables may influence each other in the long run. In order to understand how the economy functions, its framework and sectors require modelling. It also helps understanding of how developments in each sector affect other sectors and the whole economy. Secondly, as the economy consists of many sectors and comprises a great number of variables, analyses should be based on the reduction of the data generating process due to marginalizing with respect to all variables omitted from the system under study. Moreover single equation modelling may lead to losing valuable information about the contemporaneous relationships between the variables, e.g. simultaneity.

Thirdly, although individual variables are not stationary, there may be stationary relationships between these variables in the long run, indicating that they are cointegrated. Cointegration is a system property and the number of cointegrating relations can only be determined by considering the complete vector of variables which necessitates modelling the joint density. Moreover, general to specific modelling, and

especially cointegration analysis, allows researchers to test particular economic hypotheses. Any cross-equation dependencies, which might include cross-equation restrictions and cross-equation serial correlation, can be tested. At the same time, the assumption of exogeneity, which will be discussed in detail below, can also be tested.

Consider the joint data density function $D_y(\cdot)$ for T observations on a vector of n observable real random variables $y_t = (y_{1t} \dots y_{nt})'$:

$$D_y(y_1 \dots y_T | Y_0, Q^1_T, \theta) \quad (4.1)$$

where $\theta \in \Theta \subseteq \mathbb{R}^k$ and when Y_0 denotes the pre-sample initial conditions, $|$ separates the outcomes from the conditioning set, $Q^1_T = (q_1 \dots q_T)$ is a set of T observations on m deterministic conditioning variables, such as constant, seasonal, trend and dummy variables, and there are k parameters in θ with a parameter space Θ which is a subset of k -dimensional real space \mathbb{R}^k . The history of $\{y_t\}$ is denoted by $Y_{t-1} = (Y_0 : Y^1_{t-1})$ where $Y^1_{t-1} = (y_1 \dots y_{t-1})$. Writing the sequential conditional density at time t as $D_y(y_t | Y_{t-1}, Q^1_T, \theta)$, then from equation (4.1) for the complete sample $Y^1_T = (y_1 \dots y_T)$:

$$D_y(Y^1_T | Y_0, Q^1_T, \theta) = \prod_{t=1}^T D_y(y_t | Y_{t-1}, Q^1_T, \theta) \quad (4.2)$$

where θ is allowed to contain transient parameters, such as parameters of dummy variables. The parameters of interest comprise a subset $\psi \in \Psi$ of $\gamma = f(\theta)$, where $f(\cdot)$ is a 1-1 function of θ . Hendry and Doornik (1994) note that since:

$$D_y(Y^1_T | Y_0, Q^1_T, \theta) = D_y(Y^1_T | Y_0, Q^1_T, \gamma) \quad (4.3)$$

then $D_y(\cdot)$ is invariant under 1-1 parameter transformations and the resulting class of densities is isomorphic.

After defining the data generating process, Cuthbertson et al. (1992) report that the process of econometric modelling consists of simplifying this very general formulation by imposing a set of restrictions to obtain a set of explicit equations

complete with numerical parameter estimates. These simplifying assumptions may be categorized into four types.

- i) Marginalisation of the DGP. Since, the DGP contains far more variables than a researcher is interested in, one should select a subset of variables of interest, and marginalize the DGP with respect to the variables that do not matter for the determination of the variables of current interest.
- ii) Conditioning assumptions. After the determination of the variables of interest, a subset of these variables should be selected as endogenous variables (X_t). These are then conditioned on or determined by the remaining variables of interest (Z_t), which should be, at least, weakly exogenous for this conditioning to be valid.
- iii) Selection of functional form. Suitable simple representations of the conditioned marginalized DGP are assumed before estimation.
- iv) Estimation. The unknown parameters in this representation must be replaced by a set of estimated numerical values.

In the first three steps of this process economic theory guides the researcher and econometric estimation theory is considered in the final stage. Although such a categorization is possible, these stages are not sequential; the econometrician may iterate backwards and forwards. Until a final adequate model is found, the process of applied econometrics can be seen as an interaction among these stages.

Provided that the marginalization and the conditioning are valid, the very general representation of the DGP of equation (4.2) can be replaced by the much more specific

$$D_y (Y_t | Y_0, Q^1_T, \theta) = (D_{x|z} X_T | Z_T, Y_{t-1}, Q^1_T, \phi_1) \\ D_z (Z_T | Y_{t-1}, Z_{t-1}, Q^1_T, \phi_2) \quad (4.4)$$

The first expression $D_{x|z}$ gives the endogenous variables of interest X_t as a function of the lagged X_t , dummy variables and the weakly exogenous variables Z_t . The second term D_z gives the determination of the weakly exogenous variables Z_t as a function of the lagged

endogenous and exogenous variables.

For the conditioning assumptions of the model to be valid, it is required that the Z_t variables are at least weakly exogenous. If the regressors are not weakly exogenous, then they are endogenous by default and must be jointly modelled in a simultaneous system. A joint explanation of Z_t and X_t is necessary if X_t is explained by Z_t which is explained in terms of X_t in turn. To test the legitimacy of weak exogeneity requires modelling Z_t , and then testing that the marginal density does not contain any information of relevance to the parameters of interest. Weak exogeneity implies that Z_t is independent of X_t and the parameters of interest of the model to be finally estimated (θ) are a function of ϕ_1 alone ϕ_1 and ϕ_2 are variation free.

Weak exogeneity may be sufficient for hypothesis testing purposes, but forecasting requires strong exogeneity, which is weak exogeneity plus an absence of feedback. If the Z_t variables are to be strongly exogenous, then the second term in equation (4.4) takes the form $(Z_t | Z_{t-1}, \phi_2)$ that is, the exogenous variables are determined without any reference to any lagged values of the endogenous variables X_t . Hence, the strong exogeneity assumption requires the assumption that X does not Granger cause Z , in addition to the assumption of weak exogeneity. Although estimation and testing require weak exogeneity, and forecasting necessitates strong exogeneity, policy analysis requires super exogeneity which is the assumption of weak exogeneity plus the parameter vectors ϕ_1 and ϕ_2 being independent. Under this assumption a change in the ϕ_1 vector does not influence ϕ_2 . "Super exogeneity is related to the Lucas (1976) critique. Lucas points out that when we model expectations by functions of lagged variables then the parameters of these functions may vary as the regime for determining the expectation variables changes".¹

Having made the assumption about the conditioning and marginalisation, many

¹Cuthbertson et. al. (1992), pp.100.

possible model forms could be adopted to characterize the behaviour of the $\{y_t\}$ and to learn about ψ . Hendry and Doornik (1994) note that in order to choose a specific model, we should first consider the four major categorizations common to all such models, namely whether the model is closed or open (if there are unmodelled variables), whether it is complete or incomplete, that is whether there are as many equations as variables to be modelled, whether the model is linear or nonlinear and finally whether the data are stationary (I(0)) or are integrated of order 1 or 2 (I(1) or I(2))². In this study, a complete system which is linear in integrated variables is considered and the basic form of the $D_y(y_t | \cdot)$ in equation (4.2) is a vector autoregressive representation (VAR) with deterministic variables. Thus in this study VAR estimation is employed. Before summarizing VAR analysis, an account of economic theory should be given in order to determine the conditioning variables of the model and to specify the hypotheses to be tested.

4.3 Modelling the Demand for Money

There are two important issues which should be considered explicitly before moving to the money demand estimation, namely the choice of variables and the functional form. Firstly, we should select the variables of interest as the full DGP contains far more variables than we are interested in. Furthermore, the full DGP is a general functional specification, a specific functional form for the model should be assumed before moving on to estimation.

4.3.1 The Choice of Variables

In Chapter 3 it is shown that the demand for real money depends positively on a scale variable such as GDP or wealth, but is negatively related to the returns on alternative

²For a complete discussion of dynamic modelling, see Hendry (1995).

assets and the rate of inflation. Generally we have

$$\frac{M^d}{P} = f(I, R, \dot{P}) \quad (4.5)$$

where M^d denotes money demand, P the price level, I a scale variable, R a vector of interest rates on the alternatives for money, and a dot denotes the percentage change in the variable. The function $f(\cdot)$ is increasing in I , and decreasing in inflation and the elements of R .

Artis and Lewis (1991) note that much work has been done to find the precise empirical counterparts of these variables by transforming actual magnitudes into expected ones, experimenting with various functional forms and using different measures of the budget constraint and the opportunity cost of money. Since transactions and portfolio balance theories advocate different scale variables, it is not immediately apparent whether wealth or income should enter the demand function. But the absence of adequate wealth figures necessitates the inclusion of income in practice as the scale variable. Although the portfolio balance approach emphasizes that wealth-holders have the choice of holding money or a variety of financial and real assets, in most cases selection of one representative rate, such as the yield on long- or short-term securities, is reported to be adequate. This is because yields on certain assets that close substitutes for each other may move together. The long-rate government bond yields are widely used, because information on them is readily available and they are more exogenous than private yields. Moreover, the money market rates are also popular because they vary more during periods of monetary disturbances.

Artis and Lewis (1991) argue that the inclusion of inflation expectations in the money demand equation has also been theoretically controversial. Friedman (1956) argues that as inflation expectations rise, people switch to real assets and securities rather than holding money, so that both nominal interest rates and the anticipated rate of change in prices should be included in the demand function. The Keynesian approach, on the other hand, sees the margin of substitution, given financial wealth, as that between money

and bonds. It is argued that inflation expectations are incorporated into nominal interest rates, so that the cost of holding money relative to securities is the real rate of interest plus the anticipated decline in the purchasing power of money. Thus the impacts of changes in inflation expectations are taken up by the nominal rate of interest.

Finally, the different approaches advocate different appropriate definitions of money. Friedman's approach argues in favour of the definition which performs best in empirical analysis. In the alternative approach, different parts of theory emphasize different definitions of money. The transactions approach suggests concentrating on a narrow measure of money, whereas the portfolio balance approach suggests a broader magnitude.

To summarize, economic theory suggests that the variables of interest for this study are a scale variable, an opportunity cost of money and inflation. In this thesis gross domestic product (GDP) is chosen as the scale variable as it is available for all countries concerned. Yields on 10-year government bonds act as long-term interest rates (R_l), and the consumer price index is used as the appropriate price level (P). Furthermore, an extended monetary aggregate is defined for each country as the broad monetary aggregate plus the relevant cross-border deposits, which are in the form of time deposits.³ Time deposits are included in the broad monetary aggregates which are used as target variables or monetary policy indicators in the countries considered. Thus the broad monetary aggregates are chosen as the monetary aggregates in this thesis.

4.3.2 Functional Form

After determining the variables of interest and the theoretical relationships between income, inflation interest rates and real money, the next step is modelling the demand for money so that the issue of short-run stability can be investigated. If we rewrite equation

³For the definition and calculation of extended monetary aggregates see Chapter 2.

(4.5) in logarithms (lowercase variables denote the logarithms), it reduces to a convenient linear form particularly suitable for estimation by way of regression analysis:

$$m^d_t - p_t = \alpha + \delta i_t + \gamma' R_t + \eta \Delta p_t + u_t \quad (4.6)$$

where Δp denotes inflation, u_t is a random variable and $u_t \sim N(0, \sigma^2)$. Note that the residuals should be stationary to ensure that a nonsense regression has not been estimated (See Hendry (1995)). Conventional demand for money functions are generally in the form of single equation models and include lagged values of the dependent variable either because of adjustment costs or the role of expectations, or both⁴. Employing expected values of income and interest rates, approximated by geometrically declining lags on present and actual past values, a money demand equation with lagged monetary variables could be obtained.

Since theories of the money demand function do not make predictions about how much the economy will be holding, but rather the desired levels, we can substitute m^d in equation (4.6) with the amount of money that people desire to hold m^* , and obtain the simplified long-run money demand function

$$m^*_t - p_t = \alpha + \delta i_t + \gamma' R_t + \eta \Delta p_t + u_t \quad (4.7)$$

The short-run equilibrium demand may then be determined either by introducing adaptive expectations or assuming costs of adjustment. Usually the hypothesis of partial adjustment is incorporated, which argues that people will not move to their desired long-run money holdings immediately, but will take time to do so as it may be too costly to move immediately. These models were utilized in the 1970s by many authors.

The real adjustment hypothesis, which assumes that the short-run desired demand for money in real terms, $\tilde{m}^*_t = m^*_t - p_t$, adjusts by a fraction of the discrimination between the desired long-run real demand \tilde{m}^*_t and last period's short-run demand

⁴For a discussion of functional forms of conventional money demand functions, see Artis and Lewis (1991), Cuthbertson (1985) and Laidler (1993).

$$\tilde{m}_{t-1}^d$$

$$\tilde{m}_t^d - \tilde{m}_{t-1}^d = \lambda(\tilde{m}_t^* - \tilde{m}_{t-1}^d) \quad (4.8)$$

where $0 < \lambda < 1$. In combination with equation (4.7) this gives

$$\tilde{m}_t^d = \lambda\alpha + \lambda\delta i_t + \lambda\gamma'R_t + \lambda\eta\Delta p_t + \lambda u_t + (1-\lambda)\tilde{m}_{t-1}^d. \quad (4.9)$$

Although actual real balances at any time are not at the desired long-run level, their movement is always towards the desired level, so that all of the observations of real balances are capable of tracing out the long-run demand curve once allowance is made for the estimated speed of adjustment. But this formulation has some shortcomings. Firstly, there is an asymmetry of response in that nominal money holdings are assumed to adjust fully and instantaneously to prices while responding only partially to changes in real income and interest rates. Secondly, the lag response of the demand for real money to the arguments of the real demand for money function is identical for every argument. This indicates that the source of the lag entertained by the partial adjustment hypothesis is the costliness of adjustment itself and not, for example, the learning about the change in the value of the argument.

Furthermore there are econometric problems with the lagged dependent variable. If the error term in equations (4.6) and (4.7) moves completely randomly over time, then an ordinary regression like equation (4.9) fitted by least squares to observed time series would yield unbiased estimates of the long-run demand for money function and of the adjustment parameter underlying the short-run relationship. If, however, there is any systematic component to the error term then there would be econometric problems. Suppose the error term displays first order autocorrelation:

$$u_t = \rho u_{t-1} + e_t \quad (4.10)$$

where e_t is a serially uncorrelated random variable having a zero mean. Substituting equation (4.10) into (4.9) gives

$$\tilde{m}_t^d = \lambda\alpha + \lambda\delta i_t + \lambda\gamma'R_t + \lambda\eta\Delta p_t + \lambda u_t + (1-\lambda)\tilde{m}_{t-1}^d + \lambda\rho u_{t-1} + \lambda e_t \quad (4.11)$$

When equation (4.9) is estimated with the true specification being equation (4.11), the influence of u_{t-1} on the demand for money would be attributed to the lagged dependent variable. If ρ is positive, the resulting estimate of $(1-\lambda)$ will be biased upwards and adjustment will appear slower than it really is (See Artis and Lewis (1991) and Laidler (1993)).

In order to avoid some of the shortcomings of the real partial adjustment model, some studies have preferred the nominal adjustment hypothesis which can be expressed as

$$m_t^d - m_{t-1} = \lambda(m_t^* - m_{t-1}). \quad (4.12)$$

When equations (4.7) and (4.12) are combined, we obtain

$$m_t^d = \lambda\alpha + \lambda\delta i_t + \lambda\gamma'R_t + \lambda\eta\Delta p_t + \lambda u_t + \lambda p_t + (1-\lambda)m_{t-1} \quad (4.13)$$

which avoids the asymmetry in the response of the desired short-run demand for money to changes in income, interest rates and price level. However, Artis and Lewis (1991) argue that the two formulations give similar results in practice.

The arguments about adjustment costs hypotheses are cast in terms of the behaviour of the individual agent, but the empirical applications concern the aggregate demand for money function. Although it is common to start an analysis by modelling the behaviour of a representative agent, then to generalize it to the whole economy, it could be possible to commit fallacies of composition. For an individual, the desired short-run demand can always be achieved and in empirical work it is often assumed that the short-run desired demand for money equals the actual real money stock in all time periods. When aggregate data are considered, the partial adjustment model assumes that the money supply always passively responds to any change in the short-run desired demand for money. But nominal money cannot simultaneously be a variable that is exogenous to the arguments of the aggregate demand for money function and a variable that respond endogenously to variations in them.

The foregoing discussions indicate that the short-run demand for money function may not be properly identified and that procedures that might help with this problem may render any study of the demand for money vulnerable to problems arising from specification errors. Some recent empirical studies of money demand functions employ cointegration and error correction analysis, thereby avoiding the problems created by distinguishing short-run and long-run demand for money functions apriori. "They enable us, in principle at least, to estimate long-run relationships without simultaneously having to take a strong position on how to model short-run dynamic processes and to generate statistical descriptions of the latter while remaining agnostic about the economic processes underlying them".⁵ Consider a long-run demand for money which is homogenous in prices and has unit income elasticity

$$m^*_t - p_t = i_t + \gamma'R + \Delta p_t + u_t \quad (4.14)$$

The error-correction approach would begin from equation (4.14), so that while the demand for real money will be evolving as income, interest rates and inflation evolve, it will also be responding to past disequilibria, which are errors which remain uncorrected. Hence, the short-run money demand function should include a term representing an error-correction mechanism. Accordingly, Engle and Granger (1987) propose a two-step procedure where the first step is to estimate the long-run function equation (4.14) in a cointegrating regression. In the second step the lagged residuals from this estimation are entered as an error-correction term in a dynamic error-correction mechanism formulation, which captures the short-run dynamics.

Although the cointegration analysis and error correction mechanisms provide a more general approach to modelling the dynamics of the demand for money, they do not solve all of the problems. In Engle-Granger modelling approach, it is assumed that there can be only one cointegrating relation. However, if there are more than two variables,

⁵Laidler (1993), p. 130.

there is no guarantee that there is only one cointegrating vector and there might be more than one cointegrating vector. Furthermore, it is not possible to formulate specific hypotheses and test them on the long-run relationships.

Johansen (1988) suggests a method for estimating all distinct cointegrating relationships which exist within a set of variables, so that the weaknesses of Engle-Granger two step procedure are overcome. The analysis begins by estimating an unconstrained vector autoregression (VAR), and then the number of cointegrating vectors is determined. Johansen also shows how to test which of these distinct cointegrating vectors is statistically significant and also how to construct a likelihood ratio test for restrictions on the cointegrating parameters. Charemza and Deadman (1992) argue that testing and analysing cointegration in a VAR model is superior to the Engle-Granger single equation method. Furthermore, the statistical properties of the Johansen procedure are generally better and the power of the cointegration test is higher. Thus, in this study Johansen's approach is employed, which is presented in section 4.5.

The foregoing analysis of economic theory and econometric issues suggest that there are three specific restrictions that should be imposed on the money demand function and be tested. The first one is price homogeneity. The second restriction concerns the income elasticity of the demand for money. In this study a unit income elasticity restriction is imposed. But it could well be the case that empirical estimates could provide an income elasticity which is higher than unity as the monetary aggregate that has the broadest definition is modelled. The third restriction is that income, inflation and interest rates should be weakly exogenous for the parameters of money demand function. Otherwise, they should be jointly modelled. From an economic point of view, this weak exogeneity means that differenced values of interest rates, inflation and income do not react to the disequilibrium errors in money demand but may still react to lagged changes of real money. Strong exogeneity, on the other hand, would imply that differenced values of interest rates, inflation and income do not react to lagged real

money, whether it is in changes or levels.

In the previous section we defined our variables of interest. Thus the vector of variables in the joint density comprises:

$$y_t = (m_t, p_t, R_t, \Delta p_t, i_t) \quad (4.15)$$

Stationarity analysis (see Appendix 1) indicates that $\{m_t\}$ is $I(2)$, whereas $\{m_t - p_t\}$ is $I(1)$, so that long-run price homogeneity is imposed. Income (i) and the long term interest rates (R) are found to be integrated of order one. The price level, on the other hand, is $I(2)$ implying that it should be included as a transformed variable such as inflation rate (Δp).

The variables provide little information about the determination of GDP, interest rates or inflation, thus this exercise can be seen as studying the demand for extended money by commencing from a joint density, and testing the reductions to validate single equation modelling. The system approach also provides some interesting economic insights on the other variables being modelled. Since the vector of variables in the joint density is defined, the form of the anticipated money demand function is specified and the hypotheses to be tested are determined, we can move on to the estimation procedure. Thus the next sections provide a summary of VAR analysis and cointegration.

4.4 Vector Autoregressive Models

The basis for the methodology of vector autoregressive modelling was introduced by Sims (1980). Multi-equation modelling and structural econometrics attracted a lot of attention during the 1950s and 1960s. Generally, large economics models, in some cases containing thousands of endogenous variables, were constructed for the purposes of forecasting and policy analysis. Although structural modelling became popular, it also attracted a lot of criticism concerning the endogenous-exogenous division of the variables and the assumption of zero restrictions, which are imposed in order to achieve identification of the model. Charemza and Deadman (1992) report that the basic

differences of the Sims modelling methodology from the conventional multi-equation modelling are the following: Firstly, there is no a priori endo-exogenous division of the variables; secondly, no zero restrictions are imposed; and finally, there is no strict (and prior to modelling) economic theory within which the model is grounded.

Since none of the variables is excluded from any equation of a model and nothing is exogenous, every variable is allowed to affect all other variables. Furthermore, the identification problem becomes irrelevant as there are no zero restrictions and no specified exogenous variables. The starting point of modelling in the Sims methodology is the formulation of a general unrestricted vector autoregressive (VAR) model, which consists of regressing each current variable in the model on all variables lagged a certain number of times. A p th-order vector autoregression, denoted VAR(p), can be expressed as

$$y_t = c + \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + \dots + \Phi_p y_{t-p} + \Lambda q_t + \varepsilon_t \quad (4.16)$$

where vector of variables y_t is defined in equation (4.16), c denotes an $(n \times 1)$ vector of constants and Φ_j an $(n \times n)$ matrix of autoregressive coefficients for $j = 1, 2, \dots, p$, and q_t denotes the deterministic conditioning variables. The $(n \times 1)$ vector ε_t is a vector generalization of white noise: $E(\varepsilon_t) = 0$, $E(\varepsilon_t \varepsilon_\tau') = \Omega$ for $t = \tau$ and $E(\varepsilon_t \varepsilon_\tau') = 0$ otherwise, with Ω an $(n \times n)$ symmetric positive definite matrix.

Assuming ε_t is normally distributed, the sample log likelihood function is given as

$$\begin{aligned} \mathcal{L}(\theta) &= \sum_{t=1}^T \log f_{y_t | y_{t-1}, y_{t-2}, \dots, y_{-p+1}}(y_t | y_{t-1}, y_{t-2}, \dots, y_{-p+1}; \theta) \\ &= -(Tn/2) \log(2\pi) + (T/2) \log |\Omega^{-1}| - (1/2) \sum_{t=1}^T [(y_t - \zeta' x_t)' \Omega^{-1} (y_t - \zeta' x_t)] \end{aligned} \quad (4.17)$$

where x_t is a $[(np+1) \times 1]$ vector containing a constant term, deterministic conditioning variables and p lags of each of the elements of y , and ζ' denote the following $[n \times (np+1)]$ matrix:

$$\zeta' = [\Lambda \quad \Phi_1 \quad \Phi_2 \quad \dots \quad \Phi_p] \quad (4.18)$$

Hamilton (1995) shows that an OLS regression of y_{jt} on p lags of all variables and dummy variables in the system gives the maximum likelihood estimates of the coefficients for the j th equation of a VAR, conditional on Y_0 . Hence OLS regressions provide the maximum likelihood of the coefficients of a vector autoregression.⁶

4.4.1 Determination of the Lag Length

Charemza and Deadman (1992) report that there is always some limit on the number of variables which can be included in a VAR model as well as on the maximum number of lags. If a system of six variables is considered and five lags on each variable are imposed, the total number of regressors in each equation would be 30. If the data sample is small, this could make the entire modelling process impossible. In particular, the choice of the appropriate lag-length is important. Since a VAR model contains lagged dependent variables as regressors, autocorrelation of error terms can be very serious as it could lead to inconsistent estimates of parameters if the OLS method is used for estimation. However, lagged dependent variables may provide a good approximation to an autoregressive process in the error terms. Thus, the best lag-length can be established by choosing p in equation (4.16) which results in estimated model residuals without significant autocorrelation.

A practical solution to this problem would be to start from the highest possible lag-length, then reduce the lag-length one at a time and perform a likelihood ratio test at each step. To perform the likelihood ratio test, the maximum value achieved by equation (4.17), should be calculated. At this maximum, equation (4.17) can further be simplified as (see Hamilton (1995))

$$\mathcal{L}(\hat{\Omega}, \hat{\zeta}) = -(Tn/2) \log(2\pi) + (T/2) \log|\hat{\Omega}^{-1}| - (Tn/2) \quad (4.19)$$

where $\hat{\cdot}$ denotes the maximum likelihood estimate.

⁶For a thorough discussion of ML estimation of VAR models see Hamilton (1995).

This formulation makes likelihood ratio tests particularly simple to perform. Suppose we want to test the null hypothesis that a set of variables was generated from a VAR with p_0 lags against the alternative that it was generated with $p_1 > p_0$ lags. To estimate the system under the null and alternative hypotheses, a set of n OLS regressions are performed where each variable in the system is regressed on a constant term and on p_0 and p_1 lags (respectively) of all variables in the system to obtain the estimated residual variance-covariance matrix from these regressions, $\hat{\Omega}_0$ and $\hat{\Omega}_1$ respectively.

Using (4.19) it is then easy to see that twice the log likelihood ratio is

$$2(\mathcal{L}_1^* - \mathcal{L}_0^*) = T(\log|\hat{\Omega}_0| - \log|\hat{\Omega}_1|) \quad (4.20)$$

where \mathcal{L}_0^* and \mathcal{L}_1^* are the maximized log likelihood values under the null and alternative hypothesis, respectively. Under the null hypothesis, this statistic asymptotically has a χ^2 distribution with degrees of freedom equal to number of restrictions imposed under H_0 . Under the null hypothesis each equation has $(p_1 - p_0)$ fewer lags on each of the n variables compared with the alternative hypothesis. Since there are n equations in the system, H_0 imposes $n^2(p_1 - p_0)$ restrictions. Thus the statistics calculated by equation (4.20) is asymptotically χ^2 with $n^2(p_1 - p_0)$ degrees of freedom.

Furthermore two information criteria, the Schwarz and Hannan-Quinn criteria, are also obtained for each specification. The Schwarz criterion is defined as

$$SC = \log|\hat{\Omega}| + m \frac{\log(T)}{T} \quad (4.21)$$

and the Hannan-Quinn criterion is defined as

$$HQ = \log|\hat{\Omega}| + 2m \frac{\log(\log(T))}{T} \quad (4.22)$$

where m is the number of coefficients in the model. For either criterion, the lag-length which minimizes the value of the criterion is chosen.

Our analysis starts with 4 lags of each variable and VAR models are estimated using PcFiml version 8.00 (See Doornik and Hendry (1994)). The lag length is reduced

one at a time and LM test statistics and the F-approximation for the likelihood ratio based test of (4.20), provided by Doornik and Hendry (1994), are calculated to determine the appropriate lag length, together with the Schwarz and Hannan-Quinn criteria.

Additionally, the following model diagnostics, which are reported by PcFiml, are presented for each equation and for the whole system: an F version of LM test for the hypotheses of no serial correlation against serial autocorrelation up to order 4 (F_{ar}); an F version of LM test for no autoregressive conditional heteroscedasticity against a four lag alternative (F_{arch}); test for heteroscedasticity (F_{het}) and a chi-square test for normality (χ^2) and analogous vector tests are also given and these are indicated by superscript v (See Doornik and Henry (1994)). Next cointegration analysis is performed provided that VAR model diagnostics are satisfactory.

4.5 Cointegration

In this section, the linkage of cointegration analysis with VAR modelling will be outlined. One substantial disadvantage of VAR models is the number of coefficients to be estimated and hence the limited degrees of freedom, especially in small samples. Cointegration analysis investigates if we can find any stationary linearly independent underlying relations between the nonstationary variables of the system, which could in turn reduce the number of parameters to be estimated. It allows precise formulation of a number of economic hypotheses about behaviour of variables in such a way that they can be tested. In general cointegration implies certain restrictions on the VAR representation and enables the researcher to test some economic hypotheses.

Furthermore, this formulation provides an explicit classification into nonstationary and stationary components, which could be interpreted in terms of the dynamics of long-run and short-run effects. All of the variables in this study are nonstationary, that is each of the series has different means at different points in time. A

stationary series tends to return to its mean and fluctuate around it within a more or less constant range. One of the characteristics of the stationary series is that it tends to return to, or cross, its mean values repeatedly. Since a nonstationary series has time-varying mean and/or variance, its properties are time-dependent. Thus conventional inference does not apply to nonstationary series. But this problem may be overcome by cointegration analysis which provides one or more long-stationary run relationships between nonstationary series. This, in turn, leads to a short-run specification of differenced series where conventional inference applies.

The vector autoregression model, equation (4.16) can equivalently be written as

$$\Delta y_t = c + \xi_1 \Delta y_{t-1} + \xi_2 \Delta y_{t-2} + \dots + \xi_{p-1} \Delta y_{t-p+1} + \Pi y_{t-1} + \Lambda q_t + \varepsilon_t \quad (4.23)$$

where

$$\Pi = I_n = (I_n - \Phi_1 - \Phi_2 - \dots - \Phi_p) = -\Phi(1) \quad (4.24)$$

The transformation of a VAR model for $I(1)$ variables into equation (4.23) can be called a cointegrating transformation. The rank of the long-run matrix, Π , in this transformation has a particular importance. Since there are n variables which constitute the vector y_t , the dimension of Π can be at most equal to n , that is the total number of variables explained in the VAR model. In that case all the variables in y_t are integrated of order zero, that is the vector process y_t is stationary. But if the rank of the matrix is Π equal to $h < n$, then there are h stationary relations among the non-stationary variables of y_t in the long run.

If y_t has h cointegrating relations, then equation (4.24) can be represented as

$$\Delta y_t = c + \xi_1 \Delta y_{t-1} + \xi_2 \Delta y_{t-2} + \dots + \xi_{p-1} \Delta y_{t-p+1} + \alpha \beta' y_{t-1} + \Lambda q_t + \varepsilon_t \quad (4.25)$$

where α is an $(n \times h)$ matrix and β' is an $(h \times n)$ matrix. Matrix β is called the cointegrating matrix and has the property that $\beta' y_t \sim I(0)$, while $y_t \sim I(1)$. The variables y_t are cointegrated, with the cointegrating vectors $\beta_1, \beta_2, \dots, \beta_h$ being the particular column of the cointegrating matrix β . Hence, in a VAR model explaining n variables

there can be at most $h = n - 1$ cointegrating vectors, which can also be interpreted as long-run parameters. The elements of α , on the other hand, measure the speed of adjustment of particular variables with respect to a disturbance in the equilibrium relation. Quite appropriately, the matrix α is called the adjustment matrix, or since we are dealing with a VAR model where the lagged values of the left-hand side variables enter the error correction mechanism, the feedback matrix (Charemza and Deadman (1992)). If an adjustment coefficient of a particular cointegrating vector is large, it implies the average speed of adjustment toward the estimated equilibrium state is fast, whereas a small coefficient indicates a slow adjustment.

By defining the stationary ($h \times 1$) vector as $g_t \equiv \beta' y_t$, equation (4.25) can be rewritten as

$$\Delta y_t = c + \xi_1 \Delta y_{t-1} + \xi_2 \Delta y_{t-2} + \dots + \xi_{p-1} \Delta y_{t-p+1} + \Delta q_t - \alpha g_{t-1} + \varepsilon_t \quad (4.26)$$

This expression is known as the error-correction representation of the cointegrated system. Hence, in the error-correction form, changes in each variables are regressed on a constant and other deterministic variables, (p-1) lags of the variables own changes, (p-1) lags of changes in each of the other variables, and the levels of each of the h elements of g_{t-1} . Johansen (1988, 1991) provides full information maximum likelihood estimation of a system characterized by exactly h cointegrating relations.⁷

4.5.1 Determination of the Number of Cointegrating Vectors

For empirical analysis, the main problems are in the determination of the number of cointegrating vectors and estimating the cointegration matrix β . Two test statistics, the trace and maximum eigenvalue statistics, are used to determine the number of cointegrating vectors. A likelihood ratio test of H_0 , the existence of h cointegrating relations, against H_1 , existence of n cointegrating relations, can be based on

⁷Alternatively, Hamilton (1995) also presents a detailed procedure of Johansen's method.

$$\mathcal{Q}_1^* - \mathcal{Q}_0^* = - (T/2) \sum_{i=h+1}^n \log (1 - \hat{\lambda}_i) \quad (4.27)$$

where \mathcal{Q}_0^* and \mathcal{Q}_1^* denote the maximum likelihood function under the null and alternative hypotheses, and $\hat{\lambda}_i$ are the eigenvalues of the matrix

$$\hat{\Sigma}_{VV}^{-1} \hat{\Sigma}_{VU} \hat{\Sigma}_{UU}^{-1} \hat{\Sigma}_{UV} \quad (4.28)$$

where $\hat{\Sigma}_{ij}$ are the sample variance-covariance matrices of residuals \hat{u}_t and \hat{v}_t which are obtained by regression of Δy_t and y_{t-p} on $\Delta y_{t-1}, \dots, \Delta y_{t-p+1}$, constant and deterministic variables, respectively.⁸ If the hypothesis involved just I(0) variables, twice the log likelihood ratio

$$\eta_h = 2 (\mathcal{Q}_1^* - \mathcal{Q}_0^*) = - T \sum_{i=h+1}^n \log (1 - \hat{\lambda}_i) \quad (4.29)$$

would be asymptotically distributed as χ^2 under H_0 . However, Doornik and Hendry (1994) report that the distribution of the η_h test when there are h cointegrating vectors, is a functional of $n - p$ dimensional Brownian motion. Normally testing starts from $h=0$, that is from the hypothesis that there are no cointegrating vectors in a VAR model. If this cannot be rejected, the procedure stops as no confirmation of the existence of cointegrating vectors has been found. If it is rejected, the hypotheses $h \leq 1, h \leq 2, \dots$, are tested subsequently. If the null hypothesis cannot be rejected for, say $h \leq h_0$, but it has been rejected for $h \leq h_0 - 1$, then the number of cointegrating vectors or the rank of β is deduced to be h_0 . This statistic is called the trace statistic for H_0 in H_1 , and is similar to a vector Dickey-Fuller test for a single variable.

Alternatively, the null hypothesis of h cointegrating relations against the alternative of $h + 1$ cointegration relations could be tested. The test of h cointegrating relations when at most $h+1$ exists can be based on the $(h+1)^{\text{st}}$ eigenvalue using

$$\omega_h = 2 (\mathcal{Q}_1^* - \mathcal{Q}_0^*) = - T \log (1 - \hat{\lambda}_{h+1}) \quad (4.30)$$

⁸See Hamilton (1994) for an elaborate analysis.

which is called the maximum eigenvalue statistic. Under H_0 , ω_h has a distribution that is a functional of vector Brownian motion. The critical values for the trace and eigenvalue tests have been presented by Johansen (1988), Johansen and Juselius (1990) and Osterwald-Lenum (1992). If on the basis of these tests, it is decided to accept a rank of h , $0 < h < n$, the reduced long-run matrix will be $\hat{\alpha} \hat{\beta}'$, where $\hat{\alpha}$ is the estimated adjustment matrix (the first h columns of $\hat{\alpha}$) and $\hat{\beta}'$ is the matrix of estimated coefficients of the cointegrating vectors (the first h columns of $\hat{\beta}'$). From Granger's representation theorem, it follows that $\hat{\beta}' y_{t-1}$ are the error correction terms.

However, there could be cases where the evidence of a number of cointegrating relations from these two tests is mixed. Moreover, Robertson and Wickens (1994) report that the statistical tests for the number of cointegrating vectors, and the cointegrating vectors themselves, are quite sensitive to the specification, the presence and absence of dummy variables and the sample length. Hansen and Juselius (1995) suggest that, in these cases, it might be useful to investigate the eigenvalues of the long-run matrix and the roots of the companion matrix, which would give information about the $h \times n$ roots describing the dynamic properties of the process. Furthermore, one might also resort to the graphs of the cointegrating relations, that is, to the realized values of estimated disequilibria in the system. "These series need not necessarily look like $I(0)$ processes. Indeed, while the disequilibrium is continuously reduced by the feedback, realizations of the error terms continuously shock the system".⁹

Furthermore, the reduced rank tests, proposed by Johansen and Juselius (1992), can be performed to determine the number of cointegrating vectors when trace and maximum eigenvalues statistics give mixed results. This test is based on the association between the rank of the matrix and the number of distinct non-zero eigenvalues, so that the eigenvalues corresponding to non-cointegrating vectors should be zero. The method

⁹ Rinaldi and Tedeschi (1996), pp.25.

can be summarized as follows: the expected multiple cointegrating vectors are known up to a linear combination, that is only the space spanned by β' is uniquely determined. In fact, the following relation holds for the decomposition of Π

$$\alpha \beta' = \alpha V^{-1} V \beta'$$

where V is a generic invertible square matrix of the same dimension as the cointegration rank to be tested. This implies that, given a stationary combination of $\beta' y_t$, any other linear combination of β' projects y_t into a stationary process. By means of linear combinations of the cointegrating vectors, it is possible to impose $s_i = h-1$ restrictions on each vector without altering the cointegration space. However, if more than s_i restrictions are imposed, then the space spanned by β will be modified. As a result of the reduced rank tests we obtain the eigenvalues which are supposed to measure the cointegrating vectors and the remaining eigenvalues which are supposedly non-stationary together with the long-run matrix. Doornik and Hendry (1994) suggest choosing the number of cointegrating vectors which produce the long-run matrix that is closest to the unrestricted long-run matrix, Π . Economic theory might be helpful by suggesting the restrictions needed to obtain the estimated vectors and implied long-run relations, which, in turn, plays a major role in shaping the structure of the model. The identification restrictions are tested against the VAR on which the reduced rank of the matrix Π has been imposed. The next section investigates this issue.

4.5.2 Restrictions on β and α

Johansen and Juselius (1990, 1992) present testing procedures for several types of restrictions. The identifying restrictions which are determined by economic theory should be imposed on cointegrating relations in order to have unique and interpretable long run relationships. Hendry (1995) notes that unless valid identifying restrictions are imposed, the set of cointegrating vectors will not correspond to structural relations, and need not be interpretable in the light of theory. Once sufficient valid restrictions are imposed on

the cointegrating matrix β to ensure the unique identification of every element, then β would constitute structural knowledge. If an identifiable β is determined, it is unique under extensions of the information set. This follows from the fact that as $\beta'y_t$ is stationary, and β is identifiable, then that is not affected by the presence of additional stationary or nonstationary variables. In this section separate, as well as combined, tests on α and β' will be discussed. Since all tests in this section are conditional on H_0 , they are in $I(0)$ space and likelihood ratio statistics have conventional χ^2 distributions. The hypotheses that are considered in this section consist of linear restrictions on either the cointegrating relations or their weights, which can be represented as

$H_1 : \Pi = -\alpha \varphi' D' \text{ or } \beta = D \varphi$, restrictions on cointegrating relations β' ,
 $H_2 : \Pi = -F \psi \beta' \text{ or } \alpha = F \psi$, restrictions on adjustment coefficients α ,
 $H_3 : \Pi = -F \psi \varphi' D' \text{ or } \beta = D \varphi \text{ and } \alpha = F \psi$, combined restrictions on Π .

The matrices D ($n \times q$) and F ($n \times m$) are known and define linear restrictions on the parameters of β ($n \times h$) and α ($n \times h$) respectively. These restrictions reduce the unknown parameters to $\varphi(q \times h)$ and $\psi(m \times h)$, where $h \leq q \leq n$ and $h \leq m \leq n$.

In section 4.3 we defined the variables in our VAR system. They are real money ($m-p$), long-term interest rates (RI), inflation (Δp) and income (i). Since we have four variables, the system can have at most three cointegrating vectors or less. Now, for illustration purposes, consider the VAR model with lag length two and with three cointegrating vectors where α is (4×3) and β' is (4×3). Then the model can be represented as

$$\begin{bmatrix} \Delta(m-p)_t \\ \Delta RI_t \\ \Delta^2 p_t \\ \Delta i_t \end{bmatrix} = \xi_1 \begin{bmatrix} \Delta(m-p)_{t-1} \\ \Delta RI_{t-1} \\ \Delta^2 p_{t-1} \\ \Delta i_{t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} \end{bmatrix} \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} \\ \beta_{21} & \beta_{22} & \beta_{32} & \beta_{42} \\ \beta_{13} & \beta_{23} & \beta_{33} & \beta_{43} \end{bmatrix} \begin{bmatrix} (m-p)_t \\ RI_t \\ \Delta p_t \\ i_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (4.31)$$

where each column of the adjustment matrix α indicates the weights with which each cointegrating vector enters into the short run equations and the rows of the cointegrating matrix presents the cointegrating relations for real money, the interest rate, inflation and income. In order to have unique cointegrating vectors the identification restrictions can be imposed as described in the following sections.

4.5.2.1 Restrictions on β

4.5.2.1.1 The Same Restriction on all β

First consider the imposition of the same restriction on all cointegrating relations. Suppose we wish to test whether inflation and interest rates have the same coefficient in all cointegrating vectors. Then the hypothesis to be tested is

$$\beta_i = (*, \alpha_i, \alpha_i, *, *), \quad i=1, 2, 3,$$

where the '*' means that the parameter is unrestricted. The restriction on β can be expressed as

$$H_{2,0} : \beta = D\varphi$$

where

$$D = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

and φ is a 3×3 matrix of unknown parameters.

This type of hypotheses are linear restrictions on the cointegrating relations, and Johansen and Juselius (1990) show that the test of H_2 in H_1 consists in comparing the eigenvalues $\hat{\lambda}_i$ ($\tilde{\lambda}_i$) calculated without (with) the restrictions. The test statistic is

$$2 (\mathcal{L}_1^* - \mathcal{L}_2^*) = -T \sum_{i=1}^h \log (1 - \hat{\lambda}_i) + T \sum_{i=1}^h \log (1 - \tilde{\lambda}_i) \quad (4.32)$$

where $\hat{\lambda}_i$ ($\tilde{\lambda}_i$) is the largest eigenvalue of the unrestricted (restricted) matrix in equation (4.28). This test statistic has an asymptotic χ^2 distribution with $h(n - q)$ degrees of freedom, where q is the dimension of the restriction matrix D .

4.5.2.1.2 Individual Restrictions on β

Alternatively, one would want to test individual restrictions on each cointegrating relation. For example, one of the assumptions that we want to test is whether the first cointegrating vector has a unit income elasticity. That is the first and the last elements of the first cointegrating vector should be of equal and opposite sign, which can be formulated as

$$H_{2.1} : \beta_{41} = -\beta_{11}$$

with

$$D_1 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 0 & 0 \end{bmatrix}$$

and φ is a 3×3 matrix of unknown parameters.

Similarly we can test the hypothesis that money does not enter into the second cointegrating relation. In that case the hypothesis can be formulated as

$$H_{2.2} : \beta_{12} = 0$$

with

$$D_2 = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

and φ is a 3×3 matrix of unknown parameters.

In these type hypotheses cointegration relations are partitioned into two (h_1 and h_2) and h_1 relations are assumed known whereas the remaining $h_2 = h - h_1$ are to be estimated independently of the h_1 vectors. These hypotheses can be tested by the likelihood ratio test which is calculated similar to the one in previous case. The test statistic is asymptotically distributed as χ^2 with $h_1(n-h)$ degrees of freedom (See Johansen and Juselius (1992)).

Furthermore, we can jointly test the hypotheses that are imposed on individual cointegrating relations. If we have h cointegrating relations we would like to identify them as economically meaningful relations. This is usually formulated by restricting the coefficients in each relation by linear restrictions. Suppose that a hypothesis that is identifying the three cointegrating relations is given by

$$\beta = (D_1 \varphi_1, D_2 \varphi_2, D_3 \varphi_3)$$

where D_1 and D_2 defined as above and D_3 imposes a restriction on the third cointegrating vector that money and inflation do not enter this cointegrating vector, e.i.,

$$D_3 = \begin{bmatrix} 0 & 0 \\ 1 & 0 \\ 0 & 0 \\ 0 & 1 \end{bmatrix}$$

and each φ_i is a 4×1 matrix of unknown parameters.

Johansen (1995) provides a switching algorithm to calculate the likelihood ratio test statistic for this type of hypotheses. He notes that there is no general simple formula for calculating the degrees of freedom for models of this type, since it depends on how the matrices D_1 , D_2 and D_3 are related and on their dimensions. He further reports that the asymptotic distribution of the likelihood ratio test statistic for this model is χ^2 with degrees of freedom given by $\sum_{i=1}^h (n-h-q_i+1)$ where q_i is the dimension of the D_i matrix.

4.5.2.2 Restrictions on α

Johansen (1992) notes that an advantage of VAR formulation is that one can formulate a partial system as a conditional model and discuss its properties. Consider the autoregressive model (4.23) under the hypothesis of cointegration H_1 . Let the process y_t be decomposed into the variables x_t and z_t of dimensions n_x and n_z , respectively, where $n = n_x + n_z$ and let α , ξ_1, \dots, ξ_{p-1} , c , Λ , ε and Ω be decomposed accordingly. Then model (4.23) can be decomposed into the conditional model for x_t given z_t :

$$\begin{aligned} \Delta x_t = & \omega \Delta z_t + (\alpha_x - \omega \alpha_z) \beta' y_{t-1} + \sum_{i=1}^{p-1} (\xi_{xi} - \omega \xi_{zi}) \Delta y_{t-p+1} \\ & + c_x - \omega c_z + \Lambda_x q_t - \omega \Lambda_z q_t + \varepsilon_{xt} - \omega \varepsilon_{zt}, \end{aligned} \quad (4.33)$$

and the marginal model of z_t

$$\Delta z_t = \alpha_z \beta' y_{t-1} + \sum_{i=1}^{p-1} \xi_{zi} \Delta y_{t-p+1} + c_z + \Lambda_z q_t + \varepsilon_{zt} \quad (4.34)$$

where $\omega = \Omega_{xz} \Omega_{zz}^{-1}$.

Here all the cointegrating relations $\beta' y_{t-1}$ enter into the marginal as well as the conditional model, and the conditional model has new adjustment coefficients $\alpha_x - \omega \alpha_z$ depending on the covariance matrix of the errors and all the adjustment coefficients (See Johansen (1992)). Generally, the parameters of the marginal and the conditional system are interrelated, which means that full system analysis is needed to draw efficient inference about the parameters.

However, there is a special case in which the partial model (4.33) contains as much information as the full system about the cointegrating relations and the adjustment coefficients, and where the analysis of the partial model is sufficient. This is when z_t is weakly exogenous for α and β . Johansen (1992) shows that the weak exogeneity of z_t with respect to β is equivalent to the condition that $\alpha_z = 0$. That is the rows of α corresponding to the z equations are zero and the models (4.33) and (4.34) reduce to

$$\Delta x_t = \omega \Delta z_t + \alpha_x \beta' y_{t-1} + \sum_{i=1}^{p-1} \xi_{xi} \Delta y_{t-p+1} + c_x - \omega c_z + \Lambda_x q_t - \omega \Lambda_z q_t + \varepsilon_{xt} - \omega \varepsilon_{zt}, \quad (4.35)$$

and

$$\Delta z_t = \sum_{i=1}^{p-1} \xi_{zi} \Delta y_{t-p+1} + c_z + \Lambda_z q_t + \varepsilon_{zt} \quad (4.36)$$

Here β and the remaining adjustment coefficients α_y enter only in the partial model (4.35), and the parameters in models (4.35) and (4.36) are variation free. Thus the hypothesis of weak exogeneity of z_t for α and β is formulated as

$$H : \alpha_z = 0.$$

Now, we could test the hypothesis that income is weakly exogenous for the long-run parameters of this model. Here the process y_t is partitioned into the variables $x_t = \{(m-p)_t, R1_t, \Delta p_t\}$ and $z_t = i_t$. This corresponds to testing a hypothesis about row restrictions on the adjustment coefficient of the form

$$H_3 : \alpha_{4j} = 0, \quad j=1,2,3.$$

with

$$F = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}.$$

This hypothesis is a linear restriction on the adjustment coefficients, and Johansen and Juselius (1990) show that under this hypothesis the maximum likelihood estimation of the parameters could be performed by reduced rank regression. The test of H_3 in H_1 , again, consists in comparing the largest eigenvalues $\hat{\lambda}_i$ ($\tilde{\lambda}_i$) of matrix in equation (4.28), calculated without (with) restrictions. The test statistic is obtained as before and has an asymptotic χ^2 distribution with $h(n-m)$ degrees of freedoms, where m is the dimension of the F matrix.

Alternatively, we could test the hypothesis that income, inflation and the interest rates are weakly exogenous only for the parameters of the first cointegrating vector. Weak exogeneity means that income, inflation and the interest rates do not react to disequilibrium errors in real money, but still react to its lagged changes. Then the process y_t is divided into $x_t = (m-p)_t$ and $z_t = \{Rl_p \Delta p_t, i_t\}$. Assuming a reduced rank of 1 ($h_1=1$), this restriction can be formulated as

$$H_3 : \alpha_{21} = \alpha_{31} = \alpha_{41} = 0$$

with

$$F = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}.$$

Johansen and Juselius (1990) show that under that hypothesis the maximum likelihood estimation of the parameters could be performed by reduced rank regression and that the test statistic for this hypothesis is computed similar to the previous hypothesis and the is asymptotically distributed as $\chi^2(h_1 n_p)$ (See Johansen (1992)).

4.5.2.3 Combining Restrictions on β and α

Assume that we would like to combine the hypotheses on cointegrating relations and adjustment coefficients. We can combine the restrictions on adjustment coefficients with both types of hypotheses described in Section 4.5.2.1. If we consider to jointly test the hypothesis of weak exogeneity together with the hypothesis that inflation and interest rates have the same coefficient in all cointegrating vectors. Then the hypothesis to be tested is

$$\beta_i = (*, \alpha_p, \alpha_p, *, *), \quad i=1, 2, 3, \text{ and } \alpha = F\psi.$$

Then these restrictions take the form of a joint restriction. The test statistic is calculated in a similar way and has a χ^2 distribution with $(h(n-q) + h(n-m))$ degrees of freedom.

Alternatively we would like to test weak exogeneity hypothesis together with the identifying restrictions on the cointegrating relations in Section 4.5.2.1. Then the joint hypotheses can be represented as

$$\beta = (D_1 \varphi_1, D_2 \varphi_2, D_3 \varphi_3), \text{ and } \alpha = F\psi.$$

Again these restrictions take the form of a joint restriction. The test statistic has an asymptotic χ^2 distribution with $(\sum_{i=1}^h (n-h-q_i+1) + h(n-m))$ degrees of freedom.

4.6 Modelling in I(0) Space

After determining the unique cointegrating relations and obtaining the error-correction mechanisms, the next step is modelling the short-run dynamics of the system, by reducing the system to I(0) space in terms of differences and combinations of the levels of data using tests based on appropriate critical values. The resulting system is called a vector equilibrium correction and can be represented as

$$\Delta y_t = c + \sum_{i=1}^{p-1} \xi_i \Delta y_{t-i} + \sum_{j=1}^h \alpha_j g_{j,t-1} + \Lambda q_t + \varepsilon_t \quad (4.37)$$

where g_j denotes the j th error-correction mechanism obtained from $\beta' y_{t-1}$. This system can further be reduced parsimoniously by imposing restrictions on the parameters of the model. These restrictions result from the cointegration analysis, economic theory or empirical practice. For example, if the exogeneity of income, inflation and interest rates for the parameters of the demand for money function is not rejected in the cointegration analysis, then in the short run money should not affect the remaining variables. Hence, the error-correction term for the money demand equation should not enter into remaining equations. Furthermore, the roles of deterministic variables and their presence or absence from the short run can also be investigated. Hendry (1995) notes that although the best order of hypothesis tests is unclear, it is advisable to check the restrictions implied by the cointegration analysis first and then continue by a conditional factorization within which the insignificant variables are eliminated.

Rinaldi and Tedeschi (1996) note that the identification of the short-run is more tentative owing to the lack of clear indications from the economic theory. Suppose that these over identifying restrictions are represented by an $(n \times n)$ matrix M , and equation (4.37) is transformed to

$$M \Delta y_t = c + \sum_{i=1}^{p-1} M^*_{ij} \Delta y_{t-i} + \sum_{j=1}^h \Pi^*_{ij} y_{t-1} + \Lambda^* q_t + \varepsilon_t \quad (4.38)$$

which can be called the restricted VAR. In equation (4.38) M , M^* , Π^* and Λ^* denote the short-run restriction matrices for the dependent variables, explanatory variables, the cointegration relations and the deterministic variables respectively. A likelihood ratio test can be performed to see if the restrictions are valid. If so, the system can be modelled as a parsimonious vector autoregression (PVAR) to enhance its interpretability and reduce its sample dependence, or increase its invariance to regime changes and its parsimony may allow more powerful tests of some hypotheses of interest, especially constancy. Then forecasting exercises can be performed.

4.7 Conclusion

In this chapter, econometric approaches that are employed in this study are outlined. Starting from a general DGP, the general to specific modelling proposes the marginalization of this DGP with respect to the variables that are not of interest. The selection of a subset of variables of interest is a matter for economic theory which also provides information about the probable econometric model. After the determination of variables of interest a subset of these variables may be found to be exogenous, which are then used to condition the remaining variables of interest. Afterwards a suitable simple representation of the conditioned marginalized DGP should be assumed and estimation should be performed.

In section 4.2 the general to specific approach is reviewed. The first step is to determine the variables of interest with the aid of economic theory. Economic theory

provides and postulates that the demand for real money depends positively on a scale variable, which could be income or wealth, but is negatively related to the returns on alternative assets and the rate of inflation. The magnitude of the income elasticity of demand for money has been subject to a lot of discussion. Although in the long run a unit income elasticity may be anticipated, estimations for broad monetary aggregates tend to produce income elasticities that are greater than unity.

After determining the variables, the next step is the selection of a functional form which is a suitable and simple representation of the conditionalized DGP. Section 4.3 presented alternative functional forms of demand for money, including partial adjustment and error correction models. Furthermore, vector autoregressive (VAR) modelling, which is employed in this study is also presented in section 4.3. An econometric analysis of VAR models, its linkages with cointegration analysis and the importance of hypothesis testing in this context are also discussed. Since there is no a priori endo/exogenous division of variables, VAR models can provide a feasible starting point for system estimations. Furthermore, cointegration analysis allows precise formulation of a number of economic hypotheses about the behaviour of variables in such a way that they can be tested. An explicit classification into stationary and nonstationary components is provided by cointegration analysis, which could be interpreted in terms of dynamic short-run and long-run effects.

Furthermore, VAR modelling together with cointegration analysis investigates both the short-run and the long-run dynamics of the system. By cointegration analysis, stationary long-run relationships between non-stationary variables of the system can be found. Additionally, it is possible to formulate a number of economic hypotheses about the behaviour of the variables, which can be tested. In particular, the weak exogeneity assumption required by the econometric analysis is tested, in addition to restrictions implied by economic theory.

CHAPTER 5

MODELLING THE DEMAND FOR MONEY IN GERMANY

5.1 Introduction

Among the central banks of the European Union (EU) countries, the Deutsche Bundesbank is reputed for its commitment to low inflation. The general strategy of the Deutsche Bundesbank is frequently described in terms of targeting a monetary aggregate with medium-term stability in mind. The announcement of an annual growth target has aimed at influencing expectations that monetary policy will be geared to price stability. Although the concept of money has been changed from central bank money (CBM) to the broad monetary aggregate, M3, and the specific targets have varied, the underlying concept has remained the same since the early 1970s. Until 1992, monetary expansion exceeded the mid-point of the target range by only one percentage point per year on average,¹ which suggests that the Deutsche Bundesbank has been quite successful in maintaining its anti-inflation policy.

The Deutsche Bundesbank is constitutionally assigned the task of safeguarding the stability of the Deutsche Mark (DM). Although the external value of the DM depreciated in some periods, it has become the second reserve currency in the world, after the US dollar. However, fluctuations in the exchange rate, changes in banking regulations in Germany and the introduction of a withholding tax on interest income have led German residents to hold other currencies in their portfolios, (cross-border deposits), or have resulted in capital outflows. Since these CBDs are not included in the traditional monetary aggregates, an increasingly important problem with the assessment of the monetary expansion concerns the interpretation of M3. Especially since late 1988, the measurement of monetary expansion is somewhat distorted by the unusually strong growth of CBDs held by the domestic non-bank sector. "When a similar distortion occurred at the beginning of 1986, the

¹OECD Economic Surveys, Germany, 1992/93, pp.51.

Bundesbank began to calculate an extended M3 money stock, including German non-banks' Euro-deposits and short-term bank bonds."²

Although changes in banking regulations and/or exchange rate expectations may lead to instability in traditionally defined monetary aggregates, they likely to have fewer consequences for an extended monetary aggregate, as argued in Chapter 3. Moreover, an extended monetary aggregate which includes all foreign currency holdings of residents as well as deposits in domestic currency held at banks abroad would be more informative than the traditionally defined monetary aggregate. Therefore, in this chapter the stability of demand for extended money in Germany will be investigated. But first, section 5.2 presents an overview of the monetary developments in Germany since 1978. In section 5.3 the evolution of CBDs are discussed in relation to the monetary policy changes that occurred in the sample period. A brief account of existing studies on the German demand for money functions is given in section 5.4. In section 5.5, the extended demand for money is estimated for Germany employing VAR modelling which was presented in Chapter 4. Finally, section 5.6 concludes.

5.2 Economic Developments

Like many other EU countries, Germany was also affected by the second oil-price rise and experienced a period of recession between 1980-1982. Economic performance deteriorated markedly with higher inflation which was caused mainly by higher import prices, a sizeable external current account deficit and increased unemployment from the end of 1979 onwards. During that recession period the monetary authorities pursued a tight policy by restricting monetary growth and gradually raising interest rates. Reflecting the objectives of the Bundesbank, the growth of central bank money (CBM) slowed down.

Figure 5.1 presents German time series data of real extended money (m-p),

²European Commission (1990), "The Federal Republic of Germany", Economic Papers, Country Studies 1, pp.20.

GDP at 1985 prices (y), inflation (Δp) and long term interest rates (R), measured by the return on ten year government bonds, where all variables are in logarithmic form, except the interest rates.³ It is observed that inflationary pressures reached their peak in the last quarter of 1981 but declined rapidly thereafter, largely reflecting the fall in energy prices. Import prices, which increased due to exchange rate developments had been the main source of inflation but from late 1981 onwards import prices dropped, initially as a result of a temporary strengthening of the DM, later mainly due to the fall in energy prices. Interest rates increased to high levels, due to the large current external deficit and to high interest rates in the US but following the improvement in the current account and lower inflation, the authorities decided to ease monetary conditions in the fourth quarter of 1981. Long term interest rates fell from their peak level of 11.1% in the third quarter of 1981 to 8.1 in the last quarter of 1982.

The period 1982-1987 was one of recovery for the German economy. The OECD Economic Survey for Germany 1987/88 reports that the 1982-87 upswing was the longest but also the weakest on record. Although this upswing was initially led by domestic demand, foreign demand became the main dynamic element during the course of recovery. This period can also be considered as one of adjustment and disinflation, so that the pace of recovery was weak compared with previous experience. In 1984 price stability and external equilibrium was achieved, although unemployment remained at high levels and economic growth remained moderate.

In 1986-1987 the situation was reversed when imports rose much more rapidly than exports following a sharp real appreciation of the Deutsche Mark. Real domestic demand expanded rapidly, helped by tax-cuts and strong terms of trade gains. The rise in the terms of trade came from a sharp fall in import prices linked to lower oil prices and the depreciation of the US dollar. Export performance deteriorated due to the slowing down of world trade and the rapid appreciation of the DM. Real GDP fell in the last quarter of 1986 and, under the impact of severe weather conditions, in the first quarter of 1987. The lower oil prices together with a

³For precise definitions of all variables, see Appendix 1.

prudent monetary policy helped to achieve price stability in that period.

Although the growth of CBM was in the target range in the first half of the 1980s, conflicts between medium term and short term considerations led the monetary authorities to overshoot the target range during the second half of the decade. The CBM growth exceeded the upper limit of the permissible target corridor in 1986 and 1987 by 2%, as continued upward pressure on the DM dissuaded the monetary authorities from a tightening of policy. The growth rate of M3, on the other hand, had been 6% in 1987, which was less than that of CBM. Low levels of short-term interest rates together with the continual overshooting of the monetary targets, caused fears of renewed inflation and expectations of the possible tightening of policy. In 1988 the Bundesbank changed its monetary target from CBM to M3. "This move was motivated by the observation that M3 reacts less to the changes in interest rates, exchange rate changes and expectations than the CBM".⁴

The downward trend in interest rates since late 1981 was interrupted in early 1985 when the DM-US dollar exchange rate peaked and the monetary authorities chose to tolerate some rise in interest rates in order to limit capital outflows. But afterwards the fall in domestic interest rates continued, triggered by the downturn of US interest rates. Short-term interest rates had been brought down to historically low levels by the last quarter of 1987 but both short and long-term interest rates increased after that.

On July 1, 1990, East and West Germany formed a monetary union, where the Deutsche Mark became the only legal tender and the German Bundesbank became the sole monetary authority. Von Hagen (1993) reports that monetary union confronted the Bundesbank with uncertainty in the conduct of monetary policy, which influenced the public's perception of Bundesbank policies. The monetary union implied an increase in total money supply. Immediately after the conversion East German M3 balances amounted to approximately 15% of West German M3, whereas monetary union added an estimated 8.8% of real output to the unified area. "In view

⁴OECD Economic Surveys, Germany, 1987/88.

of this discrepancy, the Bundesbank repeatedly argued, during the following quarters, that the monetary union had created an excess supply of money and, thereby, a potential for a price-level increase".⁵ In response to these uncertainties, the Bundesbank pursued a tight monetary policy. The 1990 target range of 4 to 6% was extended to 1991 for the entire currency area. Although the target range was lowered after a fall in East German money demand in the first half of 1991, money demand expanded much faster than targeted through 1992 and 1993. The divergence between the 1992 target of 3.5 and the actual growth of 5.5 can be regarded as the most significant in 17 years of monetary targeting in Germany. The outflow of capital in the aftermath of the exchange market turmoil in 1992 and portfolio shifts caused by the introduction of the withholding tax on interest income in 1993 could not slow the expansion of M3.

In the wake of unification Germany had a comparatively high level of inflation. Consumer prices increased after unification with inflation reaching a peak of 4.3% in the second quarter of 1992. In contrast to the previous inflationary periods, imported inflation had not contributed to the latest acceleration of prices. By the end of 1993 inflation had been reduced to 3.6%, due to a tight monetary policy. Although short-term interest rates remained stable around 7% throughout much of 1989, they started to increase in the last quarter of 1989 showing the first reaction to unification. Long term interest rates rose to a peak close to 9% in the last quarter of 1990, before starting to decline. Short term interest rates, on the other hand, peaked in the second quarter of 1992 at 9.6%, then showed a slight decline. The turning point in short-term interest rates coincided with the decision to devalue the Italian lira on 14 September 1992, which was followed by the ERM 'black Wednesday' when sterling and the lira left the ERM. These developments in interest rates reflected the policy by the Bundesbank of easing money market conditions. According to von Hagen (1993), rising interest rates had two potential explanations, rising inflation expectations or a rise in real interest rates, in anticipation of a fiscal

⁵von Hagen (1993), pp 808.

expansion as a result of German unification. Since 1990 short term interest rates have been higher than long term interest rates producing an inverse interest rate structure, which could be expected to lead to an increase in the demand for M3⁶.

The main policy of the Deutsche Bundesbank has been the targeting of a monetary aggregate. "Since 1974, the pursuit of the price stability objective has been through the setting and subsequent adherence to quantitative targets for the expansion of the money stock derived from estimates of the growth of potential output unavoidable or normative inflation, and the trend change in the income velocity of money."⁷ Generally, a target range for the monetary aggregate is given, but deviations are tolerated whenever a need (which could be due to external factors) for policy flexibility is felt. The short-term and the long-term interest rate differentials between Germany and other ERM countries have gradually narrowed, particularly since February 1990. Even though the Bundesbank enjoys a relatively high degree of independence in its interest rate policy, due to its leadership role in the ERM, external developments, especially exchange rate developments, have never been irrelevant for monetary policy. "The stability of the ERM grid was a factor to be considered. In addition, the political commitment to create an ever-closer union, and one more specifically tied into a framework of monetary policy coordination, has constrained the authorities to a certain extent, albeit an extent has varied over time."⁸

5.3 Evolution of CBDs

Germany has a highly developed and efficient financial market where a broad range of financial services is provided for domestic clients at relatively low cost. A strong economy matched with low inflation and openness towards international competition has contributed to the success of the financial system. Germany has adopted a very

⁶See OECD Economic Surveys, Germany, 1992/1993.

⁷OECD Economic Surveys, Germany, 1992/93, pp.50.

⁸European Union (1994), "Economic and Financial Situation in Germany", No.2.

liberal regime of capital movements to and from the rest of the world since the 1950s, which allowed the economy and financial markets to develop within the framework of unrestricted financial flows.

It has been argued that capital flows between Germany and abroad, and the developments of CBDs⁹, have been influenced by two factors in addition to the monetary policy stance and exchange rate changes:

- i) the introduction of the withholding tax on interest income,
- ii) changes in banking regulations, such as changes in the reserve requirements.

Furthermore, both German unification and the ERM crisis in late 1992 have also affected capital movements and CBDs.

Figure 5.2 shows the developments of CBDs which are included in the extended monetary aggregate based on the residency of holder criterion in Germany. The distinguishing feature emerging from the analysis is the dominant role of domestic currency: at the end of 1993, out of 291.22 billion DM held abroad by German residents, 248.99 billion was denominated in DM. Until 1985 domestic and foreign currency deposits of German residents abroad, CBD2 and CBD6 respectively, increased slowly, as can be seen from Figure 5.2. But starting from 1986, the two types of deposits took different paths. Although foreign currency deposits continued to grow at low rates, DM deposits started to increase rapidly, rising almost 7 fold between 1986 and 1993. This appears to be related to changes in German banking regulations. Effective from May 1, 1986, the exemption from reserve requirements of short term bank bonds was abolished, leading to an immediate increase in DM deposits held abroad by German residents. Furthermore, this component increased by 83.4% between 1988:4 and 1989:4, apparently due to the introduction of a withholding tax on interest income, which was effective from January 1, 1989. Although this tax was abolished later, it was introduced again as from January 1, 1993, leading to a rapid capital outflow, and a slight increase in DM deposits held abroad by German residents. The favourite destinations of deposit relocation for

⁹For the definition and importance of CBDs see Chapter 2.

German holders are the United Kingdom, Luxembourg and the Netherlands.

As far as pure currency substitution is concerned, the foreign currency deposits held by German residents within Germany (CBD5) remained very small, amounting only to 0.07% of M3 in 1993:4. This indicates that, in contrast to pure relocation, currency substitution remained negligible for German residents. But, on the other hand, the increase in DM deposits held by nonresidents suggests that national currencies in the EU are being substituted by the DM. Thus, even though currency substitution remains negligible for Germany, the DM plays an important role as a reserve currency which is substituted for the other national currencies in the EU. Therefore, one may expect a stable extended money demand for Germany, but other national money demand functions may show instabilities and even be affected by German monetary developments. The first issue is considered in section 5.5.

5.4 Existing Studies

It has been widely recognized that the stability of the demand for money is one of the necessary preconditions for a successful policy of monetary targeting. Thus, the stability of the German money demand function has been investigated quite intensively since the Deutsche Bundesbank began its policy of announcing yearly monetary targets in the mid-seventies. There seemed to exist widespread agreement that the hypothesis of money demand stability could be rejected. Most researchers found structural breaks at the beginning of the 1970s, which were generally attributed to the breakdown of the Bretton Woods System or a switch in the monetary policy procedures of the Deutsche Bundesbank.¹⁰ However, another line of argument attacked these claims stating that the evidence points to misspecification of the money demand functions rather than to problems of stability. Given the conflicting evidence on the stability of German money demand function, Herz and Röger (1990) investigate the stability of M3 employing alternative specifications for the time period 1962-1984. They report that the instability of the money demand is a consequence

¹⁰See Herz and Röger (1990).

of breaks in the seasonal pattern of income. This could be attributable to measurement errors, as quarterly income reflecting changes in seasonal production patterns do not properly take into account the seasonal structure of the volume of transactions. They argue that once changes in the seasonal pattern are accounted for, the conventional money demand specifications yield relatively good results concerning stability. Furthermore, the OECD (1993) shows that the money demand (M3) equations exhibit all the properties that make M3 suitable for monetary targeting.

However, recently renewed doubts about the stability of money demand function have been raised by some authors, who argue that German unification may impair its stability. Von Hagen (1993) reports that German unification has added monetary policy uncertainty as the variability of M3 quarterly velocity has increased and parameter stability is rejected for M3. He estimates a general model for velocity of money for the time period 1965:1-1990:2 using quarterly data, then computes six quarter out-of sample prediction errors to see the effects of German unification. The models are estimated for M1 and M3, where the scale variable is GNP and inflation is defined in terms of the rate of change of the consumer price level. The results of the analysis confirm the earlier findings of a stable, constant parameter empirical representation of the German demand for money until the unification. However, he reports that monetary union increased the volatility of velocity in the following quarters and that the stability of the money demand function cannot be accepted for the broad monetary aggregate M3, but can be accepted for M1.

Hansen and Kim (1995), on the other hand, report conflicting results from those of von Hagen (1993). They estimate single equation error-correction models for M1 and M3. The estimates are obtained for the sample period before German unification, 1960:1-1989:4 for M1 and 1975:1-1989:4 for M3. The long-run cointegration relations indicate that income elasticities of both models are greater than one, and the short-term interest rate is insignificant in the long-run demand function for M3. They report adjustment coefficients of 0.05 for M1-money demand

and 0.06 for M3. By extending the sample period to 1992:4, tests of stability are performed. According to their results, cointegration seems to be destroyed after German unification for the M1- money demand function but not for that for M3. The stability tests indicate a breakpoint in M1 in 1990, which is presumed to relate to German unification. They conclude that monetary targeting based on M3 and not on M1 may still be a sensible strategy for stabilizing price level.

The impact of German unification on the stability of money demand in both Germany and in the EMS was assessed by Falk and Funke (1995). They argue that, since Germany has been the anchor of the EMS for a long time period, German unification may affect the stability of an area-wide money demand function. They compare the stability of the demand for narrow money in Germany to the demand for narrow money in two currency areas: EC-3 (Germany, France and the Netherlands) and EC-7 (Belgium, Denmark, France, Germany, Ireland, Italy and the Netherlands). They estimate a single equation error-correction model, where real GDP is the scale variable and short-term interest rates are the proxy for the opportunity costs of holding money. Moreover, they include the DM/US dollar exchange rate to take account of possible currency substitution effects. For the area-wide estimates, the national variables are aggregated using the PPP rates of a base year.¹¹ They carry out estimation for two sample periods, 1977:4-1990:1 and the whole period 1977:4-1992:4 where a dummy variable for 1990:2 is included. They report that the long run income elasticities for Germany are, at around 1.5, higher than in the two currency areas. Furthermore, the unification dummy appears to be significant in all equations, even though the size of the effect decreases with the size of the currency area. They conclude that the stability of both German demand for narrow money and the aggregate demand for narrow money cannot be rejected during the EMS period prior to German unification. German unification seems to have a significant impact on money demand in Europe as well as on money demand in Germany. However, the effects of German unification on the stability of money demand functions may be only

¹¹See Chapter 10, for various methods of aggregating national variables.

of a temporary nature.

Their results are similar to those reported by Cassard et al. (1997) who employ a one step version of the error correction procedure in estimating the demand for real M3 for the time period 1979:2-1990:2 and investigate the stability of the model using post-sample forecasts over 1990-1992. They find a cointegrating relationship between real M3, real income and the spread between the own rate of money and long-term interest rates. Like Hansen and Kim (1995) and Falk and Funke (1995), they report an income elasticity which is greater than one (1.70), together with an adjustment coefficient of 0.07. However, their results indicate that the demand for M3 in Germany is not stable.

The stability of the German demand for money function has also been investigated by employing non-linear techniques. Lütkepohl et al. (1995) and Wolters et al. (1996), investigate the stability and linearity of both German M1 and M3 money demand functions, applying smooth transition regression techniques. Both studies start from a linear error-correction model using seasonally unadjusted data and use the arguments in the short-run equations, including the lagged error correction term, as transition variables. The results of the nonlinearity tests indicate that there is no evidence of nonlinearity for demand for neither M1 or M3. Thus, the findings of both papers indicate that estimating error-correction models using data for West Germany until 1990:2 and data for the unified Germany afterwards leads to stable demand for money functions for M1 and M3, when the break in the data for GNP and money is modelled with a step dummy.

Finally, Artis et al. (1993) and Filosa (1995) investigate the existence of a stable demand for money function focusing on currency substitution between the Deutsche Mark and other major EU currencies. Artis et al. (1993) estimate the demand for real M1 for the time period 1979:2-1990:2, using real GDP as the scale variable and the long-term interest rate as the opportunity cost variable and employing a partial adjustment form to take care of the dynamics. They also include the expected exchange rate changes vis-a-vis other European currencies and the US

dollar to test for the existence of currency substitution. They report that devaluation expectations (proxied by the three-month forward premium) have a powerful influence on the demand for money function. However, the significance of the currency substitution term is confined to the European currencies, and does not embrace the US dollar.

Demand for M3 is estimated by Filosa (1995) using the error-correction method with quarterly data for the time period 1980-1991. He employs an indicator of the expected depreciation of the Deutsche Mark vis-a-vis the US dollar. The results indicate that an income elasticity of around 1.7, which is consistent with most of the existing studies. The expected rate of depreciation against the dollar has a negative effect on the demand for money, contrary to the findings of Artis et al. (1993). Finally, Chow tests for parameter stability show that the demand for M3 is stable in Germany.

Overall, existing studies give uniform results concerning the economic interpretation and the stability of the German money demand function prior to German unification. Even though price homogeneity is accepted, the long-run real income elasticity is found to be significantly greater than one. In most studies short-term interest rates are not found to be significant. The long-term interest rate and the own rate of money have a significant effect on the demand for money. It is generally agreed that German unification seems to have had a significant impact on money demand in Germany as well as on money demand in core countries of the ERM (See Falk and Funke (1995)). However, Lütkepohl et al. (1995) and Wolters et al. (1996), argue that stable demand for money functions for M1 and M3 are obtained, when the break in the data for GNP and money is modelled with a step dummy. Furthermore, studies employing error-correction models to estimate German money demand functions report that the speed of adjustment, which is around 0.05-0.07 per quarter, to disequilibrium errors is relatively slow. Finally, studies concerning currency substitution report that depreciation expectations relative to other European currencies, especially the French Franc and Italian Lira, have significant negative

effects on German money demand functions (Filosa 1995).

5.5 Modelling the Demand for Extended Money¹²

In order to examine the economic and stability properties of the demand for extended money, a four equation VAR model is considered. The data are extended M3 (M), GDP at 1985 prices (I), the consumer price index (P) and long-term interest rates (RI) which is the yield on 10-year government bonds. Most of the existing studies estimate the demand for M3, which could be due to the fact that M3 is the target variable in Germany. Generally, GDP is employed as the scale variable, with other explanatory variables being inflation and either the short-term interest rates or the spread between the own rate on money and the long-term interest rates. Furthermore, it is reported by Lütkepohl et al. (1995) and Wolters et al. (1996) that inclusion of a unification step dummy to account for the break in the series improves the stability of the demand for money function. Thus dummy variables for unification are employed in this chapter in both the long-run and the short-run dynamics. Seasonally adjusted quarterly data is available for the time period 1978:1-1993:4. All variables are in logarithmic form, except interest rates, and are represented as lowercase letters.

Prior to modelling the relationships between the economic variables, their univariate time series properties are established.¹³ The results of augmented Dickey-Fuller tests (shown in Appendix 1) indicate that apart from the price level, all variables considered by the study qualify as I(1). Furthermore, tests suggested by Perron (1989) for variables which have structural breaks, are applied to some of the variables, as German unification in the last quarter of 1990 causes breaks in the data. But the results of the Perron tests suggest that the null hypothesis of unit roots for

¹²As this is the first chapter where estimation results are presented, each step of the empirical analysis is presented. However, following chapters for other countries provide shorter versions.

¹³The definitions of all variables, their sources and the results of unit root tests are given in Appendix 1.

all variables cannot be rejected, in accordance with the conventional unit root tests. In particular real extended money, $(m-p)$, is $I(1)$. As a major consequence of the price level not being $I(1)$, the consumer price index cannot be included as separately but appears in transformed variables, such as inflation, Δp , and real money balances. Long-run price homogeneity is imposed, leading to a system of four stochastic variables $((m-p), Rl, \Delta p, i)$ with a constant and a trend.

Furthermore, the trend is restricted to the long-run dynamics where it is assumed to be a proxy for financial innovations which have taken place over the sample period. Hendry (1995) notes that the trend should enter into the cointegration space, as otherwise it would induce a quadratic trend in levels, for which there is no evidence. From an economic point of view, on the other hand, the time trend may pick up the effects of other determinants of money demand which are missing in the model. Financial innovation and deregulation increased in the EU countries in the late 1980s, including the abolition of the exchange controls. Technological progress in the area of financial services enables financial institutions to provide better quality services which meet customers' needs and may increase the demand for the broad money. New financial instruments were introduced during this period, leading to increases in the liquidity of and the returns on interest-bearing assets included in national broad monetary aggregates. Muscatelli and Papi (1996) argue that trends are certainly *ad hoc* variables to capture the effects of these developments. Ideally economic variables, such as measures of real and financial wealth, should be used instead of such proxies. However, data limitations for several EU countries do not allow inclusion of these variables in the model.

Empirical analysis started from an augmented VAR with four lags on all variables. In order to see if German unification led to a structural change in any of the equations, Chow tests were performed.¹⁴ Although German unification officially took place in the third quarter of 1990, monetary aggregates were fully combined during 1991. Since the GDP series was adjusted backwards, but M3 was not, a break in the

¹⁴See Appendix 1 for the implementation of the Chow test.

M3 series is clearly visible at the first quarter of 1991. Therefore, when performing Chow tests, the break point for M3 was taken as the first quarter of 1991, but for other variables it was assumed to be the third quarter of 1990. Alternatively, the break point could be taken as the three quarters from 1990:3 onwards. Table 5.1 presents the results of the Chow test applied to the slope coefficients of the separate equations of the VAR(4). The test results indicate that evidence of structural change is not found for any of the equations. Therefore, there is no need to include slope dummies in the equations. Only intercept dummies, D1990:3 and D1991:1, are used to capture the possible effects of German unification on any of the equations.

Table 5.1: Chow Tests

Variable	Break Point	Test Statistic	Critical Value at 5% level
(m-p)	1991:1	2.10	2.57
	1990:3-1991:1	0.65	
Rl	1990:3	0.91	2.38
	1990:3-1991:1	1.01	
Δp	1990:3	0.98	2.38
	1990:3-1991:1	1.12	
i	1990:3	1.87	2.38
	1990:3-1991:1	1.91	

After establishing the results of the structural change tests, we can now start modelling the system. The vector of variables in the joint density comprises:

$$((m-p)_t, Rl_t, \Delta p_t, i_t)$$

In addition to these four stochastic variables, the system contains a constant and a trend. After allowing for lags, estimation is carried over 1979:1-1993:4, yielding 60 observations. The first step to the modelling is the determination of the lag length of the VAR model to simplify the specification of the system at hand. As explained in

Chapter 4, a practical solution would be to start from the highest possible lag-length, then reduce it one lag at a time and perform the likelihood ratio test at each step. Throughout this study, empirical analysis starts with four lags of each variable and the results are obtained using PcFiml version 8.00 (see Doornik and Hendry (1994)), then the lag-length is reduced by one at a time. The F-approximation of the likelihood ratio test, and Schwarz and Hannan-Quinn criteria statistics are reported by PcFiml and presented in Table 5.2.¹⁵

Table 5.2: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-27.68	-29.21	1 → 2	F(16,119) = 2.02* (0.01)
2	3	-28.04	-29.23	2 → 3	F(16,132) = 1.11 (0.34)
3	2	-28.74	-29.59	1 → 3	F(32,145) = 1.61* (0.03)

Note: * denotes significant at the 5% level and p-ratios are in parentheses.

In Table 5.2, Schwarz and Hannan-Quinn criteria have a minimum for model 3, suggesting a two-lag system. However, the F-form of the likelihood ratio tests (see Chapter 4) indicates that reduction by 16 parameters for eliminating lag-length 4 and the reduction by 32 parameters for eliminating lags 3 and 4 are not accepted. But if the analysis started from lag-length 3, the reduction by 16 parameters to eliminate lag 3 would be acceptable and a 2 lag model would be chosen. Since the F-tests indicate a four lag system and some lag-4 variables matter greatly, a four lag model is chosen as the initial model.

The graphical analysis of the scaled residuals of the initial system, presented in Figure 5.3, suggests the inclusion of two dummy variables in addition to the

¹⁵For the determination of the lag-length see Chapter 4.

Table 5.3: Unrestricted VAR Estimates

	$(m-p)_{t-1}$	$(m-p)_{t-2}$	$(m-p)_{t-3}$	$(m-p)_{t-4}$	RI_{t-1}	RI_{t-2}	RI_{t-3}	RI_{t-4}	Δp_{t-1}	Δp_{t-2}	Δp_{t-3}	Δp_{t-4}	i_{t-1}	i_{t-2}	i_{t-3}	i_{t-4}
$(m-p)$	0.96 (13.2)	-0.08 (-0.97)	0.08 (0.94)	-0.06 (-0.98)	-0.006 (-2.12)	0.003 (1.01)	-0.0009 (-0.28)	0.0008 (-0.03)	-0.46 (-1.49)	0.60 (1.54)	-0.26 (-0.69)	0.12 (0.57)	-0.07 (-0.53)	0.07 (0.43)	0.15 (0.73)	0.06 (0.34)
RI	1.57 (0.40)	5.08 (1.08)	-2.38 (-0.50)	0.12 (0.03)	0.55 (3.44)	-0.14 (0.79)	0.39 (2.31)	-0.009 (-0.06)	6.21 (0.37)	9.26 (0.44)	-9.41 (-0.45)	5.91 (0.51)	24.0 (3.22)	-4.02 (-0.41)	-9.78 (-0.86)	-8.30 (-0.84)
Δp	0.02 (0.54)	0.008 (0.18)	0.03 (0.61)	0.01 (0.35)	0.001 (0.65)	0.0007 (0.39)	0.002 (1.31)	-0.001 (-1.10)	1.22 (7.15)	-0.84 (-3.93)	0.51 (2.45)	-0.23 (-1.95)	0.14 (1.90)	-0.39 (-3.92)	0.26 (2.28)	-0.009 (-0.93)
i	0.15 (2.05)	-0.10 (-1.19)	0.05 (0.66)	-0.03 (-0.44)	0.002 (0.73)	-0.003 (-1.04)	0.001 (0.42)	-0.001 (-0.50)	-0.004 (-0.01)	0.10 (0.26)	-0.07 (-0.19)	0.12 (0.55)	0.80 (5.69)	0.07 (0.39)	0.48 (2.24)	-0.62 (-3.36)

Note: t-ratios are in parentheses.

Table 5.4: Residual Correlations and Lag Length Statistics for VAR(4)

Residual Correlations

	(m-p)	Rl	Δp	i
Rl	-0.001	-	-	-
Δp	-0.28	0.03	-	-
i	0.26	0.29	-0.09	-

Lag Length Dynamics

	(m-p)	Rl	Δp	i
$F_{s=1}(4,34)$	45.13** (0.00)	3.78* (0.01)	11.8** (0.00)	9.75** (0.00)
$F_{s=2}(4,34)$	0.93 (0.45)	0.80 (0.53)	3.72* (0.01)	3.68* (0.01)
$F_{s=3}(4,34)$	0.69 (0.69)	1.58 (0.20)	0.23 (0.23)	3.46* (0.01)
$F_{s=4}(4,34)$	0.23 (0.91)	0.38 (0.82)	0.96 (0.43)	3.20* (0.02)
$ \mu $	0.38	0.38	0.066	0.066

Note: *denotes significant at the 5% level, and p-values are in parentheses.

dummy variables for unification of D1990:3 and D1991:1, which are D1981 and D1987:1. The dummy variable D1987:1 can be assumed to capture the effects of a fall in output caused by severe winter weather (see OECD economic survey of Germany 1987/88). The dummy variable D1981 is not so clear cut. It takes the value 1 for the first three quarters of 1981, in which period long term interest rates reached what were for Germany exceptionally high levels. It was expected that German unification would have long-run implications due to the break in the series. Thus, in addition to the impulse dummy of D1991:1, a unification step dummy, S1991:1, is

also included in the analysis and, like the trend, is conditioned to the long run to capture the long-run implications of German unification. Thus, a 4 lag system with 5 dummy variables and a trend is selected as the final model. The resulting unrestricted VAR estimates, other than the dummy variables, are presented in Table 5.3.

The residual cross-correlations and the lag-length statistics of this final model and statistics on lag-length are given in Table 5.4 where $|\mu|$ denotes the modulus of eigenvalues of the long-run matrix and $F_j(\dots)$ denotes an F-test for the hypothesis for all i lag coefficients being zero. The residual cross - correlations indicate that there are large unexplained positive correlations between income and real extended money,

Table 5.5: Goodness of Fit and Diagnostic Test Results

	(m-p)	RI	Δp	i	VAR
$\hat{\sigma}$	0.6%	3.6	0.3%	0.6%	
$F_{ar}(4,33)$	0.56 (0.68)	0.21 (0.92)	3.19* (0.02)	1.97 (0.12)	
$F_{arch}(4,29)$	0.30 (0.87)	0.15 (0.95)	0.62 (0.65)	0.94 (0.45)	
$F_{het}(35,1)$	0.04 (1.00)	0.04 (1.00)	0.02 (1.00)	0.03 (1.00)	
$\chi^2_{nd}(2)$	2.56 (0.27)	0.61 (0.73)	0.10 (0.94)	3.29 (0.19)	
$F^v_{ar}(64,72)$					1.52* (0.04)
$\chi^{2v}_{het}(350)$					356.18 (0.39)
$\chi^{2v}_{nd}(8)$					5.26 (0.72)

Note: * denotes significant at the 5% level, and p-values are in parentheses.

and income and the long term interest rate. The long-run matrix has two eigenvalues close to zero and two larger ones, suggesting that there are two cointegrating vectors. Furthermore, the lag-length statistics reveal that all lags of income and three lags of inflation are significant, whereas real extended money and the long-term interest rates have only one significant lag.

Table 5.5 records statistical information about the unrestricted VAR reported by PcFiml. In Table 5.5 $\hat{\sigma}$ denotes equation standard deviation; $F_j(\cdot, \cdot)$ denotes F-tests for the hypotheses of no serial correlation against serial autocorrelation up to order 4 (F_{ar}), no autoregressive conditional heteroscedasticity against a four lag alternative (F_{arch}), no heteroscedasticity (F_{het}) and a chi-square test for normality (χ^2); analogous vector tests are also given and these are indicated by superscript v. Although there is some indication of a problem of autocorrelation of fourth order in the inflation equation, it is not significant at 1% level. Furthermore, all other diagnostics are satisfactory.

5.5.1 Cointegration Analysis

After the VAR model is adequately specified, cointegration in the four equation system is investigated. Table 5.6 gives the cointegration analysis, where λ denotes the eigenvalues, Max and Tr denote the associated maximum eigenvalue and trace statistics as discussed in Section 4.5. The test statistics indicate that there are four cointegrating vectors. But this would imply stationarity of each variable possibly around a trend, which is not compatible with the univariate unit root analysis. There could only be at most three cointegrating vectors in a system of four stochastic variables. As discussed in Chapter 4, the test statistics are sensitive to the inclusion of dummy variables and to the length of the sample period. This could be the reason for this mixed result. There are two relatively large eigenvalues and two smaller ones. Furthermore, the eigenvalues of the long-run matrix, presented in Table 5.4, also indicate the existence of two cointegrating vectors. Thus rank of the long-run matrix, which is also presented in Table 5.6, could possibly be two, indicating the existence

Table 5.6: Cointegration Analysis

r	1	2	3	4
λ	0.52	0.41	0.30	0.26
Max	44.37**	32.3**	22.2*	18.41**
Tr	117.3**	72.9**	40.6*	18.41**

Eigenvectors β

	(m-p)	Rl	Δp	i	trend	S1991:1
(m-p)	1.00	0.34	9.89	-16.6	0.057	1.20
Rl	-28.4	1.00	-137.8	-10.8	0.3627	7.34
Δp	-0.58	-0.01	1.00	1.23	0.0008	-0.01
i	0.26	0.02	-3.91	1.00	-0.010	0.03

Adjustment Coefficients α

(m-p)	-0.008	0.001	0.10	-0.03
Rl	-0.30	-0.11	-2.95	-0.66
Δp	0.0007	0.0001	-0.11	-0.05
i	-0.003	0.0001	-0.18	-0.09

Long-Run Matrix

	(m-p)	Rl	Δp	i	trend	S1991:1
(m-p)	-0.107	-0.003	-0.007	0.22	0.0003	-0.005
Rl	-4.40	-0.19	11.22	1.958	-0.053	-1.149
Δp	0.074	0.0002	-0.33	-0.077	-0.0006	0.003
i	0.072	-0.001	0.142	-0.264	0.0006	-0.002

of two cointegrating relationships.

Only the first cointegrating vector resembles a money demand equation, with negative effects from inflation and interest rate and a positive effect from income. Thus it can be interpreted as the excess demand for extended money. The second cointegrating vector can be interpreted as an interest rate equation and indicates that

the deviations of the interest rate from trend is positively related to inflation and income. The German unification dummy, which was conditioned in the long run, has a negative affect on the extended demand for money equation, although it was expected to have a positive coefficient capturing the jump in the money series.

Table 5.6 also presents the adjustment coefficients, which can be interpreted as the weights with which cointegration vectors enter the four equation system. They represent the average speed of adjustment towards the estimated equilibrium state, such that a small coefficient indicates a slow adjustment. The first column of the adjustment matrix $\alpha' = (-0.008, -0.30, 0.0007, -0.003)$ can be interpreted as the weights with which the excess demand for extended money enters into the four equations of the system.

The final determination of the number of cointegration vectors is based on the reduced rank test, which is explained in Chapter 4. If rank of the cointegration matrix is two, we would expect the first two linear combinations to look stationary and that the estimated long-run matrix would be close to the unrestricted long-run matrix (Doornik and Hendry (1994)). Table 5.7 presents the implied long-run matrix when the rank is assumed to be two. When Tables 5.6 and 5.7 are compared, it can be seen that the long-run matrix which obtained when the cointegration rank is fixed at 2, is very close to the unrestricted outcome. The graphs of the cointegration vectors which are presented in Figure 5.4 also suggests that the first two relations look stationary. Thus it is assumed that there are two cointegrating vectors in this chapter.

Table 5.7: The Reduced Rank Estimates

Long-run matrix

	(m-p)	RI	Δp	i	trend	S1991:1
(m-p)	-0.940	-0.003	-0.006	0.195	-0.0001	-0.002
RI	3.86	-0.21	12.33	2.88	-0.005	-1.18
Δp	-0.004	0.001	-0.024	-0.010	0.0000	0.00003
i	-0.006	-0.001	-0.050	-0.055	-0.0001	-0.003

5.5.2 Restrictions on β and α

In order to have unique cointegrating vectors, the identifying restrictions which are determined by economic theory should be imposed on cointegrating relations. The hypotheses that are considered in this section consist of restrictions on either the cointegrating relations or their weights and are explained in Chapter 4. As we assume the existence of two cointegration vectors, the adjustment coefficient and cointegrating vector matrices, α and β respectively, can be represented as follows, as in Chapter 4:

$$\alpha = \begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \\ \alpha_{31} & \alpha_{32} \\ \alpha_{41} & \alpha_{42} \end{bmatrix}, \quad \beta' = \begin{bmatrix} \beta_{11} & \beta_{21} & \beta_{31} & \beta_{41} & \beta_{51} & \beta_{61} \\ \beta_{12} & \beta_{22} & \beta_{32} & \beta_{42} & \beta_{52} & \beta_{62} \end{bmatrix} \quad (5.1)$$

Note that, as a trend and a dummy variable are conditioned in the long-run structure, β matrix becomes $((n+q_r) \times h)$ where q denotes the dimension of the additional variables in the system. The column of the adjustment matrix α indicates the weights with which each cointegrating vector enters into the short-run equations. The rows of the cointegrating matrix present the cointegrating relations. In Chapter 4, the restrictions on either the cointegrating relations or their weights are explained, and represented as

$H_2 : \Pi = -\alpha \varphi' D' \text{ or } \beta = D \varphi$, restrictions on cointegrating relations β' ,

$H_3 : \Pi = -F \psi \beta' \text{ or } \alpha = F \psi$, restrictions on adjustment coefficients α ,

$H_4 : \Pi = -F \psi \varphi' D' \text{ or } \beta = D \varphi \text{ and } \alpha = F \psi$, combined restrictions on the long-run matrix Π .

The matrices D ($n \times q$) and F ($n \times m$) are known and defined linear restrictions on the parameters of β (6×2) and α (2×4) respectively. These restrictions reduce the unknown parameters to $\varphi(q \times h)$ and $\psi(m \times h)$, where $h \leq q \leq n$ and $h \leq m \leq n$.

After determining the number of cointegrating vectors, the next step is to identify them. To uniquely determine cointegrating vectors relevant to the economic analysis requires economic theory and examination of the adjustment coefficients and eigenvectors. The adjustment coefficients corresponding to the standardized eigenvalues show market feedbacks of cointegrating vectors onto real money and interest rates. The remaining adjustment coefficients are small, and we will test below the hypothesis that they are zero.

i) Firstly the long-run weak exogeneity of $(Rl, \Delta p, i)$ for the parameters of the demand for money function is considered. This requires that the first cointegrating vector does not appear in short-run equations of $(Rl, \Delta p, i)$ indicating that interest rates, inflation and income do not react to disequilibriums in real money and the second cointegrating vector does not appear in the first equation. The restriction on the adjustment coefficients can be formulated as described in Section 4.5.2.2, as follows:

$$H_2 : \alpha_{21} = \alpha_{31} = \alpha_{41} = \alpha_{12} = 0$$

with

$$F = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & * \\ 0 & * \end{bmatrix}.$$

However, it is observed in Table 5.6 that the elements of the third and fourth rows of the adjustment coefficient matrix and the long-run matrix are quite small, suggesting the possible weak exogeneity of inflation and income for the long-run parameters in this model. Thus, the long-run weak exogeneity of $(\Delta p, i)$ for the long-run parameters is tested as described in Section 4.5.2.2. This requires that the first and second cointegrating vectors appear only in the short-run equations of money and interest rates, respectively, but do not appear in those of inflation and income. The restriction on the adjustment coefficients can be formulated as

$$H_2: \alpha_{ij} = 0, \quad i=3,4, \text{ and } j=1,\dots,4.$$

with

$$F = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}.$$

The resulting test statistic is $\chi^2(4)=3.168$ ($p>0.5301$), where the degrees of freedom is $h(n-m)=2(4-2)=4$ (see Chapter 4). This indicates that the weak exogeneity of $(\Delta p, i)$ for the long-run parameters is accepted. Thus the process y_t can be partitioned into the variables $x_t = \{(m-p)_t, R1_t\}$ and $z_t = \{\Delta p_t, i_t\}$, and cointegrating vectors and the adjustment coefficients enter in the partial model (See Section 4.5.2.2).

ii) Suppose we want to test the hypothesis that income has a unit elasticity in the first cointegrating vector. This is a restriction on the cointegration relations and can be formulated as

$$H_3: \beta_{41} = -\beta_{11}.$$

with

$$D_1 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}.$$

The resulting test statistic is $\chi^2(4)=29.374$ ($p>0.000$) where the degrees of freedom is $h_1[(n+q_1)-h]=1(6-2)=4$ and calculated as described in Section 4.5.2.1.2. This suggests that the restriction is rejected. Thus long-run demand for real extended money does not have a unit income elasticity.

iii) The previous estimations without dummy variables, which are not presented here, produced a long-run demand for extended money function where

inflation and interest rates have the same coefficient. In order to test if this is still prevailing, the following restriction is imposed on the first cointegrating relation:

$$H_4: \beta_{31} = \beta_{41}$$

with

$$D_2 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}.$$

This restriction is accepted yielding $\chi^2(4)=8.52$ ($p>0.0743$).

iv) In addition to the restrictions on the first cointegrating vector, the following restrictions are imposed on the interest rate equation: no effect from real money, income and the unification dummy, which can be expressed as

$$H_5: \beta_{12} = \beta_{42} = \beta_{62} = 0.$$

$$D_3 = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix}.$$

This restriction is also accepted yielding $\chi^2(4)=1.11$ ($p>0.8920$).

Now we can combine restrictions (i), (iii) and (iv) and test them jointly as described in Section 4.5.2.3. This requires imposition of these restrictions together

$$H_2: \alpha_{ij}=0, i=3, 4 \text{ and } j=1, \dots, 4, H_4: \beta_{31} = \beta_{41} \text{ and } H_5: \beta_{12} = \beta_{42} = \beta_{62} = 0.$$

When jointly tested, these restrictions are barely accepted yielding $\chi^2(6)=16.49$ ($p>0.03$). The degrees of freedom is given by $(\sum_{i=1}^h (n+q_r-h-q_i+1) + h(n-m)) =$

$$(6-2-5+1)+(6-2-5+1)+(6-2-3+1)+2(4-2)=6.$$

As a consequence of the above analysis, the data are mapped to $I(0)$ linear combinations, defining the two cointegrating vectors as follows:

$$CI1 = (m-p)_t - 2.21 \cdot i_t + 0.035 \cdot R_t + 0.035 \cdot \Delta p_t - 0.0018 \cdot \text{Trend} + 0.028 \cdot S_{1991:1}$$

$$CI2 = R_t - 63.61 \cdot \Delta p_t + 0.003 \cdot \text{Trend}$$

These two cointegrating vectors determine the stationary long run relationships between the variables. Inflation and interest rates have equal negative effect on the long run extended demand for money. In line with the previous studies, the long-run demand for extended money has an income elasticity of 2.21. As mentioned above, the dummy variable for German unification has a negative effect on the demand for money contrary to our expectations. The currency conversion in 1990 added about 15 per cent to the money supply M3, while only 8.8 per cent was added to real output, creating a potential accommodating higher prices. Furthermore little was known about the portfolio choices East Germans would make in the new financial environment both with regard to liquidity holding and the desired structure of financial assets. Moreover, with the introduction of withholding tax on interest earnings in 1993, lead to portfolio shifts out of demand deposits. All these factors might have led to a shift from monetary assets to real assets. Most of the existing studies investigating effects of unification on the money demand stability include dummy variables in the short-run dynamics. It is generally found that in the short-run the unification dummy has a positive effect. Only Wolters et al. (1996) include the unification dummy in the long-run analysis, as here. The results of their Engle-Granger two-step approach indicate that the unification dummy has a negative coefficient in the long-run, although in the short-run money demand equation it has a positive sign. They argue that higher inflation rates that are observed after the unification, encouraged a substitution from broad money into real assets.¹⁶ Alternatively, this negative coefficient may imply that the dummy could capture the recession that occurred in Germany since mid-1990. The second cointegrating vector,

¹⁶Wolters et al. (1996), pp. 6.

which measures the deviations of the interest rate from its long run equilibrium level, depends positively on inflation; the trend has a negative effect, indicating the tight monetary policy pursued by the Bundesbank.

The $I(0)$ system determines six variables ($\Delta(m-p)_t$, ΔR_t , $\Delta^2 p_t$, Δi_t , $CI1_t$ and $CI2_t$). The information set used consists of three lags of $\Delta(m-p)_t$, ΔR_t , $\Delta^2 p_t$, Δi_t , $CI1_{t-1}$ and $CI2_{t-1}$, together with four dummy variables and an intercept entailing a reduction to parsimonious VAR with 16 explanatory variables in each equation. Table 5.8 records the estimates of the $I(0)$ PVAR, other than the dummy variables. The dimensionality of this PVAR is high and many coefficients are insignificant, so we model it in the next section.

5.5.3 Modelling the $I(0)$ PVAR

Hendry (1995) argues that the main reasons for modelling the $I(0)$ PVAR are to enhance its interpretability, and reduce its sample dependence, or increase its invariance to regime changes. Although the best order of hypothesis tests is not clear, here we test first the weak exogeneity of inflation and income for the long-run parameters. In Table 5.8, it can be seen that the first and second cointegrating vectors are significant only in the short-run equations of money and interest rates, respectively. The cointegrating vectors do not matter for the remaining short-run equations, matching the earlier cointegration tests on the adjustment coefficients. Thus we can exclude the first cointegrating vector from the short-run interest rate, inflation and income equations, and the second cointegrating vector from the money, inflation and income equations.

The rest of the marginalization process is done according to the data evidence from Table 5.8. Basically the insignificant variables are excluded from the equations. For example, all lags of differenced real money are insignificant in all equations, thus they are excluded from the system. In the differenced interest rate equation, all lags of differenced inflation appear to be insignificant, so they are excluded from the short-run interest rate equation. After a similar analysis for all equations, the results

Table 5.8. PVAR Estimates

	$\Delta(m-p)_{t-1}$	$\Delta(m-p)_{t-2}$	$\Delta(m-p)_{t-3}$	ΔR_{t-1}	ΔR_{t-2}	ΔR_{t-3}	$\Delta^2 p_{t-1}$	$\Delta^2 p_{t-2}$	$\Delta^2 p_{t-3}$	Δi_{t-1}	Δi_{t-2}	Δi_{t-3}	CI_{t-1}	CI_{t-1}
$\Delta(m-p)$	0.067 (1.13)	-0.020 (-0.35)	0.058 (1.02)	-0.002 (-0.78)	0.001 (0.45)	0.0001 (0.05)	-0.48 (-2.32)	0.16 (0.74)	-0.17 (-0.90)	-0.31 (-2.22)	-0.23 (-1.55)	-0.10 (-0.70)	-0.12 (-5.93)	0.0003 (0.21)
ΔR	-0.89 (-0.26)	3.25 (0.96)	0.03 (0.009)	0.02 (0.13)	-0.22 (-1.74)	0.20 (1.61)	-3.24 (-0.26)	-3.91 (-0.31)	-3.81 (-0.34)	24.41 (3.00)	14.8 (1.73)	10.9 (1.26)	-0.69 (-0.57)	-0.34 (-4.83)
$\Delta^2 p$	0.048 (1.26)	0.033 (0.90)	0.057 (1.56)	0.0007 (0.42)	0.001 (0.77)	0.002 (1.84)	0.54 (4.05)	-0.41 (-2.96)	0.20 (1.66)	0.16 (1.83)	-0.27 (-2.84)	0.092 (0.95)	0.002 (0.18)	-0.0003 (-0.34)
Δi	0.10 (0.13)	-0.022 (-0.32)	0.013 (0.19)	0.005 (1.76)	-0.0001 (-0.05)	0.0005 (0.22)	-0.23 (-0.94)	0.093 (0.36)	-0.35 (-1.54)	-0.062 (0.37)	0.02 (0.10)	0.35 (1.97)	-0.24 (-0.96)	-0.001 (-0.80)

Note: t-ratios are in parentheses.

presented in Table 5.9 are estimated by FIML. The test of overidentifying restrictions does not reject ($\chi^2_{or}(51) = 57.31, p > 0.252$), so the marginalization is complete. The resulting equations parsimoniously encompasses the PVAR.

The short-run estimates of the model in Table 5.9 indicate that the inclusion of the dummy variables for unification improve the estimation results and have considerable impact in the extended money demand equation. In the short-run demand for money equation the coefficient of the unification dummy is positive, indicating an increase in demand which could be attributable to unification. Also in this equation, the change in inflation has a strong negative effect, whereas the effect from the interest rates is relatively smaller. Furthermore, the magnitude of the adjustment coefficient is very close to those found by previous studies estimating the M3-demand in Germany. In the interest rate equation the second lag of the differenced interest rate has a negative effect though its third lag has a positive effect, both of the same magnitude. Furthermore, income also plays an important role in the determination of the interest rates. The adjustment coefficient of the interest rate equation is very high with a strong effect. The change in inflation is negatively correlated with its second lag, whereas its first lag has a positive effect. As in the interest rate equation, the first and second lags of income have strong effects. The equation for income confirms the inclusion of the dummy variable D1987:1, which was assumed to capture the outlier in the income series which occurred due to bad weather conditions in that year. The third lag of income has a strong positive effect, whereas the long-term interest rate has a relatively smaller effect.

Additionally model diagnostic statistics, given in Table 5.10, are all insignificant, matching the valid reduction from the parsimonious VAR. The residual correlations are also given in Table 5.10, where the residual standard deviations are shown on the diagonal. The residual cross-correlations of the unrestricted VAR are presented below the diagonal, whereas those of restricted PVAR are presented above the diagonal, which reveal relatively low correlations between the residuals.

In order to test the constancy of the model a one-step forecast analysis is

Table 5.9: FIML Model Estimates

$\Delta(m-p)_t$	$= -0.39 \Delta^2 p_{t-1} - 0.004 \Delta Rl_{t-1} - 0.09 CI1_{t-1} + 0.098 D1991:1 - 1.30$
	(-2.58) (-2.41) (-6.38) (15.8) (6.33)
ΔRl_t	$= -0.18 \Delta Rl_{t-2} + 0.18 \Delta Rl_{t-3} + 25.3 \Delta i_{t-1} + 14.1 \Delta i_{t-2} - 0.27 CI2_{t-1}$
	(1.95) (4.51) (2.47) (-4.77) (6.10)
	$+ 1.33 D1981$
	(4.07)
$\Delta^2 p_t$	$= 0.51 \Delta^2 p_{t-1} - 0.22 \Delta^2 p_{t-2} + 0.20 \Delta i_{t-1} - 0.20 \Delta i_{t-2} + 0.003 D1981$
	(4.35) (-2.08) (3.34) (-3.04) (1.51)
	$+ 0.008 D1990:3$
	(1.84)
Δi_t	$= 0.003 \Delta Rl_{t-1} + 0.37 \Delta i_{t-3} - 0.016 D1987:1 + 0.009 D1990:3 + 0.003$
	(1.90) (3.62) (-2.44) (1.39) (2.81)

t ratios are in parentheses.

Table 5.10: Model Statistics

$F^m_{ar}(64, 143)$	1.13
	(0.26)
$F^m_{het}(320, 151)$	0.97
	(0.56)
χ^2_{nd}	5.70
	(0.68)

FIML Residual Correlations

	$\Delta(m-p)_t$	ΔRl_t	$\Delta^2 p_t$	Δi_t
$\Delta(m-p)_t$	0.65%	0.01	-0.23	0.33
ΔRl_t	0.02	3.78%	0.10	0.29
$\Delta^2 p_t$	-0.24	0.03	0.42%	-0.06
Δi_t	0.28	0.28	-0.05	0.77%

Note: p-values are in parentheses.

performed for the time period 1992:1-1993:4. Figure 5.5 reports the one-step model based forecasts. The constancy of the model is accepted with almost every lag lying inside the individual 95 per cent confidence bars and the overall test statistic is $F(32,47)=1.45$ ($p>0.11$) is not significant at the ten per cent level, implying that the model is stable. Figure 5.6 presents a sequence of one through eight step ahead from 1992:1 onwards with error bars of 95 per cent confidence intervals. The forecasts converge to their unconditional means for all equations.

5.6 Conclusion

As European financial integration has increased and exchange controls have been abolished in most EU countries, German residents as well as other EU residents have an easy access to a wider range of financial instruments and hold different currencies in their portfolios in the form of CBDs. Moreover any change in banking regulations, such as the introduction of a withholding tax in Germany, or expected exchange rate depreciations might lead to fluctuations in these CBDs, which could reflect currency substitution as Filosa (1995) suggests. These may lead to instability in traditionally defined monetary aggregates, as argued in Chapter 3, whereas an extended monetary aggregate could be expected to be stable. Thus, this chapter has analysed the stability of the demand for real extended money in Germany.

The VAR estimates of the initial system revealed that there are two cointegrating relationships in the long run: the first one measures the extended money demand as a function of income, inflation and interest rates; the second one measures the deviations of long term interest rates from its long run equilibrium level. Furthermore a dummy variable for unification is also included in the extended money equation in order to account for the break in the series and assuming that German unification has long run effects. In the short run structure, on the other hand, a four equation model was estimated by FIML.

Empirical findings indicate that the weak exogeneity of income and inflation for the long-run parameters was satisfied. Therefore, the extended monetary

aggregate and the long-run interest rates can be regarded as being exogenously given for the long-run structure. The long term interest rate appears to be an effective policy variable, as it is negatively related to extended money both in the long run and in the short run. Thus it could be possible to control extended money by manipulating the long term interest rate. Furthermore, the negative effect from inflation on extended money demand indicates that agents demand less financial assets as inflation rises, given interest rates. Although the main concern of this chapter was the examination of the extended money demand equation, empirical findings also suggest important issues concerning the remaining equations in the system. Income plays an important role in the model, affecting both interest rates and inflation. Furthermore, the results of the analysis suggests that the demand for extended money, defined according to the residency of holder criteria, appears to be stable over the sample period.

Our results concerning the economic and stability properties of the German money demand function are very close to those of previous studies. Even though existing studies argue that German unification causes instability of the demand for money equation, the inclusion of a step dummy for the unification, as suggested by Lütkepohl et al. (1995) and Wolters et al. (1996) might have led to stable money demand relationships in those studies. The income elasticity is found to be greater than one here as in many other studies, and inflation and the long-term interest rates have significant effects on the demand for money. The adjustment coefficient of the short-run money demand equation is also close to those of previous studies. The similarity between our results and those obtained by previous studies, such as Filosa (1995) and Cassard et al. (1997), may indicate that the use of the extended money is not particularly important for Germany. This may be because, the degree of currency substitution is relatively small compared to other EU countries.

Figure 5.1: German Time Series Data

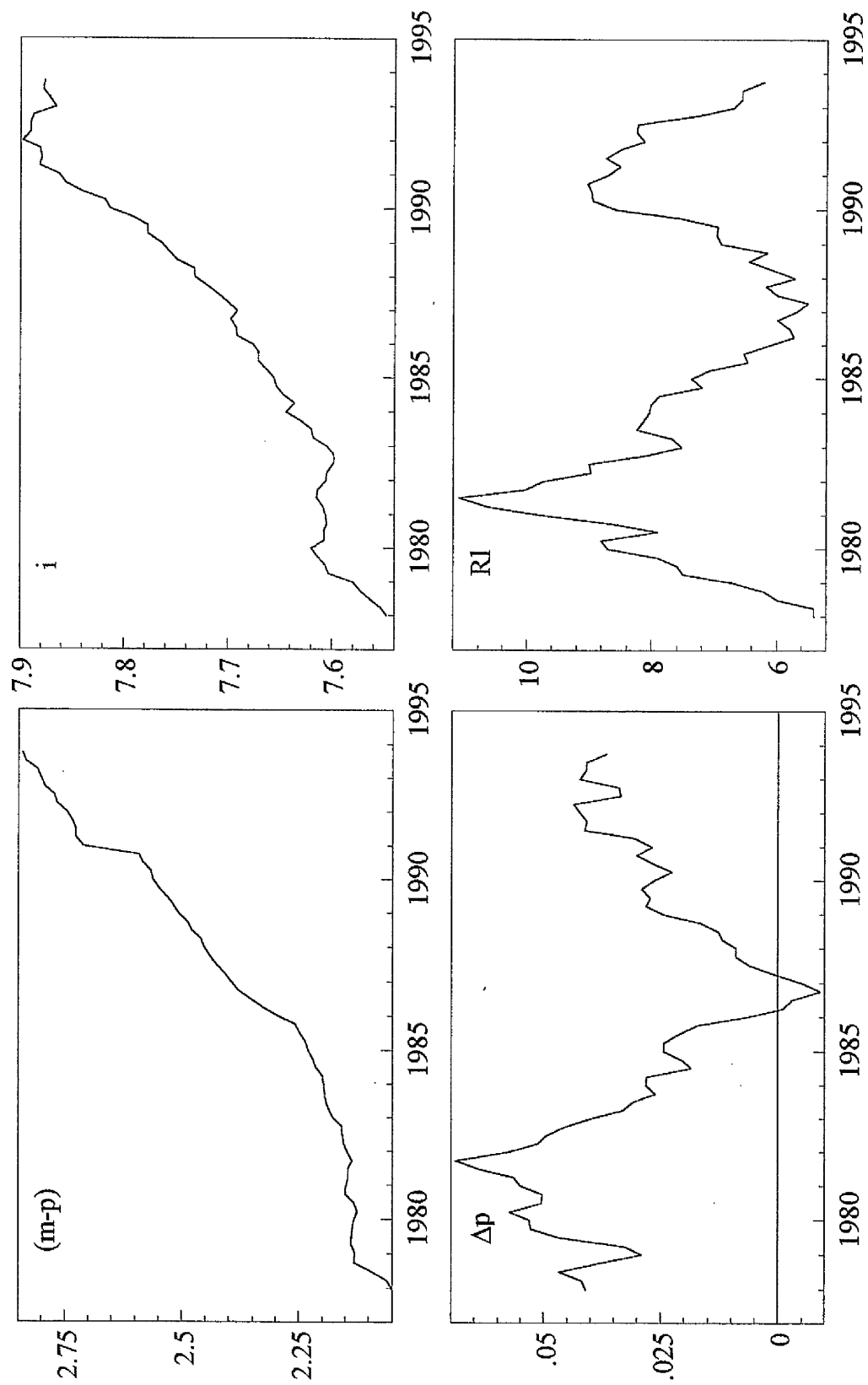


Figure 5.2: The Evolution of CBDs (in billions of DM)

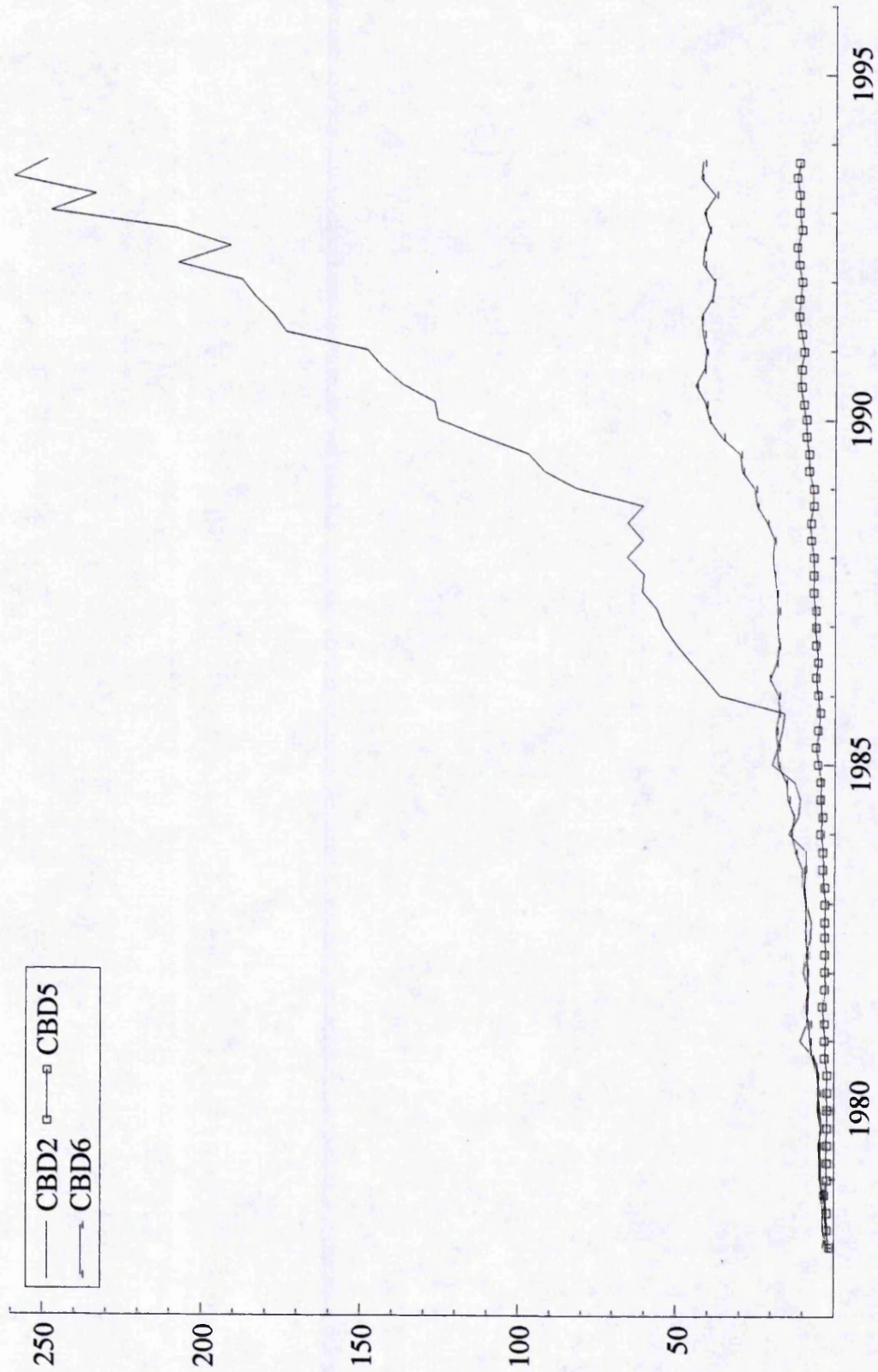


Figure 5.3: Scaled Residuals of the Initial Model

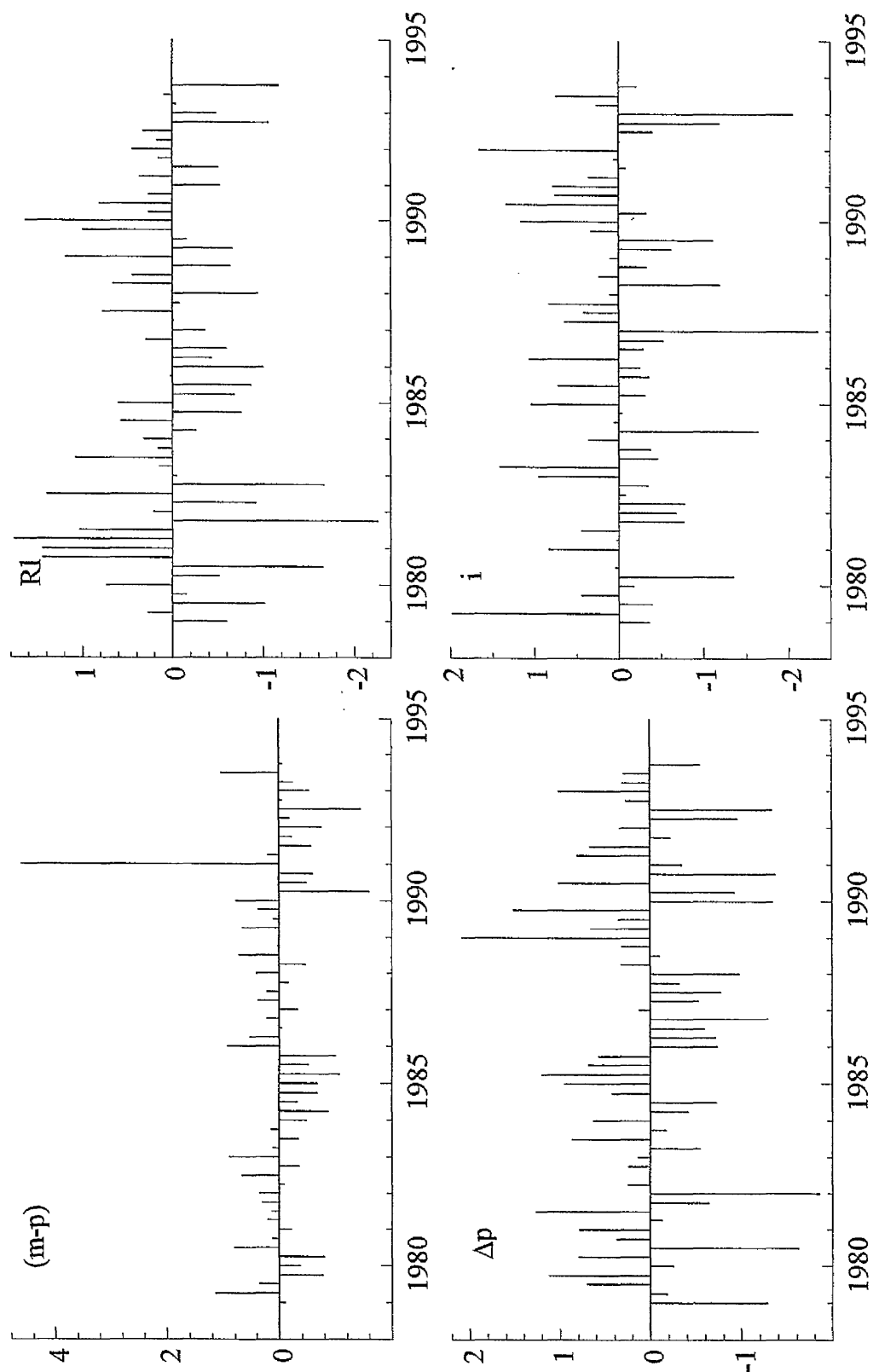


Figure 5.4: Cointegration Vectors

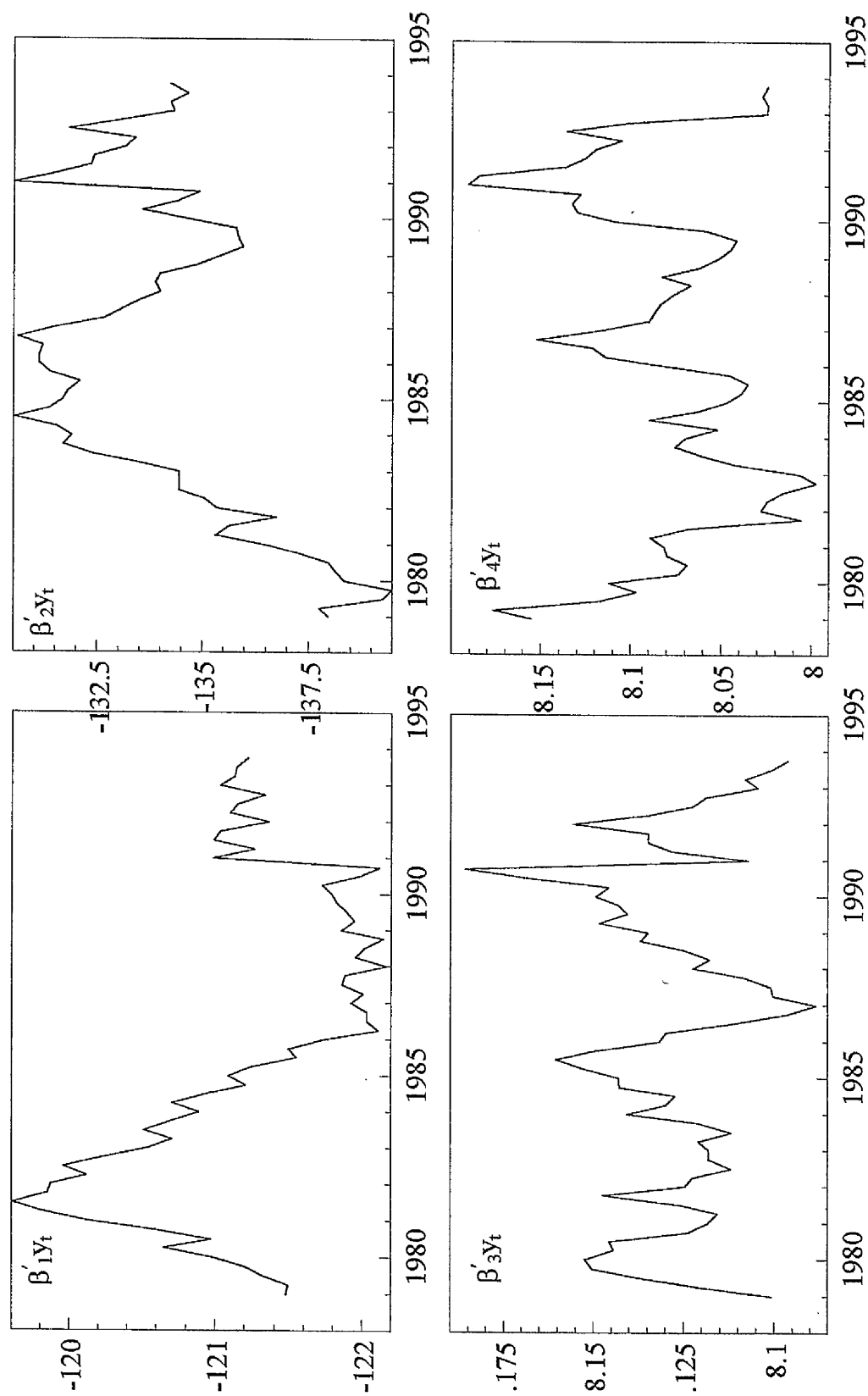


Figure 5.5: 1-Step Ahead Forecasts

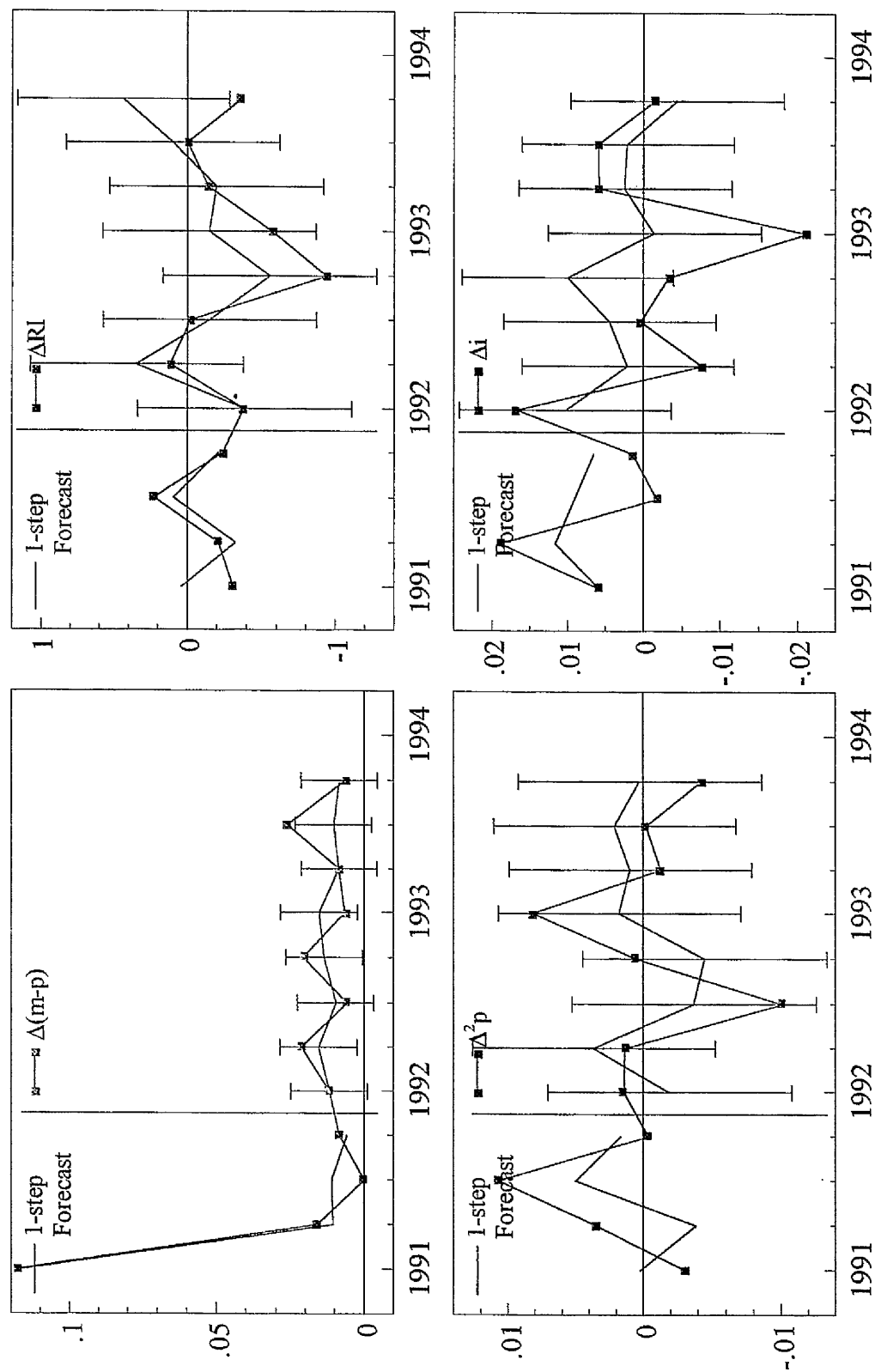
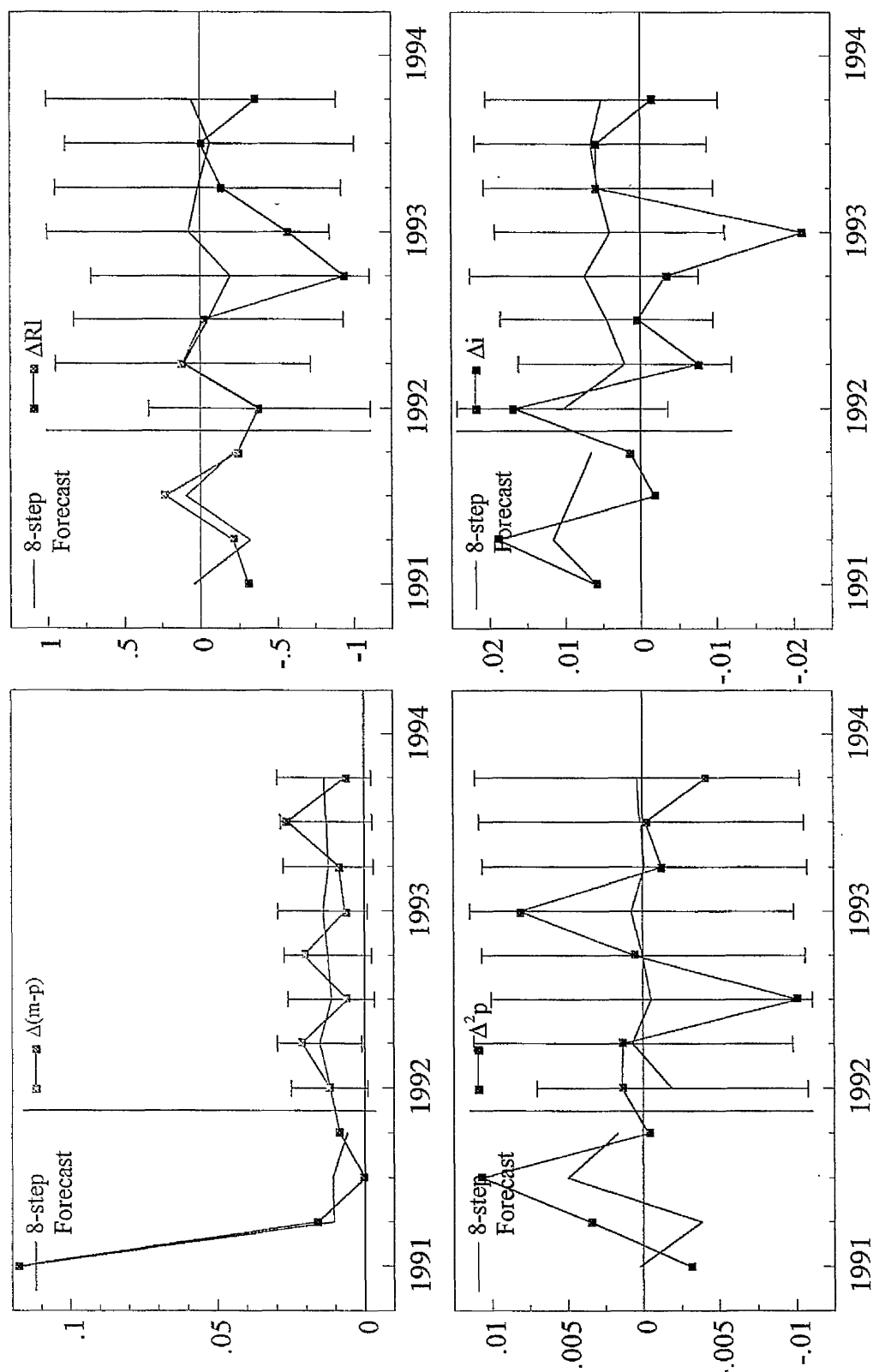


Figure 5.6: 8-step Ahead Forecasts



CHAPTER 6

MODELLING THE DEMAND FOR MONEY IN FRANCE

6.1 Introduction

As in many other western countries, the monetary authorities in France give priority to achieving price stability and preserving the value of the French franc (FF) against major currencies. Prior to the early 1980s, credit controls were employed as the main monetary policy instrument, but afterwards such controls were first eased then abolished and increasing reliance has been placed on a more active policy with respect to interest rates and the minimum reserve ratio. Since the early 1980s, there has been a series of financial innovations, one of the most important of which was the creation of a market in financial futures. Apart from the reform of the tax system applying to savings and the abolition of exchange controls, saving instruments have become more varied. Furthermore, the French authorities implemented a series of reforms which were intended to increase the efficiency of the financial market. Banks were allowed to securitise, which could reduce the cost of both intermediation and credit. As new financial instruments were introduced, the monetary aggregate M2 which had been targeted since 1977 appeared to lose its informative value and showed greater fluctuations. Hence new, broader monetary aggregates, M3 and L, were defined in 1985.

During 1980s, many European countries experienced financial innovation, and exchange controls were gradually abolished.¹ As in other countries, financial innovations, new investment instruments and easy access to foreign financial markets meant French economic agents tended to hold more foreign currency in their portfolios, which was reflected by the increasing amount of cross border deposits. When there were changes in the value of the Franc (FF) against major currencies, or an institutional change, such as the imposition of a withholding tax, the composition

¹See respective country chapters for financial innovations which took place in countries of concern in this study.

of agents' portfolios has tended to change as well, which has possibly led to partial instability in the demand for money functions. As traditionally defined monetary aggregates do not include cross border deposits, analysis based on these monetary aggregates may not reflect the true amount of money demanded. However, an extended monetary aggregate, which includes relevant cross border deposits may be more informative. Hence in this chapter demand for an extended monetary aggregate for France will be estimated and its stability properties will be examined. This chapter is organized as follows: section 6.2 presents an overview of the monetary developments in France since 1978, while section 6.3 discusses the evolution of the cross-border deposits.² Existing studies of the French demand for money function are reviewed in section 6.4. In section 6.5 the demand for extended money is estimated for France. Finally, section 6.6 concludes.

6.2 Economic Developments

Economic developments in France since 1978 have followed a similar path to other European countries. During the 1970s both oil shocks had caused economic instability in all European countries. After the recession of the early 1970s, the French economy grew at an average rate of nearly 3 percent between 1976 and 1979, but on the other hand, unemployment remained high and the annual rate of inflation did not fall below 9 percent for any length of time. During this period quantitative credit control was the main instrument of monetary policy. With the second oil price rise in 1979 and then the US dollar's appreciation from the third quarter of 1980, economic recovery ended and GDP fell during the following year. Unemployment rose sharply, and the rise in inflation continued. Figure 6.1 presents graphs of real extended money ($m-p$), GDP at 1985 prices (i), inflation (Δp) and the long term interest rates (R_l) where all variables except the interest rates are in logarithms. Economic policy became very restrictive in the early 1980s and, as can be seen in Figure 6.1, long term interest rates reached their historic peak at 16.9 percent in the

²For the definition of cross-border deposits and extended monetary aggregates, see Chapter 2.

third quarter of 1981.

In view of the persistent high rate of inflation between 1978-1981, the government introduced a number of measures. All prices were frozen for six months with effect from October 1981. With a second series of measures to counter inflation in June 1982, prices and wages were fixed until December 1982. The period 1982-1986 can be regarded as a recovery period, with tight monetary policy to promote disinflation through slower growth of monetary aggregates. These policies were successful in reducing inflation, from its peak of 13 percent in the third quarter of 1981, to 2 percent in the last quarter of 1986. One of the explanatory factors lying behind the disinflation was the fall in import prices, with at least half of the slowdown in price rises since the early 1980s being attributable to a reduction in imported inflation. The strongest effect was felt in 1986 when imported raw material prices fell sharply due to a collapse of the oil-price and the fall in the value of dollar.

After 1983, the macroeconomic framework in France moved towards giving direct priority to price stability. "Disinflation has been achieved among other things through exchange rate stability vis-a-vis the Deutsche Mark and a non-accommodating monetary policy based upon increasing market mechanisms and budgetary consolidation."³ Increasing reliance was placed on a more active policy with respect to interest rates and the minimum reserve ratio. While pursuing interest rate management, the French authorities publish a yearly target for monetary growth. Although constrained by the exchange rate commitment, monetary targeting is intended to convey to the markets the determination of the monetary authority. It is expected that with interest rates being set more in line with market forces, the allocation of productive investment and saving would become more effective in the medium term, although investors would be exposed to the risk of interest rate fluctuations. Reserve requirements were used as a tool of monetary policy in combination with changes in interest rates. Furthermore, it has been widely argued

³"France", Commission of the European Communities, Directorate General for Economic and Financial Affairs, No:5, 1991, pp. 4.

that the recent financial innovations have affected the stability of the demand for money taken as an intermediate target. In late 1985, the monetary authorities introduced new monetary aggregates M3 and L, which were argued to be more closely correlated with nominal GDP than M2.

During the late 1980s, the macroeconomic performance of the French economy improved. Among the major factors contributing to these favourable developments was the sharp expansion of France's export markets, a reflection of buoyant growth among its trading partners, world disinflation, the fall in oil prices and the decline in interest rates. Moreover, the depreciation of the Franc after 1988 provided an impetus for foreign demand. Furthermore, the remaining capital controls were lifted in order to earn the confidence of foreign investors and to conform with EU requirements. The gradual abolition of credit ceilings, which had started in 1984, was completed in 1987. In this transitional period, the role of reserve requirements as a potential shock absorber increased.⁴

The slow growth of GDP in the early 1990s turned into a recession in 1993. Between the second quarter of 1990 and the third quarter of 1993, the average annual GDP growth was only 0.5 percent. After 1991 the government budget deficit increased rapidly, partly due to a fast increase in interest payments. The French authorities were induced to maintain a tight monetary policy in view of the exchange rate objective of the ERM, despite the sharp weakening of activity in this recession period. According to OECD country reports, the objective of exchange rate stability of the French authorities was inconsistent with domestic conditions, leading to pressures on the French Franc. It came under pressure due to uncertainties about the outcome of the French referendum on the Maastricht Treaty in September 1992, the floating of the lira and the pound sterling, and the devaluation of the peseta. The French Franc was saved from devaluation by heavy market intervention and a sharp increase in short term interest rates. There was renewed pressure on the Franc at the

⁴"France", Country Studies, Commission of the European Communities, Directorate-General for Economic and Financial Affairs, No:5, 1991.

beginning of 1993 and the subsequent speculative attack, reflecting market doubts about the stability of ERM, occurred in the second half of 1993. Although, in response, the Banque de France tightened monetary conditions, the speculative tide could not be prevented. Hence, in August 1993 the exchange rate bands of the ERM were widened to 15 per cent.

Although there had been sharp movements in short term interest rates, after 1989 long-term interest rates became lower than short term interest rates, giving rise to an inverse interest rate structure. Despite monetary policy having eased in late 1992, this inverse interest rate structure remained.⁵ The growth of narrower monetary aggregates, M1 and M2, remained moderate, reflecting the continued attractiveness of investments in short-term money market funds, which are included in M3. Although the growth of M3 was above the target range in 1992, it remained below the target range in 1993, reflecting weak activity and portfolio shifts. Although there had been fluctuations in the rate of inflation between 1986 and 1991, a period of sustained disinflation started afterwards, consistent with the objectives of the monetary authorities.

On the whole, the French monetary authorities have been implementing a low inflation policy on the basis of two intermediate indicators. One was the value of the Franc, which was constrained to remain within the limits set by the exchange rate mechanism of the EMS, and the other was the evolution of the monetary aggregates in relation to official targets set every year. It is widely argued that the most impressive results of French anti-inflationary policy can be seen in the drastically reduced interest rate differentials with German interest rates, indicating a virtual disappearance of the relative risk premium. Furthermore, yield curves became flatter, pointing to a high degree of credibility acquired by the anti-inflationary stance of the French monetary authorities.

⁵See OECD Country Surveys, France, 1992/93.

6.3 Evolution of CBDs

The French economy had long been characterized by foreign exchange controls, but these were gradually lifted in the late 1980s and early 1990s. The dominant feature of financial markets in France during the second half of the 1980s was the extensive financial liberalization and reform. Among the main events of the financial liberalization programme were the abolition of credit ceilings and the deregulation of interest rates. In June 1988 French residents were allowed to borrow from abroad for the first time, and in March 1989 loans to nonresidents were permitted, banks were authorized to hold short-term foreign currency deposits and residents became free to hold ECU accounts. Moreover, restrictions prohibiting French residents holding foreign currency accounts in France were eliminated in January 1990, when all exchange controls were abolished. These developments immediately affected CBDs. In addition, exchange rate developments, changes in banking regulations and variations in the withholding tax on interest earnings are also likely to have affected the developments in CBDs.

Figure 6.2 presents the developments of CBDs in France⁶. The extended monetary aggregate which is based on the residency of holder criteria, consists of deposits of French residents in banks abroad (CBD 2 and CBD 6), foreign currency deposits held by French residents at domestic banks (CBD 5) and domestic currency deposits held in domestic banks. The developments in particular types of cross-border deposits are assumed to reflect the extent of currency substitution. The volume of Franc deposits held by residents at banks abroad (CBD 2) is considered to reflect pure relocation. As seen by the large jump in this series in Figure 6.2, this component increased by nearly 7 times from the second quarter of 1989 to the third quarter of 1990. Increases in Franc deposits held by French residents at banks abroad continued, although there have been decreases when the Franc depreciated against major currencies; but at the end of 1993 such deposits accounted for almost 2 percent of M3. Similarly, foreign currency deposits of French residents held with banks abroad

⁶For the definitions of various types of cross-border deposits, see Chapter 2.

(CBD 6), which reflect currency substitution, almost doubled in the same time period. Furthermore, as can be seen in Figure 6.2, foreign currency deposits held by French residents with domestic banks (CBD 5), which are not subject to reserve requirements, increased by 160 percent between the third quarter of 1988 and the third quarter of 1989, before falling again in 1990. This latter change could be attributed to the reduction of the withholding tax on interest earnings in 1990.

Overall with the abolition of exchange controls, deposits of French residents in banks abroad (CBD 2 and CBD 6) and foreign currency deposits held by French residents at domestic banks (CBD 5) increased considerably, almost 110 percent since 1989. Furthermore, it can be observed that developments of CBDs are affected by exchange rate movements, which, in turn, could lead to instabilities in the money demand functions.

6.4 Existing Studies

The studies which examine the stability and economic properties of the French money demand function mainly emphasize the financial innovation process and currency substitution. They generally employ the Engle Granger two step or Johansen procedures.⁷ Dooley and Spinelli (1989) focus on the stability of the monetary aggregate that is being targeted, M2, and if instability is detected, they further investigate whether it is attributable mainly to the availability of the new financial instruments. They employ a two-stage-non-linear estimation package to cope with non-linearity and simultaneity. They estimate the demand for M2 in France for the time period 1960:1-1983:3 using quarterly data, where the scale variable is real per capita income, and the two proxies for the opportunity cost of holding money are long-term interest rates and inflation. The empirical results suggest that the demand for M2 over the period had elasticity greater than unity with respect to income and that both of the proxies for opportunity costs were statistically significant and with the right sign. However, it was found that money demand had shifted downward and

⁷See chapter 4, for different approaches to modelling the demand for money.

there appeared to be a one-to-one correspondence between the size of missing money and the amounts of funds placed into new assets, suggesting that the fall in money demand was related to financial innovation.

The stability of the French money demand function is investigated by Cassard et al. (1997) who employ a one step version of the error-correction procedure where the long-run money demand equation is substituted into a dynamic error-correction model and the coefficients are estimated using non-linear least squares (NLLS). They use seasonally adjusted data and carry out estimation over the period 1979:2-1990:2. They find that real M3⁸ (price homogeneity is imposed) cointegrates with real income and the spread between one measure of the own rate of return on money and long-term interest rates. They report a long-run income elasticity of 1.59, and an adjustment coefficient of 0.12 which is very close to the findings of this chapter, presented in the following section. However, they conclude that the stability of the equation cannot be rejected at the 1% significance level but that it can be rejected at the 5% significance level. Furthermore, to verify their estimates, they employ the Johansen approach which indicates that there are two cointegrating relationships one of which can be identified with the long-run money demand function. Finally, the short-term interest rate differential with Germany is found to be significant in some variants of the equation, which could possibly suggest the existence of currency substitution between the French Franc and the Deutsche Mark.

Giucca and Levy (1992) construct three extended monetary aggregates⁹, which include CBDs, in a consistent fashion and compare them with the traditionally defined monetary aggregate. They construct a VAR model for the period 1979-1990 where the variables are traditional (M3), or an extended monetary aggregate, GDP at 1985 prices and short-term interest rates. They report that although different information contents are found across the definitions of money, it is difficult to

⁸For the definitions of monetary aggregates, see Appendix 2.

⁹For the definition of the extended monetary aggregates and their calculations, see Chapter 2 and Appendix 2.

discriminate between traditional and extended definitions of money. On the basis of VAR estimates and Granger-Causality tests, all the definitions of money help to predict the future evolution of nominal income to roughly the same extent. They argue that this may reflect the fact that the differences between the definitions are still small, owing to the short time that had then elapsed since the abolition of all exchange controls.

The implications for the French money demand function of currency substitution between the FF and other major EU currencies are investigated by Artis et al. (1993) and Filosa (1995). Artis et al. (1993) estimate the demand for M1 for the time period 1979:2-1990:2 and employ real GDP as the scale variable and long term interest rates as the opportunity cost variable. Furthermore, they include expected exchange rate changes vis-a-vis other European currencies and the US dollar in the specification and test for the existence of currency substitution. Their findings indicate the existence of an unstable money demand function, however, currency substitution is found to be insignificant.

Filosa (1995) estimates demand for M3 for the time period 1980-1991 using quarterly data. An indicator of expected depreciation of the central parities vis-a-vis the Deutsche Mark is used to capture currency substitution. The results indicate that although the long-run price elasticity is found to be equal to one, the long-run income elasticity differs from one. Additionally, the expected depreciation vis-a-vis other European currencies and the US dollar negatively affects the demand for M3 in France, indicating a currency substitution effect contrary to the findings of Artis et al. (1993). Finally, the hypothesis of stability for the estimated money demand function is not rejected.

Mixed results concerning the stability and the economic properties of the French money demand function emerge from these studies. An income elasticity which is greater than one is reported by Dooley and Spinelli (1989), Filosa (1995) and Cassard et al. (1997), but price homogeneity is accepted for all studies. Current inflation and income as well as long term interest rates are generally found to be

significant explanatory variables, even though the specifications differ from one study to other. The estimated money demand functions are reported to be stable, with the exception of Artis et al. (1993) and Dooley and Spinelli (1989) who attribute this instability to financial innovations that took place in the 1980s. Evidence of currency substitution is reported by Filosa (1995) and suggested by Cassard et al. (1997), contrary to the findings of Artis et al. (1993). Guicca and Levy (1992) report that the informative contents of traditional and extended monetary aggregates cannot be distinguished due to the relatively small time period that had then elapsed since the abolition of all exchange controls.

6.5 Modelling the Demand for Extended Money

In order to investigate the stability of the demand for extended money, a four equation VAR model is considered, as in the previous chapter. As for all countries, the variables are extended M3 (M), GNP at 1985 prices (I), consumer price index (P) and a long term interest rate (RI).¹⁰ Among the available existing studies only Cassard et al. (1997) employ the VAR modelling in estimating the demand for M3, with real GDP and the interest rate differential between the own rate of money and the long term interest rates being explanatory variables. In that sense this chapter can be seen as an extension of Cassard et al. (1997), by employing an extended monetary aggregate rather than M3. Seasonally adjusted quarterly data is available for the time period 1978:1-1993:4. After allowing for lags, estimation is carried over 1978:3-1993:4, which yields 62 observations. All variables are in logarithmic form, except the interest rate, and denoted by lowercase letters.

Prior to modelling the relationships between the economic variables, their univariate time series properties are established¹¹. The results of augmented Dickey-Fuller tests indicate that, apart from the price level and nominal money which are

¹⁰See Appendix 1 for the descriptions of the variables.

¹¹The results of unit root tests are given in Appendix 1.

found to be $I(2)$, all variables considered by the study qualify as $I(1)$. Thus, the consumer price index itself cannot be included in the analysis but appears in transformed variables, such as inflation, Δp , and real money balances. Therefore long-run price homogeneity is imposed, leading to a system with four stochastic variables $((m-p), R, \Delta p, i)$ with a constant and trend. All dummy variables discussed below are included in the short run dynamics. The trend is restricted to the long-run dynamics as it is assumed to be a proxy for financial innovations which have taken place over the sample period.¹²

Empirical analysis started from the augmented VAR with four lags on all variables. The results of the specification tests, which are given in Table 6.1, indicate that the reduction by 32 parameters for eliminating lags 3 and 4 is acceptable on the overall F-tests. Furthermore the Schwarz and Hannan-Quinn criteria also indicate the selection of the 2 lag system. Hence a two lag model is chosen. The scaled residuals of the initial model, presented in Figure 6.3, suggests the inclusion of two dummy variables, namely D8134 and D8234. The dummy D8134 takes the value of one for the last two quarters of 1981, when interest rates reached their historic highest point, as can be seen from Figure 6.1. The dummy D8234 takes the value one for the last two quarters of 1982, and reflects the effects of the wage and price freeze. Hence a two lag system with two dummy variables, a trend and a constant is selected as the final model. The residual cross-correlations and lag-length statistics of this final model are given in Table 6.2.

Table 6.2 indicates that there are large negative residual correlations between inflation and real extended money, and large positive residual correlations between inflation and the long term interest rate. Furthermore, the lag-length statistics reveal that the first lags of all variables and the second lags of real extended money and the interest rate are significant, suggesting that a two lag VAR model is appropriate for modelling. Furthermore, only one of the eigenvalues of the long-run matrix is close to zero, while three of the eigenvalues are larger, indicating the possible existence of

¹²For a discussion about the inclusion of trend in the analysis, see Chapter 5.

Table 6.1: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-28.75	-30.28		
2	3	-29.34	-30.53	1→2	F(16,119) = 1.33 (0.18)
3	2	-29.97	-30.82	2→3	F(16,132) = 1.12 (0.17)
				1→3	F(32,145) = 1.36 (0.11)

Note: p-values are in parentheses.

Table 6.2: Residual Correlations and Lag Length Statistics for VAR (2)

Residual Correlations

	(m-p)	Rl	Δp	i
Rl	-0.142	-	-	-
Δp	-0.332	0.340	-	-
i	-0.137	0.212	0.003	-

Lag Length and Dynamics

	(m-p)	Rl	Δp	i
$F_{s=1}(4,47)$	13.91** (0.00)	13.35** (0.00)	17.97** (0.00)	18.20** (0.00)
$F_{s=2}(4,47)$	5.33** (0.00)	3.06* (0.02)	1.34 (0.26)	1.00 (0.41)
$ \mu $	0.37	0.22	0.16	0.07

Note: * and ** denote significant at the 5% and 1% levels and p-values are in parentheses.

three cointegrating vectors. Diagnostic test results, which are defined in Chapter 4, are presented in Table 6.3. Although there is an indication of a problem of autocorrelation of fourth order in the inflation equation and problems of normality in the extended money and interest rate equations, they are not significant at the 1 per cent level. Moreover, the vector diagnostic tests are not significant at the 5 per cent level. All other diagnostics are satisfactory.

Table 6.3: Goodness of Fit and Diagnostic Test Results

	(m-p)	Rl	Δp	i	VAR
$\hat{\sigma}$	0.97%	5.10	0.44%	0.52%	
$F_{ar}(4,46)$	0.87 (0.48)	2.25 (0.07)	3.01* (0.02)	0.90 (0.46)	
$F_{arch}(4,42)$	0.19 (0.94)	0.30 (0.87)	0.58 (0.67)	0.49 (0.74)	
$F_{het}(18,30)$	0.69 (0.78)	0.59 (0.82)	0.75 (0.72)	0.87 (0.60)	
$\chi^2(2)$	7.06* (0.02)	6.11* (0.04)	0.82 (0.66)	0.89 (0.63)	
$F_{ar}^v(64,123)$					1.34 (0.08)
$F_{het}^v(180,152)$					0.64 (0.99)
$\chi_{nd}^{2v}(8)$					11.3 (0.18)

Note: * denote significant at the 5% level and p-values are in parentheses.

The cointegration analysis, presented in Table 6.4, formally supports the hypothesis that there is only one cointegrating vector.¹³ However, as mentioned above, there are three large and only one small eigenvalue, indicating the possibility

¹³See Chapter 4 and Chapter 5 for cointegration analysis and identification of cointegrating vectors.

of three cointegrating vectors. Furthermore, the reduced rank restrictions also indicate that the long-run matrix obtained when the rank is restricted to 3 is very close to the unrestricted outcome. Figure 6.4 presents the estimated error corrections for the three cointegrating vectors and the remaining one non-stationary component. Figure 6.4 suggests that only the last component seems non-stationary. Hence, the presence of three cointegrating vectors is assumed throughout the chapter.

Table 6.4: Cointegration Analysis

r	1	2	3	4
λ	0.41	0.22	0.19	0.07
Max	32.97*	15.26	12.35	4.67
Tr	65.25*	32.28	14.83	4.67

Eigenvectors β					
	(m-p)	Rl	Δp	i	trend
(m-p)	1.00	0.003	2.97	-3.73	0.0172
Rl	22.80	1.00	-71.35	-39.55	-0.0137
Δp	-0.75	-0.013	1.00	0.87	0.0027
i	-0.12	-0.002	0.47	1.00	-0.0032

Adjustment Coefficients α				
(m-p)	-0.090	0.001	0.21	0.015
Rl	-0.75	-0.32	0.23	0.42
Δp	-0.046	-0.0008	-0.087	0.008
i	-0.005	-0.0008	-0.002	-0.076

Only the first cointegrating vector resembles a money demand equation, with negative effects from inflation and interest rates and a positive effect from income. Thus it can be interpreted as the excess demand for extended money, with an income

elasticity of 3.73, which is implausibly high notwithstanding that the income elasticity for French money demand is generally found to be greater than one, as discussed in the previous section. Furthermore, there is a strong negative effect from inflation, whereas the effects of long term interest rate and trend are very small. The second cointegrating vector can be interpreted as an interest rate equation and indicates that the deviations of interest rate from trend are positively related to inflation and income. The third cointegrating vector suggests that the deviations of inflation from its equilibrium level are negatively related with income and positively related with interest rates. Table 6.4 also presents the adjustment coefficients, which can be interpreted as the weights with which cointegration vectors enter the four equation system.¹⁴ The first column of the adjustment matrix $\alpha' = (-0.09, -0.75, -0.04, -0.005)$ can be interpreted as the weights with which the excess demand for extended money enters into each of the four equations of the system.

The cointegrating vectors are normalised as described in Chapters 4 and 5, and identification restrictions are imposed in addition to $(Rl_t, \Delta p_t, i_t)$ being long-run weakly exogenous for the money demand parameters. The examination of the eigenvectors, adjustment coefficients and long run matrix in cointegration analysis, suggest that interest rates have negligible effects on inflation, and the trend has a negligible effect on interest rates. Accordingly, the following identification restrictions were imposed on the unrestricted cointegration vectors as described in section 5.5.2: for long run money demand unit income elasticity; for the interest rate equation no effect from real money or trend; and for inflation no effect from real money and interest rates. These restrictions are accepted when jointly tested, yielding $\chi^2(5)=13.51$ with $p>0.098$, where the degrees of freedom equals the number of over-identifying restrictions. Even though the unrestricted income elasticity is greater than one, compatible with previous studies, when the restriction of unit income elasticity is imposed here it is not rejected at the one per cent level. Moreover, changes in income, interest rates and inflation will not react to disequilibrium errors, but may still

¹⁴See Chapter 4, for the interpretation of the adjustment coefficients.

react to lagged changes of extended money.

As a consequence of the above analysis three cointegrating vectors are determined, indicating that there are three stationary relationships between the four non-stationary variables of the system. The restricted cointegrating vectors are defined by

$$CI1 = (m-p)_t - i_t + 0.67 \Delta p_t + 0.008 R_t - 0.0017 \text{Trend}_t,$$

$$CI2 = R_t - 75.56 \Delta p_t - 6.14 i_t,$$

$$CI3 = \Delta p_t - 1.01 i_t + 0.007 \text{Trend}_t.$$

The long run extended demand for money depends negatively on inflation and interest rates. The second cointegrating vector, which measures the deviations of interest rates from its long run equilibrium level, depends positively on inflation and income. The third cointegrating vector measures long term inflation and depends positively on income, with a negative effect from the trend.

The $I(0)$ system determines seven variables ($\Delta(m-p)_t$, ΔR_t , $\Delta^2 p_t$, Δi_t , $CI1_t$, $CI2_t$ and $CI3_t$). The information set used consists of the first lags of $\Delta(m-p)_t$, ΔR_t , $\Delta^2 p_t$ and Δi_t together with $CI1_{t-1}$, $CI2_{t-1}$, $CI3_{t-1}$, two dummy variables and an intercept, entailing a reduction to parsimonious VAR. In order to enhance interpretability and to reduce its sample dependence, the system is modelled as an $I(0)$ parsimonious vector autoregression (PVAR), as explained in Chapter 4 and Chapter 5. As explained in Section 5.5.3, the weak exogeneity of R_t , Δp_t and i_t for the parameters of the first cointegration relation is examined first. Then the conditional factorization is performed following the procedure outlined in Section 5.5.3.

The resulting VAR equations are estimated by FIML and given in Table 6.5. Since the test of overidentifying restrictions does not reject at 1 per cent level ($\chi^2_{0.01}(25) = 40.16$, $p > 0.028$), the model parsimoniously encompasses the PVAR. The short run estimates of the model in Table 6.5 indicate that the change in demand for extended money is not affected by any of the variables in the system except the lagged value of itself, the first cointegrating vector and the constant. Although the short run demand for money equation does not seem to be affected by interest rates,

Table 6.5: FIML Model Estimates

$\Delta(m-p)_t$	$= 0.19 \Delta(m-p)_{t-1} - 0.13 (CI1)_{t-1} - 0.011 (D8134) - 0.45$
	(1.76) (-3.78) (-1.65) (-3.74)
ΔRI_t	$= 0.43 (\Delta RI)_{t-1} - 0.15 (CI2)_{t-1} - 5.85$
	(4.42) (-3.86) (-3.87)
$\Delta^2 p_t$	$= 0.25 (\Delta^2 p)_{t-1} - 0.11 (CI3)_{t-1} + 0.008 (D8134) - 0.011 (D8234) - 0.81$
	(2.96) (-5.10) (2.56) (-4.01) (-5.11)
Δi_t	$= 0.28 (\Delta^2 p)_t + 0.002 (D8134) + 0.004$
	(1.68) (0.64) (5.93)

t ratios are in parentheses.

Table 6.6: Model Statistics

$F_{ar}^m(64,158)$	1.42 (0.04)*
$F_{het}^m(160,301)$	0.94 (0.66)
$\chi_{nd}^{2m}(8)$	8.50 (0.38)

FIML Residual Correlations

	$\Delta(m-p)_t$	ΔRI_t	$\Delta^2 p_t$	Δi_t
$\Delta(m-p)_t$	0.98%	-0.06	-0.31	-0.07
ΔRI_t	-0.07	4.92%	0.27	0.13
$\Delta^2 p_t$	-0.32	0.32	0.44%	-0.03
Δi_t	-0.16	0.18	0.01	0.61%

the inclusion of the error correction term means that interest rates do affect long-run as well as short-run demand for money and thus can be treated as a policy variable. Furthermore, the short-run demand for extended money function has an adjustment coefficient of 0.13, which indicates that 13 percent of disequilibrium is corrected in each quarter and it is very close to that obtained by Cassard et al. (1997) who

estimate the demand for M3. The short run interest rate and inflation equations have similar speed of adjustment coefficients to that of extended money equation with strong effects. Both of the equations have their lagged dependent values as explanatory variables, indicating that they follow AR(1) processes, but at the same time respond to the long-run disequilibrium levels. Finally, the short run income equation is affected by the current value of inflation. Additionally the model diagnostic statistics, given in Table 6.6, are all insignificant at 1 per cent level of significance, matching the valid reduction from the parsimonious VAR.

In order to test the constancy of the model, a one-step forecast analysis is performed for the time period 1992:1-1993:4. Figure 6.5 reports the one-step model based forecasts. Even though there is some sign of the model not being entirely satisfactory for the short-run money demand equation at the end of the forecast period, the stability of the model cannot be rejected with the overall test statistic is $F(32, 51)=1.46$ ($p>0.11$). Figure 6.6 presents a sequence of one through eight step ahead forecasts from 1992:1 onwards with error bars of 95 per cent confidence intervals. The forecasts converge to their unconditional means for all equations, except the extended money and acceleration of inflation equations.

6.6 Conclusion

The abolition of exchange controls and financial innovations which occurred in the late 1980s allowed French residents to borrow from abroad and to hold foreign currency deposits both at domestic banks and banks abroad. These developments caused sharp increases in CBDs, which could reflect currency substitution as Filosa (1995) suggests. Due to the increased degree of currency substitution, any expected exchange rate or institutional change may lead to instabilities in the traditional monetary aggregates. Thus, as in the previous chapter, an extended monetary aggregate based on the residency of holder criterion is defined so that international spill-over effects could be internalized.

In this chapter the demand for extended money in France was analysed and

its economic and stability properties were investigated. The VAR estimates of the initial system revealed that there are three cointegrating relationships in the long run: the first one measures the extended money demand as a function of income, inflation and interest rates; the second one measures the deviations of interest rate from its long run equilibrium level; the third one measures inflation. All of the variables in each of the cointegrating vectors have the correct signs. Empirical findings indicate that the weak exogeneity of income, interest rates and inflation for the parameters of the money demand equation was satisfied and the error correction term for extended money does not appear in the short run equations for these variables. Thus it can be argued that the causality goes from income, interest rates and inflation to money. Furthermore, the extended monetary aggregate appears to have no impact on any of the short run equations. The adjustment coefficients in the equations for extended money, interest rates and acceleration of inflation have similar magnitudes.

Although the short run extended money demand equation does not include any variables other than its own lagged value, the cointegrating vector, a constant and a dummy variable, this does not indicate that interest rates cannot be used as a policy variable. Interest rates fulfill their role as a policy instrument in the long run, and in the short run the demand for extended money adjusts to the disequilibrium from the long run level. Furthermore, the stability analysis of the model suggests that the demand for extended money is stable, which is in line with other studies of the French money demand function. The long-run demand for money function has a unit income elasticity unlike many other studies. The adjustment coefficient of the short-run money demand equation is very close to that of Cassard et al. (1997). When compared to the results of the previous chapter, it emerges that the demand for extended money in both Germany and France appears to be stable, as expected.

Figure 6.1: French Time Series Data

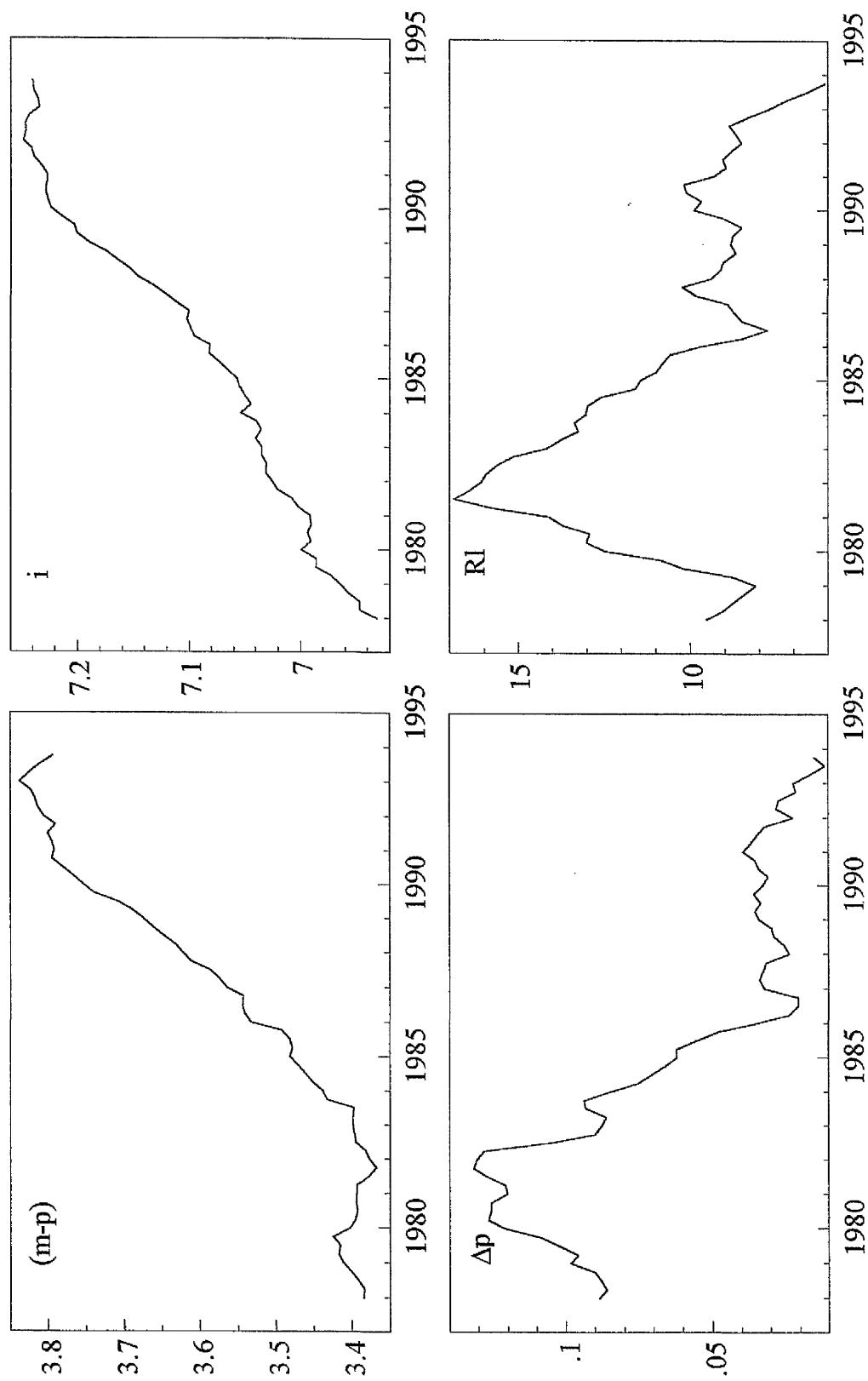


Figure 6.2: The Evolution of CBDs (in billions of FF)

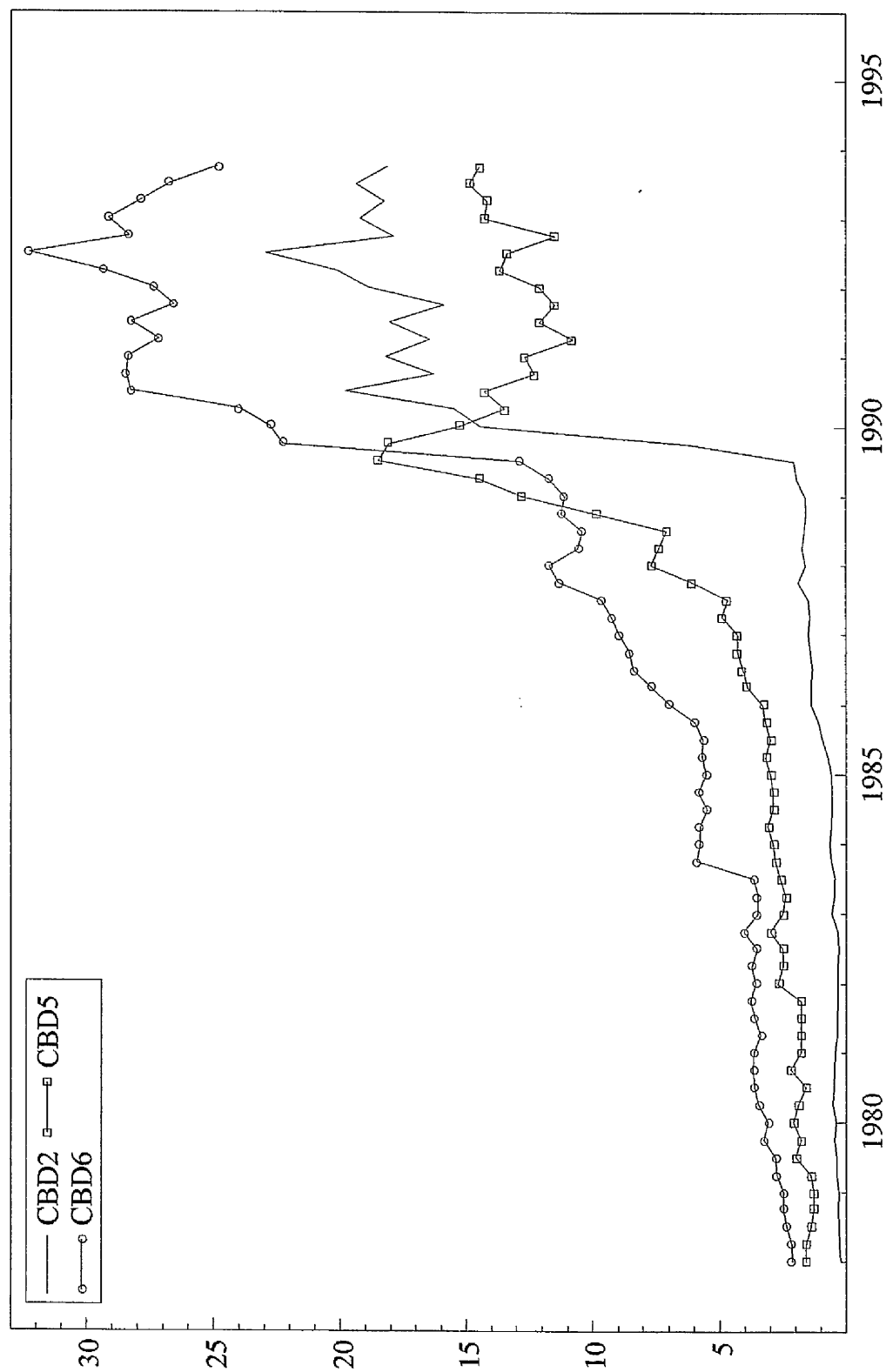


Figure 6.3: The Scaled Residuals of the Initial Model

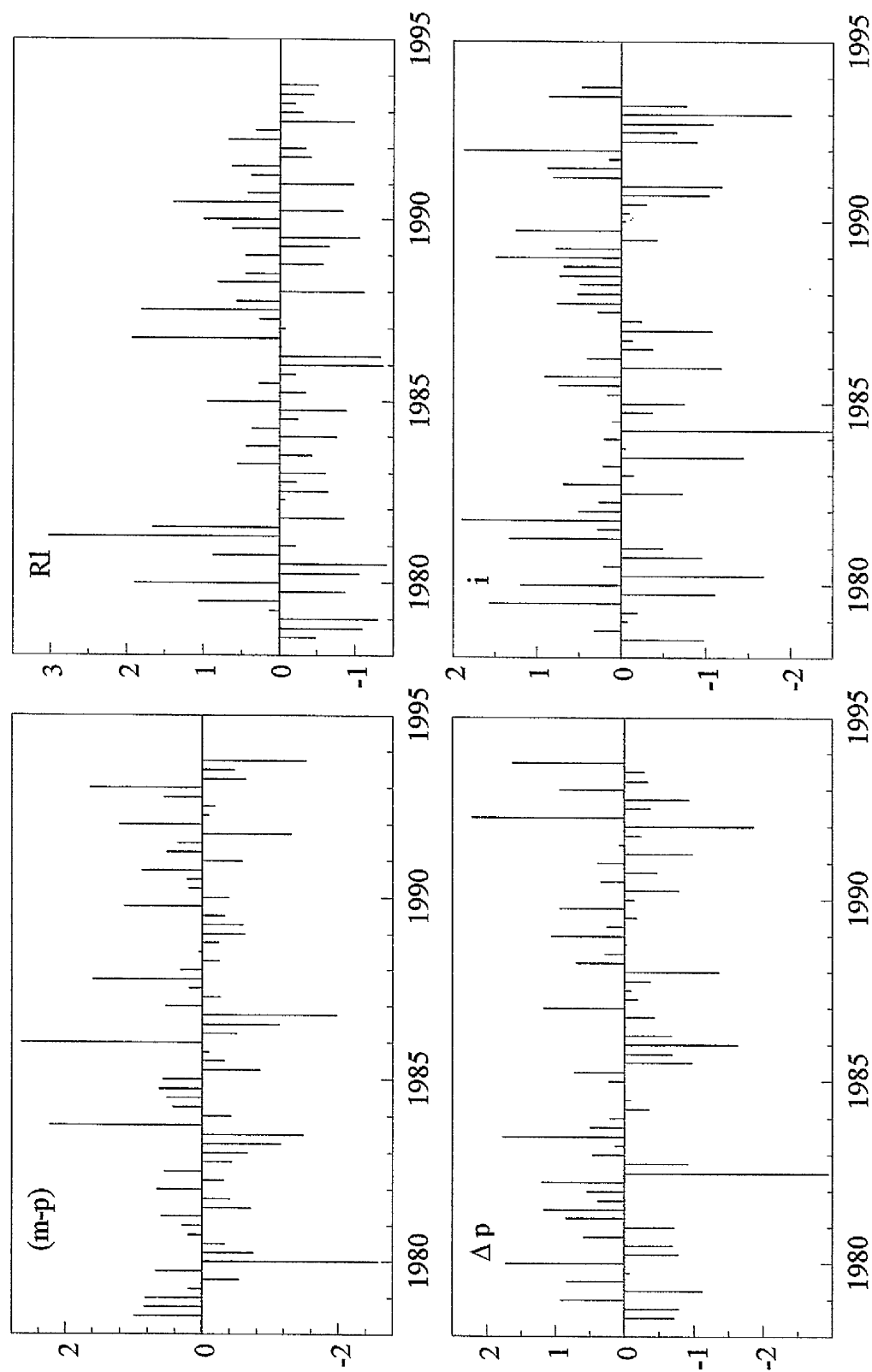


Figure 6.4: Cointegration Vectors

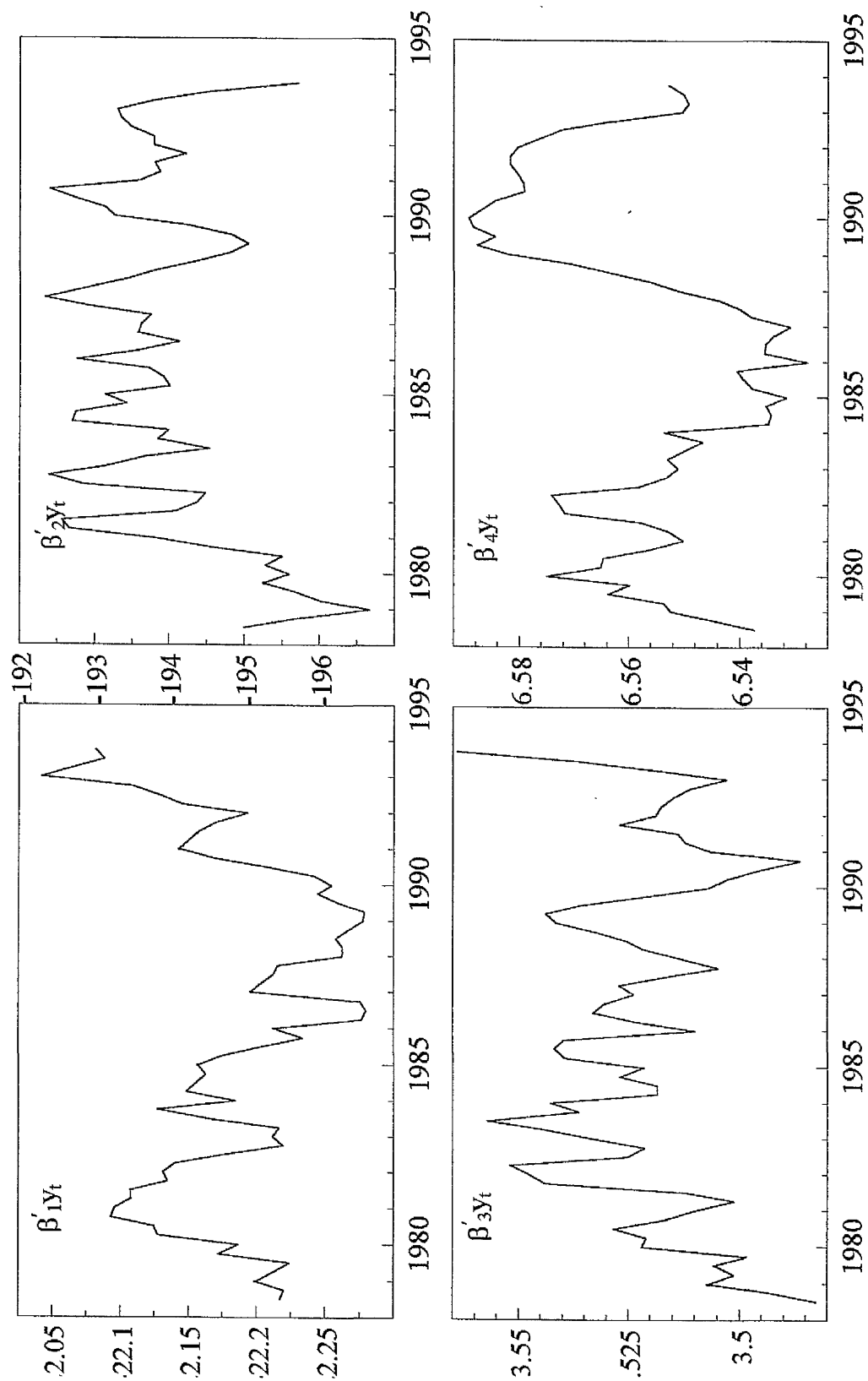


Figure 6.5: 1-Step Ahead Forecasts

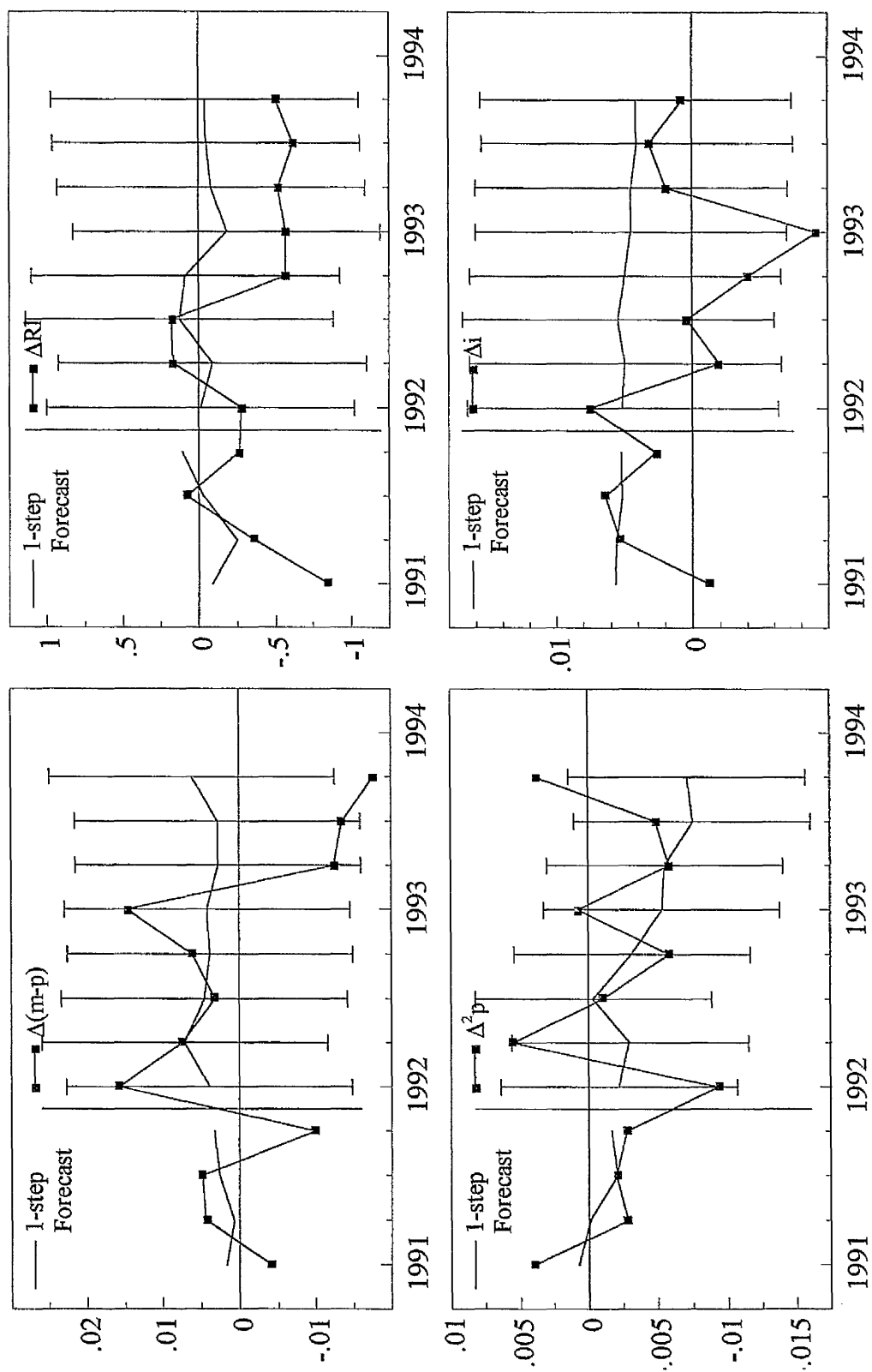
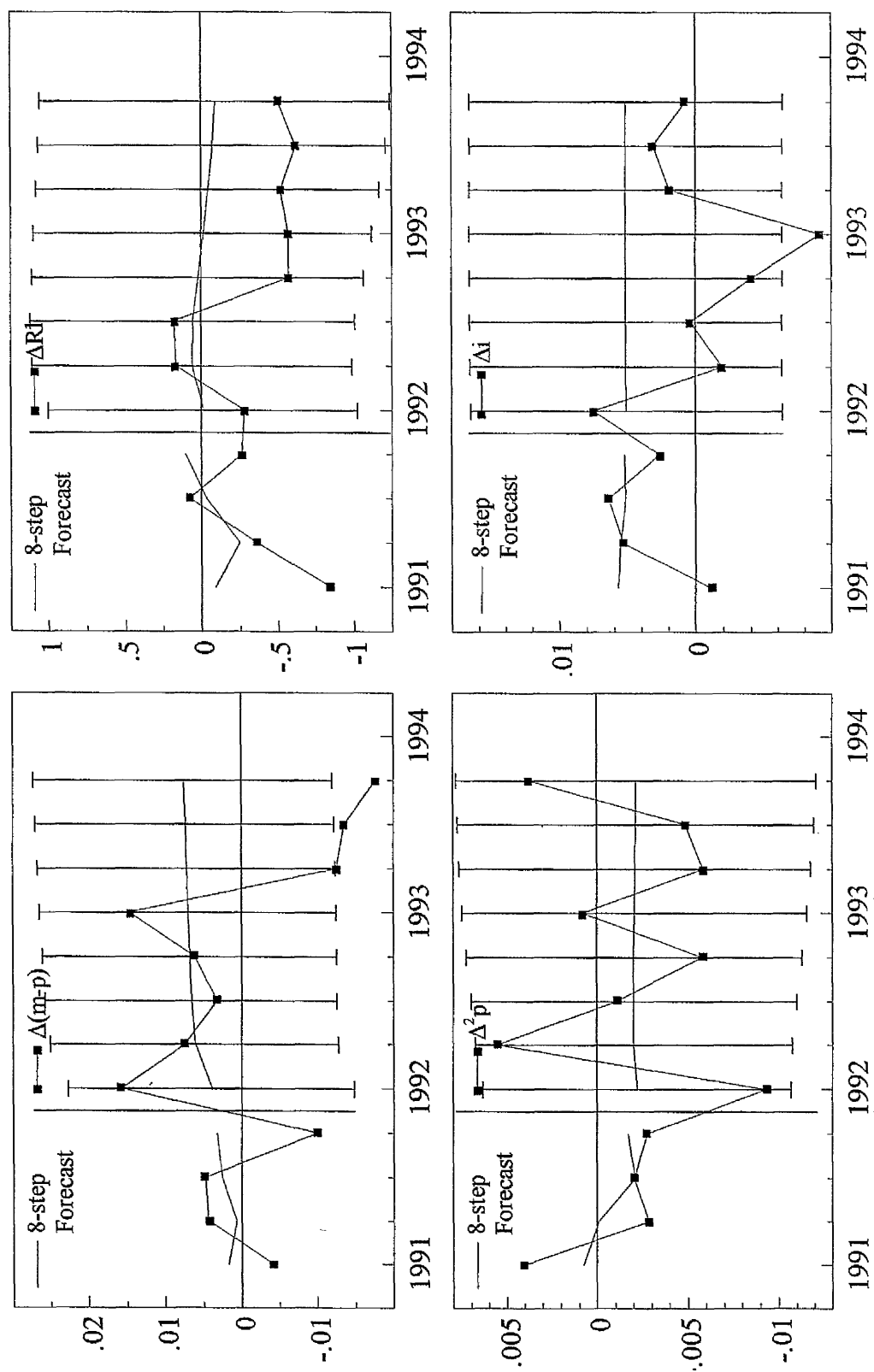


Figure 6.6: 8-Step Ahead Forecasts



CHAPTER 7

MODELLING THE DEMAND FOR MONEY IN THE UK

7.1 Introduction

Following the two oil price shocks in the 1970s, the reduction of inflation became the main objective of the British monetary authorities. The first oil price rise in 1973-1974 produced an unacceptable mixture of high inflation, rising unemployment and macroeconomic uncertainty for many countries, including the United Kingdom. Following the second oil price rise in 1979, leading industrial countries adopted counter-inflationary policies. The United Kingdom's own policies have reflected the same commitment since 1979, even though in the late 1980s policy was eased too much.

Control of the money supply was the main policy used against inflation, and in 1980 the first version of the medium-term financial strategy (MTFS) was published. The main aim of the MTFS was to reduce inflation, initially by having reducing targets for the growth rate of a broad monetary aggregate, together with a medium-term reduction in the public sector borrowing requirement (PSBR) in relation to gross domestic product (GDP). However, it became difficult to keep the money supply on course, and the monetary aggregate targeted has been changed several times.

As the UK is not a member of the ERM and enjoys a relatively flexible exchange rate regime compared to other EU countries, the degree of currency substitution in the UK could be expected to be relatively small. Thus it can be argued that the UK should not be included in this study. However, after the abolition of exchange controls between June and October 1979, together with the availability of new financial instruments and improved computing and telecommunication facilities, the foreign currency holdings of UK residents increased considerably. Examination of the evolution of CBDs (in Section 7.3) indicates that there could be a considerable degree of currency substitution in the UK, thus, leading to the inclusion of the UK

in this study. Furthermore, these CBDs tend to be sensitive to changes in exchange rates or banking regulations. As argued in Chapter 3, these developments may lead to instability in the money demand functions. Hence, this chapter presents an empirical study of the demand for extended money function in the UK, including a stability analysis. Section 7.2 gives a brief account of economic developments in the UK since 1978. Evolution of cross-border deposits are summarized in section 7.3. Section 7.4 surveys existing estimates of money demand function in the UK. Empirical results are reported in section 7.5. Finally, some concluding remarks are made in section 7.6.

7.2 Economic Developments

The UK economy experienced severe recessions following the two oil-price shocks in the 1970s. During the recovery period which followed the first oil-price rise in 1973 economic performance improved, the rate of inflation decreased, output increased. However, there was an increase in unemployment. The UK economy was hit by the second oil-price rise in 1979 even before completing full recovery from the first. The rate of inflation had climbed to high levels in early 1980s as can be seen from Figure 7.1 where the graphs of real extended money ($m-p$), GDP at 1985 prices (i), inflation (Δp) and long term interest rates (R_l) are presented, where all variables, except the interest rates, are in logarithms.¹

Strong inflationary pressures led the newly elected government in 1979 to pursue an anti-inflationary programme. "In essence, the Government was attempting to put the economy over the medium term onto a relatively rapid non-inflationary growth path by diminishing the role of the State in the economy and giving greater responsibility to the individual through improving incentives to enterprise, innovation and efficient working".² The reduction of inflation was central to the government's

¹See Appendix 1 for the definitions of the data.

²OECD Economic Surveys UK, February 1980.

medium term strategy of a steady policy approach which it stated it intended to maintain irrespective of short-run adverse effects on output and employment. The main instrument of the new approach was monetary policy and this implied that fiscal policy was to be modified in line with the monetary objectives. Over the medium term, a gradual reduction in the rate of growth of the money supply was planned in order to reduce inflation. The other main objective of the government was the improvement of supply-side performance through the liberalisation of markets. Foreign exchange controls had been lifted in 1979 as part of a programme of reducing restrictions on the economy. UK residents were allowed to place deposits in and borrow from international markets. This was followed by the abolition of the supplementary special deposit scheme (the corset) in 1980.

The coherency of monetary and fiscal policies was improved with the establishment of the Medium Term Financial Strategy (MTFS) in the 1980 budget, where the movements in the PSBR were directly linked to movements in the money supply. Government aimed to control the growth of money supply, through the control of PSBR and an active interest rate and debt financing policy, assuming that the achievement of a progressive reduction in money supply would be a sufficient condition for reducing inflation. According to the MTFS, interest rate decisions were to be based on a comprehensive assessment of monetary conditions so as to maintain downward pressure on inflation.

The MTFS was based on the view that traditional policies of fiscal expansion could not work because of their impact on inflation and because of the interest rate crowding-out. Policy targets were set for the medium term with the intension of generating favourable expectations and providing a consistent framework for macroeconomic policy. It was expected that in a low inflation environment unemployment and output would recover in due course. Initially target growth rates for sterling M3 were set by the MTFS. The broad definition of money supply had been chosen on the basis that it had more predictive content than the narrower monetary magnitudes and was more likely to be exogenous with respect to current

nominal income than the narrow magnitudes. But the early years saw monetary growth well in excess of target ranges. Moreover, the PSBR was larger than projected in fiscal years 1980-81 and 1981-82. Following the overshooting of the sterling M3 targets in these years, targets were revised up and supplemented by targets for M0 and private sector liquidity 2 (PSL2) in the 1982 budget. In the 1984 budget a second change came. A target for sterling M3 was retained and the previously announced target range was confirmed, but the targets for M1 and PSL2 were both dropped and replaced by a monetary base M0.

Due, at least in part, to the continuing structural change and innovation in financial markets and institutions, monetary aggregates became volatile and less reliable and sterling M3 growth was frequently above the target range. Emphasis shifted to the exchange rate. Although there was no explicit target for sterling, the exchange rate had a greater influence on policy than before. Sterling M3 target was dropped altogether from the 1987 restatement of the MTFs.³

The 1981-1988 period was a recovery period, with inflation falling from 12 to 6 per cent. The deterioration in performance in the 1970s appeared to have been reversed during this recovery period. One of the contributors to the recovery was the rapid development of North Sea oil. The UK became a net oil exporter in the 1980s, even though up to 1975 it imported all its oil requirements. The development of the oil sector had favourable effects on the current account and on the structure of the non-oil economy, where large gains in income increased the demand for goods and services.

The UK economy entered a period of excess demand in early 1987. Over the two year period 1987-88, growth of real domestic demand averaged some 7 to 8 per cent a year and that of real GDP almost 4.5 per cent. By early 1988, the level of aggregate demand had probably surpassed that of potential output. According to the OECD, one factor in the unexpectedly strong expansion of demand was the interplay

³See Artis and Lewis (1991) for target ranges for the monetary aggregates and out-turns year by year.

of financial market liberalisation, asset price inflation and the emergence of excessive private sector debt levels.⁴

In view of these developments, the authorities had progressively tightened monetary conditions from mid-1988. Interest rates were increased gradually to control the rate of inflation; the expansion of narrow money M0 remained just below the top of the 2 to 6 per cent target range; mortgage borrowing and consumer demand slowed, house prices and real estate transactions fell and private consumption growth slowed. Domestic demand fell in the second half of 1990, lowering real GDP growth for 1990 to 0.6 per cent.

The UK had refrained from entering the European Exchange Rate Mechanism (ERM) primarily because it wanted to put monetary targeting ahead of the goal of stabilizing the exchange rate. But, as described above, the monetary aggregates had become more volatile and less reliable over the period. Furthermore, it was supposed that the European Monetary System would be rigid and inflexible. However, it had in fact allowed a number of realignments in the early 1980s. Finally, on October 1990, sterling entered the ERM at a central parity of 2.95 Deutsche Mark to the pound. With this development, priority in monetary policy was to keep sterling within its permitted ± 6 per cent fluctuation band. At the time of entry, annual inflation had risen close to 11 per cent, and the fight against inflation had again become the main objective of the Government. It was assumed that maintaining sterling's position within its ERM band would provide a more effective nominal anchor for the MTFS than existed in the 1980s, together with a powerful external discipline on domestic economic policies to achieve low inflation. Monetary conditions had been tightened leading to an increase in interest rates to a peak level of 15 per cent.

From the second quarter of 1990 to the second quarter of 1992 real GDP fell by more than 4 per cent, while unemployment rose sharply to over 10 per cent. Given the commitment to the ERM parity, there was little room for manoeuvre in monetary policy to overcome the recession. As a result, financial market participants

⁴OECD Economic Surveys UK, 1989.

increasingly perceived sterling's obligations within the ERM as out of line with economic fundamentals and pressure against sterling intensified. On 16 September 1992, the heavy speculative attack against sterling led to the suspension of sterling from the ERM, in spite of massive interventions by the Bank of England.

Since September 1992, the authorities have established a new monetary policy framework to replace the ERM's previous role as a nominal anchor. Monetary policy is based on targeting inflation, with a continuing monitoring of narrow (M0) and broad money (M4). By early 1993, sterling had fallen to around 2.39 against the Deutsche Mark; a depreciation of 14 per cent since it left the ERM.

7.3 The Evolution of Cross-Border Deposits

Since the abolition of exchange controls in 1979, the cross-border deposits held by UK residents have increased continually. The recent behaviour of CBDs, which are included in the extended monetary aggregate defined according to the residency of holder criterion, is summarized in Figure 7.2. The national monetary aggregate M4 includes residents' national currency deposits held in domestic banks. However, unlike the broad monetary aggregates of other countries, M4 does not include foreign currency deposits held by UK residents in domestic banks. Thus, in order to obtain the extended monetary aggregate defined according to the residency of holder criterion, three types of CBDs are added to M4⁵. These are foreign currency deposits held by residents in domestic banks (CBD 5), national currency deposits held by residents in banks abroad (CBD 2) and foreign currency deposits held by residents in banks abroad (CBD 6). Figure 7.2 indicates that sterling deposits held abroad (CBD 2) by residents (excluding banks and financial institutions), which reflects pure relocation of deposits, remained small relative to other CBDs (only 1.5 per cent of M4 in 1993:4). This could be due to the fact that Bank of England relaxed all the controls on deposits such as reserve requirements. The foreign currency deposits of residents, either with domestic or foreign banks (CBD 5 and CBD 6), which reflect

⁵See Chapter 2, for the extended money definitions.

currency substitution, increased steadily up to 1991:4. Although there was a decrease in the sterling value of foreign currency deposits held by non-bank residents with domestic banks between 1992:1-1992:4, reflecting the appreciation of sterling, CBD 5 and CBD 6, continued to increase accounting for 11 per cent and 7 per cent respectively of M4, in 1993:4. To sum up, the amount of foreign currency deposits held by British residents have increased since the abolition of exchange controls in 1979 suggesting that currency substitution may exist in the UK.

7.4 Existing Studies

Although early studies of demand for money functions found short run and long run money demand function which appeared to be fairly stable, in the early 1970s instability in the money demand functions were observed both in the UK and in the US. The instability of money demand functions was widely attributed to the rapid financial innovations, new techniques of financial management and market liberalisation. However, Adam (1991) argues that despite financial innovation there has been no fundamental change in the underlying money demand function, indicating that financial innovation cannot be a sufficient explanation for the breakdown of the stability. Additionally, Baba et al. (1992) interpret this breakdown as a misspecification of money demand functions. The stability properties of money demand equations for both narrow money and broader aggregates in the UK have been considered in many studies. The estimation techniques which are generally used are the two step Engle-Granger modelling and vector autoregressive modelling.⁶ The sample period varies as well as the variables employed.

It is widely argued that the use of a limited set of explanatory variables such as income, price level and interest rates could lead to the instability of the broad monetary aggregates. However, if a more appropriate scale variable is chosen, such as wealth, the stability of the equation is re-established (Hall, Henry and Wilcox (1990)). Another explanation for the instability in the demand for money function

⁶See Chapter 4 for alternative methods of modelling the demand for money function.

could be attributable to the misspecified dynamics and/or omitted interest rate volatility. For example Hendry and Ericsson (1991) argue that there had been numerous financial innovations in the UK in the sample period. To model the adaptation following financial innovation, they adopt the approach proposed in Baba, Hendry and Starr (1985, 1990) of learning adjustment on own interest rates. They estimate an error correction model for M1 for the time period 1964:3-1985:2, where the scale variable is real total final expenditure (at 1985 price), and the price variable is the total final expenditure deflator. They report that the instability of the conventional error-correction equation disappears when interest rate elasticity is allowed to vary according to the logistic learning process. In the second step of the error-correction analysis, they report an adjustment coefficient of 0.094, with a unit income elasticity in the long run specification.

New econometric techniques are also employed in the analysis by, among others, Johansen (1992), Hendry and Doornik (1994) and Sumner (1997). Johansen (1992) replicates the analysis on the UK money demand given in Hendry and Ericsson (1991), and particularly examines the weak exogeneity of inflation, interest rates and income for the parameters of the long-run money demand equation. After obtaining a long-run money demand function, which is homogeneous in prices and income and negatively related to the opportunity cost variable, he reports that inflation, interest rates and income are weakly exogenous for the long-run parameters. Hendry and Doornik (1994) can be seen as an extension of Johansen (1992) using the same data, except that the learning adjusted differential between the three-month local authority interest rate and the M1 retail sight-deposit interest rate is used as the opportunity cost variable. Their results support the existence of a stable demand for money function for M1 with a unit income elasticity and equal effects from inflation and the interest rate differential.

The performances of alternative scale variables, real GDP, real disposable income or wealth are compared by Sumner (1996) who estimates the demand for M4 using Johansen's VAR methodology. He reports that the certificate of deposit rate

has markedly greater explanatory power than other opportunity cost variables both in the short and the long run. The short-run money demand functions, estimated using different scale variables, have highly significant error-correction terms, around 0.16, and the performance of these alternative scale variables are similar. However, the extra-sample performance of the estimates suggests that there is some instability in the demand for M4.

Mizen and Pentecost (1994) test currency substitution effects on sterling real money demand by EU residents and estimate both the demand by non-residents for sterling and the demand for real sterling M1 in the UK. The former is studied using a transaction services model originally proposed by Bergstrand and Bundt (1990)⁷, where the foreign demand for sterling denominated money depends positively on the level of income and the interest rates in the foreign country, and negatively on the interest in the UK. The foreign countries are Germany, France, Belgium, the Netherlands, Italy, Denmark and Ireland. They employ Engle-Granger Johansen cointegration methodology. The results show that no cointegrating vector can be identified, indicating that currency substitution, in the Bergstrand and Bundt sense, does not occur between individual European currencies and sterling.

Their alternative model starts from a modified version of the portfolio balance model due to Cuddington (1983), where the demand for sterling M1 is assumed to depend on a UK interest rate, a foreign interest rate plus expected depreciation of sterling and a separate term for the expected depreciation of sterling. The expected rate of depreciation is initially identified with the forward discount and subsequently with the relative inflation differential. As in previous estimations, valid cointegrating vectors cannot be identified. However, they proceed to the second stage and provide the estimates of the short-run equations, where error-correction terms are uniformly insignificant. They report evidence of currency substitution between the currencies of some European countries (Germany, Belgium and Ireland) and sterling holdings, but the currency substitution between sterling and other EU countries is not

⁷See Chapter 2, for alternative models of currency substitution.

widespread in either the short or the long-run. "When the question of existence of the currency substitution was raised neither the money services production function approach nor the portfolio balance approach revealed any clear evidence of currency substitution."⁸

Milner, Mizen and Pentecost (1996) employ a model of Ratti and Jeong (1994)⁹ to investigate currency substitution between sterling and the currencies of ERM7 countries¹⁰. They hypothesise that there is an impact of intra-European trade on currency substitution. The ratio of domestic money to resident holdings of sterling-denominated deposits is regressed for each country separately on the net bilateral trade balance, real exchange rate, relative interest rates and expected depreciation. The model is estimated using Johansen cointegration methodology. The results show that for five of the seven countries there are cointegrating relationships between the variables. However, only the cointegrating vector for Italy is consistent with the postulated model, indicating that the hypothesis of currency substitution by Europeans is established as a long-run relationship for Italy. For most countries the trade variable appears in the long-run cointegrating relationship with a positive sign, confirming the earlier empirical findings of Ratti and Jeong (1994), that trade has an influence upon currency substitution.

Finally, Filosa (1995), investigates the existence of the currency substitution and stability of demand for money in the UK, among six other EU countries. He estimates the demand for M4 for the time period 1980:1-1991:4 employing error-correction modelling. It is found that although the long-run price elasticity is equal to one, the long run income elasticity is around 1.60. The hypothesis of currency substitution is tested by specifying devaluation expectations as the three-month forward premium vis-a-vis the US dollar and it is reported that the expected

⁸Mizen and Pentecost (1994), pp.1068.

⁹See Chapter 2, for a brief discussion of the model employed by Ratti and Jeong (1994).

¹⁰They are Belgium, Denmark, France, Germany, Ireland, Italy and the Netherlands.

depreciation vis-a-vis the US dollar negatively affects the demand for broad money in the UK suggesting a substantial currency substitution between the sterling and the US dollar. However, the Bertola and Svensson devaluation expectations index could not be computed for the entire sample period and "it has not been possible to find a statistically significant influence of the forward premium vis-a-vis European currencies".¹¹

Almost all of the studies investigating the stability properties of narrow or broad money in the UK, identify instability in the demand for money function. It is widely argued that the instability of the demand for money function may be due to misspecification of the money demand function or to omitted variables. When the specification of the demand for money function is corrected or financial innovation and a learning process are modelled (Hendry and Ericsson (1991), Hendry and Doornik (1994)) a stable demand for money function can be obtained. However, in cases where no such modifications are made an unstable demand for money function is obtained, especially for M4 (Sumner (1996)). When currency substitution is considered, the existing studies do not reveal any significant currency substitution effect for the UK demand for money (Mizen and Pentecost (1994) and Filosa (1995)). However, considering that the previous studies report instability in the traditionally defined aggregates, if the demand for extended money in the UK is found to be stable, this could indicate that the instability in the demand for money in UK may, alternatively, be due to currency substitution effects. Hence, the demand for extended money in the UK is modelled in the next section.

7.5 Modelling the Demand for Extended Money

A four equation VAR model is estimated to investigate the stability properties of the demand for extended money, as in previous country chapters. A VAR model is employed by Hendry and Doornik (1994) to model the demand for M1 and by Sumner (1996) to model the demand for M4. Doornik and Hendry (1994) include

¹¹Filosa (1995), pp.26.

real GDP, inflation and a learning adjusted interest rate differential as explanatory variables whereas Sumner (1996) compares the performance of alternative scale variables such as real GDP, real disposable income and wealth with alternative opportunity cost variables. In this chapter the variables are the extended M4 (M), real GDP at 1985 prices (I), the consumer price index (P) and long-term interest rate (Rl). Thus the estimation can be seen as an extension of Sumner (1996), with real extended M4 replacing real M4. Seasonally adjusted quarterly data is available for the time period 1978:1 -1993:4. After allowing for lags estimation is performed over 1978:3-1993:4, which yields 62 observations. All variables are used in logarithmic form, except the long term interest rates, and this is indicated by lower case letters. The results of stationarity tests indicate that apart from the price level, which is $I(2)$, all variables considered by the study are integrated of order one. As a result, the consumer price index is not included separately in the analysis, but is included as transformed leading to a system in four stochastic variables real extended money ($m-p$), real income (i), inflation (Δp) and interest rates (Rl) with a constant and trend.

As in all previous estimations, the analysis started from an augmented VAR with four lags on all variables. The initial estimates of the model indicated a number of outliers in the inflation equation (the scaled residuals of the model are presented in Figure 7.3), which caused serious autocorrelation problems in the inflation equation and in the system estimation as a whole. These outliers could be attributable to VAT tax changes in the early 1980s. In order to refrain from adding dummy variables to capture these outliers, the GDP deflator is substituted for the consumer price index, on the grounds that it will be less affected by VAT changes as it is a broader price measure. The first estimates of the new model indicate that it is largely free from outliers and autocorrelation problems, justifying the inclusion of the GDP deflator instead of consumer price index.¹²

Simplification F-tests, presented in Table 7.1, indicate that two lags are

¹²Even though the GDP deflator has been employed as the price variable here, in the aggregate estimation of Chapter 10 the consumer price index is used to obtain the aggregate variable for consistency across countries.

Table 7.1: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-24.42	-25.95		
2	3	-25.14	-26.33	1 → 2	F(16,119) = 0.98 (0.47)
3	2	-25.63	-26.48	2 → 3	F(16,132) = 1.77 (0.05)
				1 → 3	F(32,138) = 1.37 (0.10)

Note: p-values are in parentheses

Table 7.2: Residual Correlations and Lag Length Statistics for VAR (2)

Residual Correlations				
	(m-p)	i	Δp	Rl
i	0.141	-	-	-
Δp	-0.233	0.146	-	-
Rl	0.054	-0.107	-0.051	-

Lag Length and Dynamics

	(m-p)	i	Δp	Rl
$F_{s=1}(4,46)$	13.1** (0.00)	3.85** (0.00)	8.25** (0.00)	11.0** (0.00)
$F_{s=2}(4,46)$	3.83** (0.00)	6.05** (0.00)	0.19 (0.94)	0.91 (0.46)
$ \mu $	0.41	0.24	0.12	0.12

Note: ** denotes significant at the 1% levels and p-values are in parentheses.

sufficient. Additionally, the Schwarz and Hannan-Quinn criteria also indicate the selection of the 2 lag system. The scaled residuals of this system, Figure 7.4, indicate that there are three outliers in the income equation: the second and third quarters of 1979, and the second quarter of 1984 which could be due to the miners' strike in that year. In order to account for these outliers three dummy variables are included in the model. They are D1979:2, D1979:3 and D1984:2 which take a value of unity in the indicated quarter. Doornik and Hendry (1994) note that the dummy variable D1979:2 can be attributed to the first effects of the Thatcher government on output and D1979:3 can be attributed to the effects of the oil price rise. The dummy variable D1984:2 is expected to reflect the negative effects of the miners' strike for output.

Table 7.3: Goodness of Fit and Diagnostic Test Results

	(m-p)	i	Δp	Rl	VAR
$\hat{\sigma}$	1.64%	0.67%	1.08%	0.60	
$F_{ar}(4,45)$	1.26 (0.29)	1.86 (0.13)	2.50 (0.05)	1.62 (0.18)	
$F_{arch}(4,41)$	0.99 (0.41)	0.36 (0.83)	0.68 (0.60)	0.56 (0.69)	
$F_{het}(18,31)$	0.19 (0.94)	0.30 (0.87)	0.58 (0.67)	0.49 (0.74)	
$\chi^2(2)$	3.66 (0.16)	4.68 (0.09)	1.86 (0.39)	2.06 (0.35)	
$F_{ar}^v(64,119)$					1.17 (0.22)
$F_{het}^v(180,205)$					0.86 (0.84)
$\chi_{nd}^{2v}(8)$					11.2 (0.18)

Note: * denote significant at the 5% level and p-values are in parentheses.

Hence a two lag model with three dummy variables, a trend and a constant is chosen as the final model.¹³

The residual correlations and lag-length statistics of this final model are given in Table 7.2. It appears that there is relatively large negative residual correlation between inflation and the real extended money. The first lags of all variables and the second lags of real extended money and income are highly significant. From the eigenvalues of the long-run matrix, it seems that the rank of the long-run matrix is two or three as all eigenvalues are greater than zero. Furthermore all diagnostics of the model are satisfactory as presented in Table 7.3, where all statistics are defined as in Chapter 5.

The results of the cointegration analysis are presented in Table 7.4. The maximum eigenvalue statistic indicates that there is only one cointegrating vector, whereas trace statistic suggests that there are three cointegrating vectors.¹⁴ As mentioned in Chapter 4, in some cases the evidence on the number of cointegrating relations from the trace and maximum eigenvalue statistics could be mixed. This could be due to the sample length and inclusion of dummy variables. In such cases, it is useful examine the eigenvalues of the long-run matrix or to resort to the graph of the cointegrating vectors which are presented in Figure 7.4. From this figure it seems that only the last cointegrating vector exhibits non-stationarity. This is supported by the presence of three relatively large and one relatively small eigenvalues. Thus the existence of three cointegrating vectors is assumed throughout the analysis.

The first cointegrating vector can be interpreted as the excess demand for extended money with, a positive effect from real income and negative effects from inflation and interest rates. The two remaining cointegrating vectors represent the deviations of output and inflation from their long-run equilibrium levels. Identification restriction are imposed on the cointegrating vectors as described in Chapters 4 and

¹³See Chapter 5 for the discussion of inclusion of a trend in the analysis.

¹⁴See Chapters 4 and 5, for cointegration analysis and identification of cointegrating vectors.

Table 7.4: Cointegration Analysis

r	1	2	3	4
λ	0.43	0.30	0.25	0.15
Max	35.8*	22.9	18.0	10.5
Tr	87.51**	51.64**	28.6*	10.5

Eigenvectors β					
	(m-p)	i	Δp	Rl	Trend
(m-p)	1.00	-2.94	3.67	0.03	0.003
i	-0.19	1.00	-0.66	0.02	0.0001
Δp	-1.71	4.61	1.00	-0.006	0.008
Rl	-64.0	85.8	-24.1	1.00	0.82

Adjustment Coefficients α				
(m-p)	-0.049	-0.108	0.047	0.002
i	-0.042	-0.079	-0.023	-0.00007
Δp	-0.056	0.192	0.0002	-0.0007
Rl	-0.408	-5.86	-3.22	-0.058

5. In addition to the unit income elasticity and weak exogeneity restrictions the following restrictions are also imposed after examining the adjustment coefficients and long-run matrix: for the income vector no effect from trend, and for inflation no effect from interest rates. When jointly tested, these restrictions are accepted yielding $\chi^2(5)=14.9$ ($p>0.056$). The estimated restricted cointegrating vectors are as follows:

$$CI1 = (m-p)_t - i_t + 0.31 \Delta p_t + 0.013 Rl_t - 0.012 \text{Trend}_t,$$

$$CI2 = i_t + 1.304 \Delta p_t + 0.045 Rl_t,$$

$$CI3 = \Delta p_t - 0.74 i_t + 0.0047 \text{Trend}_t.$$

The cointegrating vectors are similar to other countries' long-run equations, except

that the output equation (CI2) does not include a trend. Although output could be expected to have a positive trend coefficient, the downward sloping inflation and interest rates over the period apparently capture the trend effect. The long-run extended money demand function is particularly similar to that of France, except it has a comparatively strong effect from interest rates.¹⁵ The long-run extended demand for money functions in France and in the UK have unitary income elasticities, whereas that of Germany has an income elasticity greater than unity. The third cointegrating vector representing the deviations of inflation from its long-run equilibrium level, indicates that interest rates do not affect inflation in the long-run.

The $I(0)$ system determines the seven variables, namely $\Delta(m-p)_t$, Δi_t , $\Delta^2 p_t$, ΔR_{t-1} , $CI1_t$, $CI2_t$ and $CI3_t$. The information set used consists of $\Delta(m-p)_{t-1}$, Δi_{t-1} , $\Delta^2 p_{t-1}$, ΔR_{t-1} , $CI1_{t-1}$, $CI2_{t-1}$ and $CI3_{t-1}$ together with three dummy variables and an intercept. The system is modelled as an $I(0)$ parsimonious vector autoregression (PVAR) as explained in Chapters 4 and 5. This indicates that none of the variables in the system contributes to the explanation of interest rates. Thus it is assumed to be exogenous and a three equation system is estimated. The conditional factorization is performed, as described in Chapter 4, and the resulting equations are estimated by full information maximum likelihood (FIML) and are shown in Table 7.5. The test of overidentifying restrictions does not reject ($\chi^2(22)=24.34$ (0.3293)), so the model parsimoniously encompasses the PVAR.

The magnitude of the adjustment coefficient of the short-run extended money demand function is similar to that of Sumner (1996) who reports an adjustment coefficient of 0.16. However, the short run money demand equation does not include income, inflation and interest rates, unlike Hendry and Doornik (1994). The output equation depends on the lagged values of itself and real extended money, with the excess demand cointegrating vector having a significant role as well as the output and miners' strike dummies. The short-run inflation equation depends only on the third cointegrating vector. The real extended money and inflation equations are influenced

¹⁵For an elaborate comparison of the results for each country see Chapter 11.

Table 7.5: FIML Model Estimates

$$\begin{aligned} \Delta(m-p)_t &= -0.16 (CI1)_{t-1} - 0.033(D1979:3) - 0.80 \\ &\quad (3.32) \quad (-3.81) \quad (-3.25) \\ \Delta i_t &= -0.43 (\Delta i)_{t-1} + 0.20 \Delta(m-p)_{t-1} - 0.07 (CI2)_{t-1} + 0.02(D1979:2) \\ &\quad (-5.51) \quad (4.34) \quad (-6.72) \quad (6.30) \\ &\quad -0.018(D1984:2) + 0.47 \\ &\quad (-2.89) \quad (6.72) \\ \Delta^2 p_t &= -0.21 (CI3)_{t-1} + 0.023 (D1979:3) - 0.90 \\ &\quad (-5.06) \quad (3.81) \quad (-5.07) \end{aligned}$$

t ratios are in parentheses.

Table 7.6: Model Statistics

Model Diagnostic Tests

$F_{ar}^m(36,130)$	1.37 (0.10)
$F_{het}^m(114,197)$	1.12 (0.22)
$\chi_{nd}^{2m}(6)$	6.36 (0.38)

FIML Residual Correlations

	$\Delta(m-p)_t$	Δi_t	$\Delta^2 p_t$
$\Delta(m-p)_t$	1.60%	0.14	-0.24
Δi_t	0.15	0.63%	0.15
$\Delta^2 p_t$	-0.23	0.13	1.13%

by the oil price dummy D1979:3. Furthermore, all diagnostics are satisfactory as presented in Table 7.6.

In order to test the constancy of the model one-step forecast analysis is performed for the time period 1992:1- 1993:4 as in previous chapters of country

estimation. Figures 7.5 reports one-step model based forecasts. The constancy of the model is accepted with almost every forecast lying inside the individual 95 per cent confidence bars and the overall test statistic $F(24,42)=0.99$ ($p>0.4883$). Figure 7.6 presents a sequence of one through eight steps ahead from 1992:1 onwards with error bars for 95 per cent confidence intervals where the forecasts converge to their conditional means.

7.6 Conclusion

The aim of this chapter was to analyse the extended money demand in the UK and examine its properties. A four equation VAR model with two lags was estimated as the initial general model, and then cointegration analysis was performed. In the long-run structure, three relations have been found: the first one measures extended money demand as a function of income, inflation and interest rates; the second one measures deviations of income from its long run equilibrium level; the third one measures inflation. In the short-run structure, on the other hand, a three equation model was estimated by FIML.

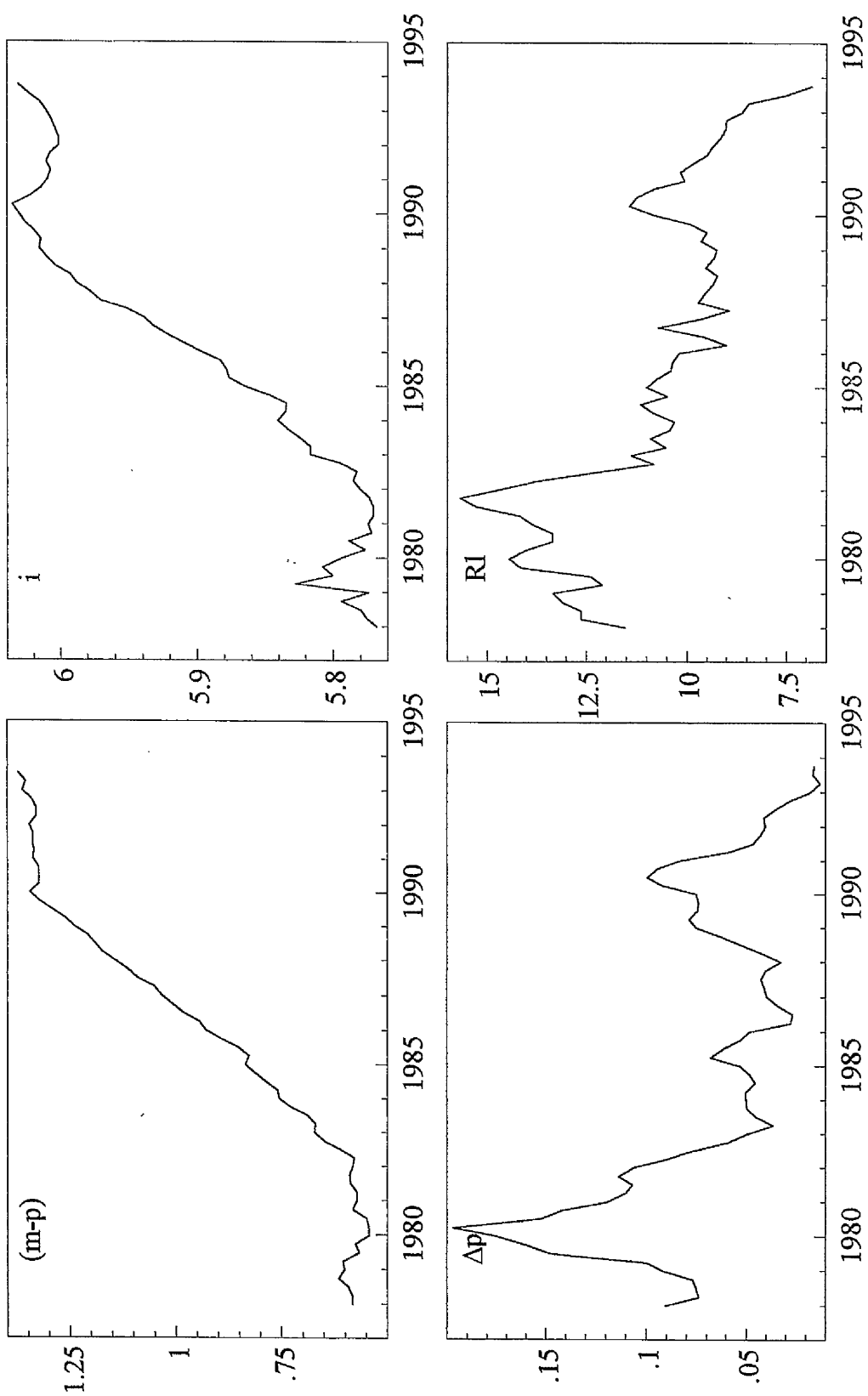
Similar to the previous country estimates, a long-run money demand function with unit income elasticity and negative effects from inflation and interest has been obtained following the cointegration analysis. The hypothesis maintained throughout the thesis is that individual countries' money demand functions have similar functional forms, so that aggregation bias, which is discussed in detail in Chapter 3, would not affect significantly the results of the aggregate estimation. In that sense, obtaining an extended money demand function for the UK which is similar to other countries' money demand functions is encouraging.

When the results of this chapter concerning the demand for extended money are compared with the previous studies, it emerges that the adjustment coefficient is very close to the one obtained by Sumner (1996)'s M4 estimation. Moreover, as the weak exogeneity of income, inflation and interest rates for the parameters of money demand equation is satisfied, in accordance with the findings of Johansen (1992) and

Hendry and Doornik (1994), it can plausibly be argued that the causality goes from income, inflation and interest rate to money.

Furthermore, the results of the analysis suggest that the demand for the extended monetary aggregate, defined according to the residency of holder criteria, appears to be stable over the sample period, contrary to Sumner (1996) who reports an unstable demand for M4. Our results indicate that when CBDs are added to M4, a stable demand for money function can be obtained, implying the existence of currency substitution effects.

Figure 7.1: UK Time Series Data



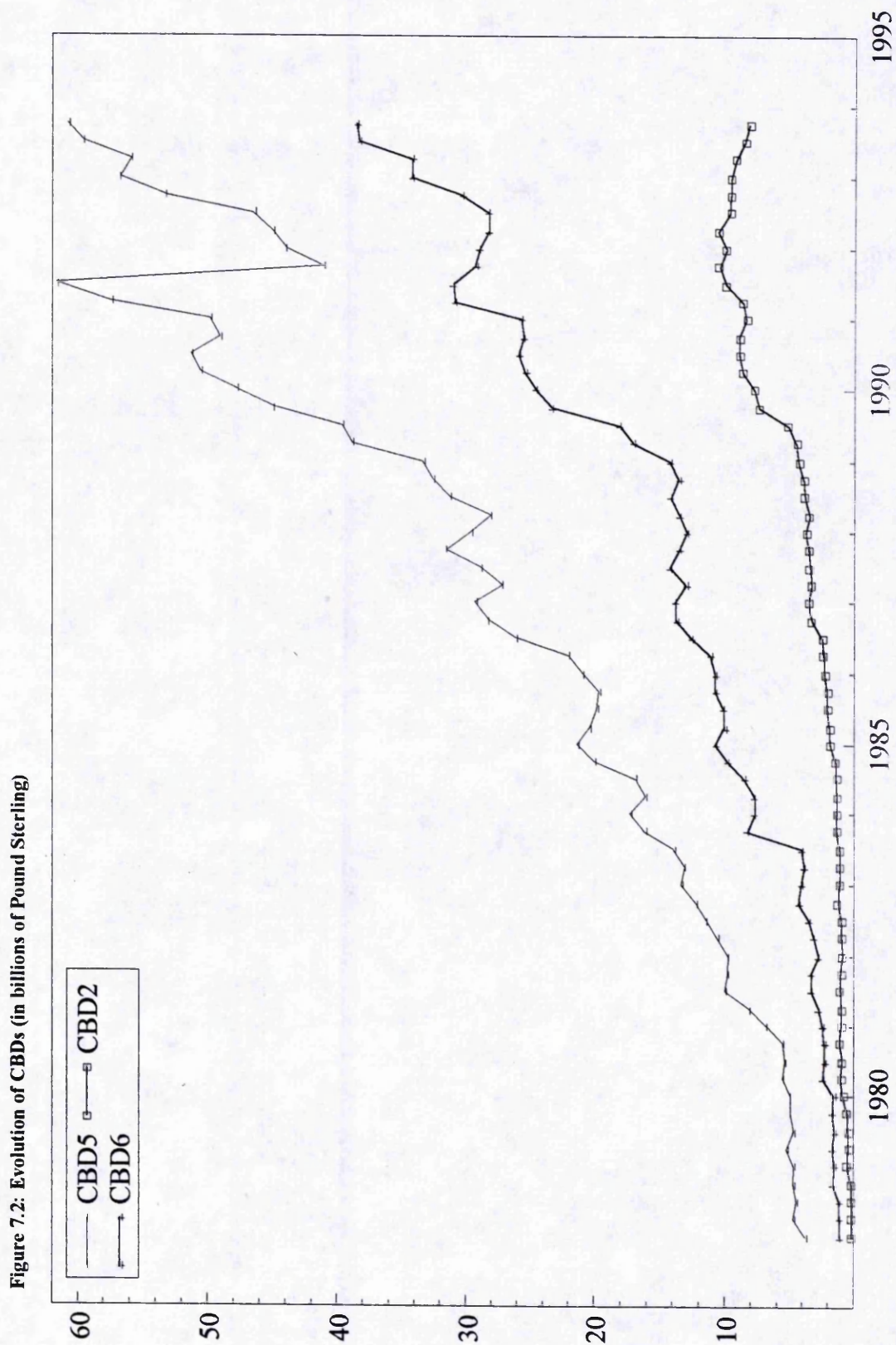


Figure 7.3: Scaled Residuals of the Initial Model

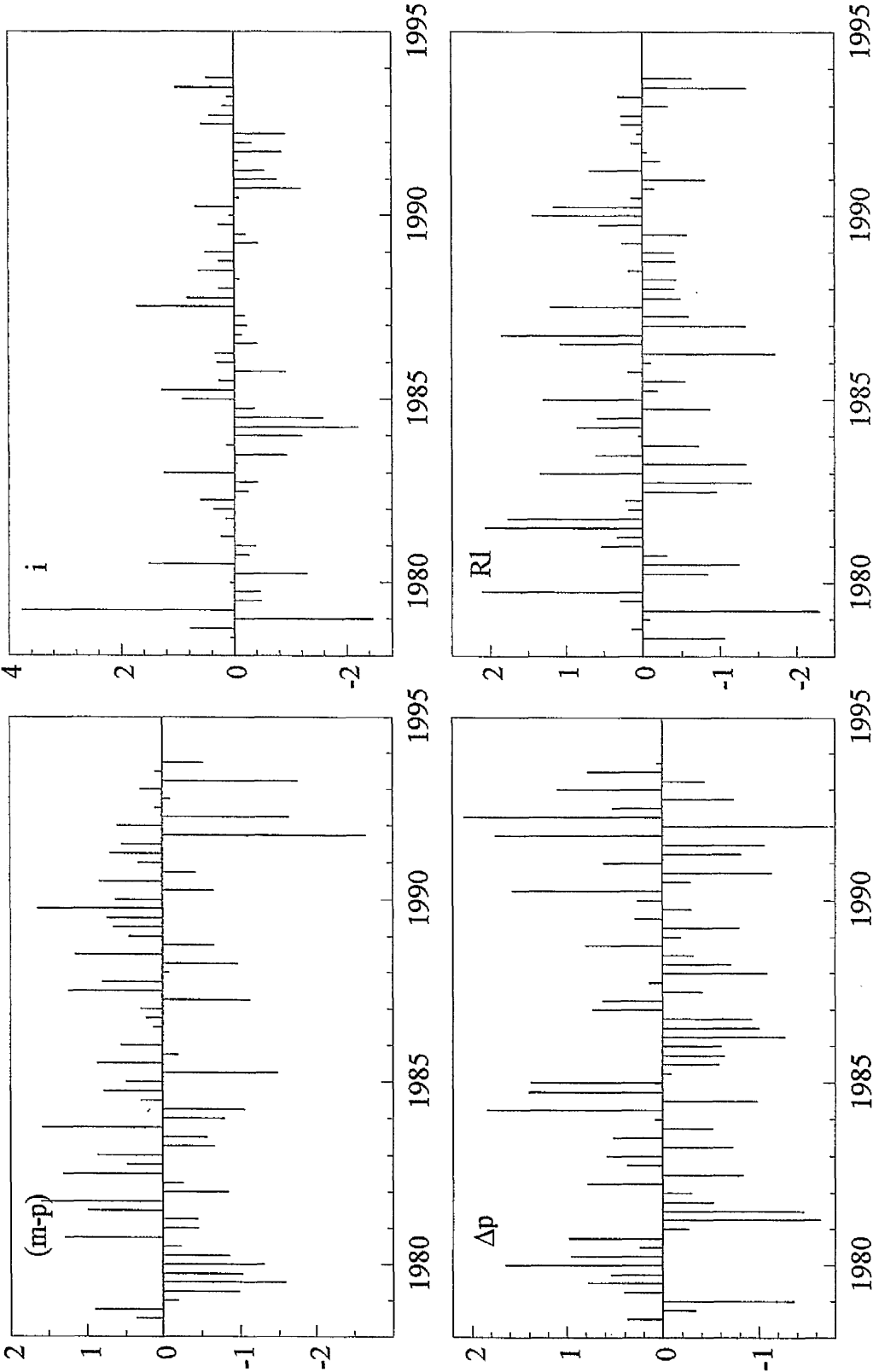
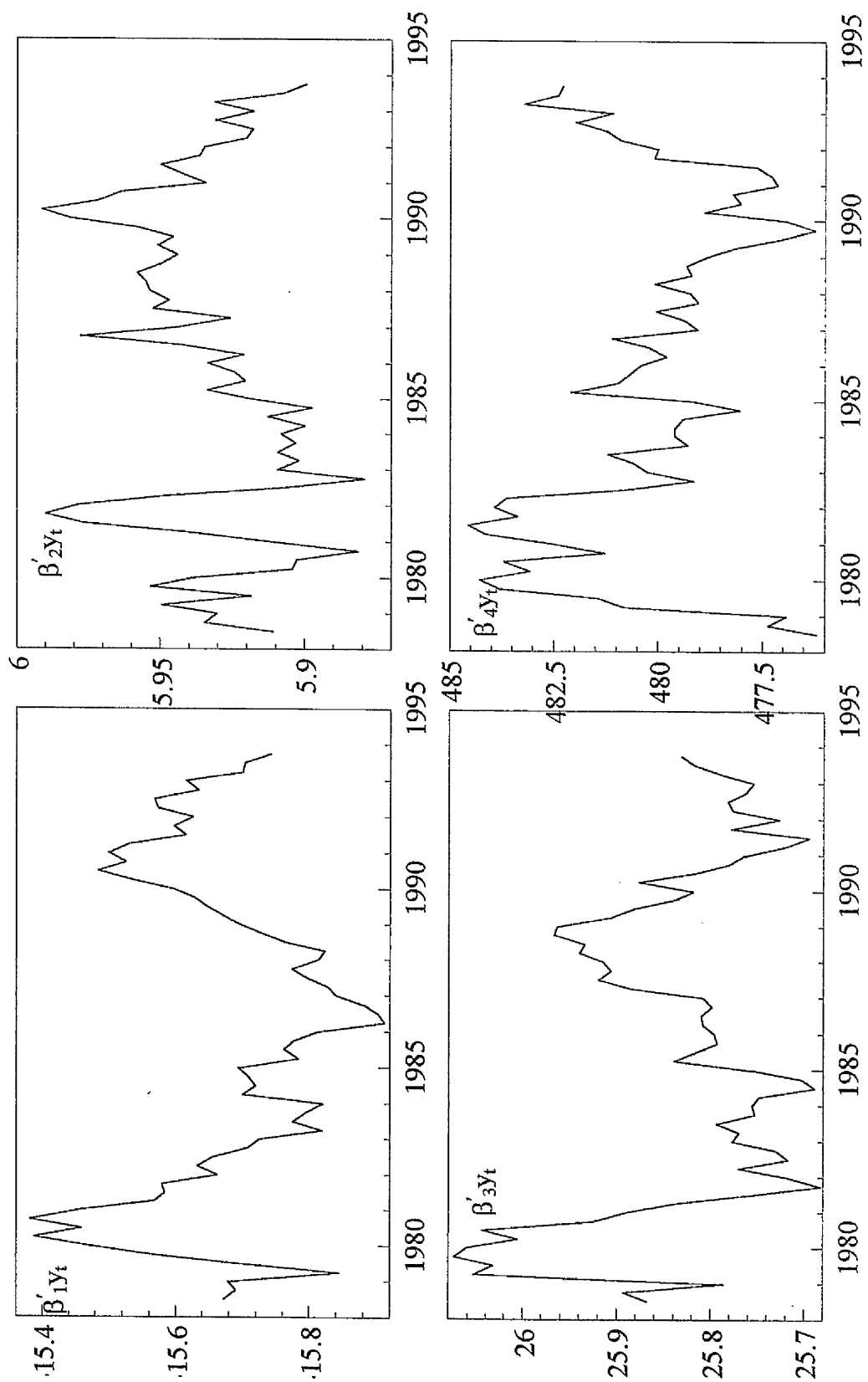


Figure 7.4: Cointegration Vectors



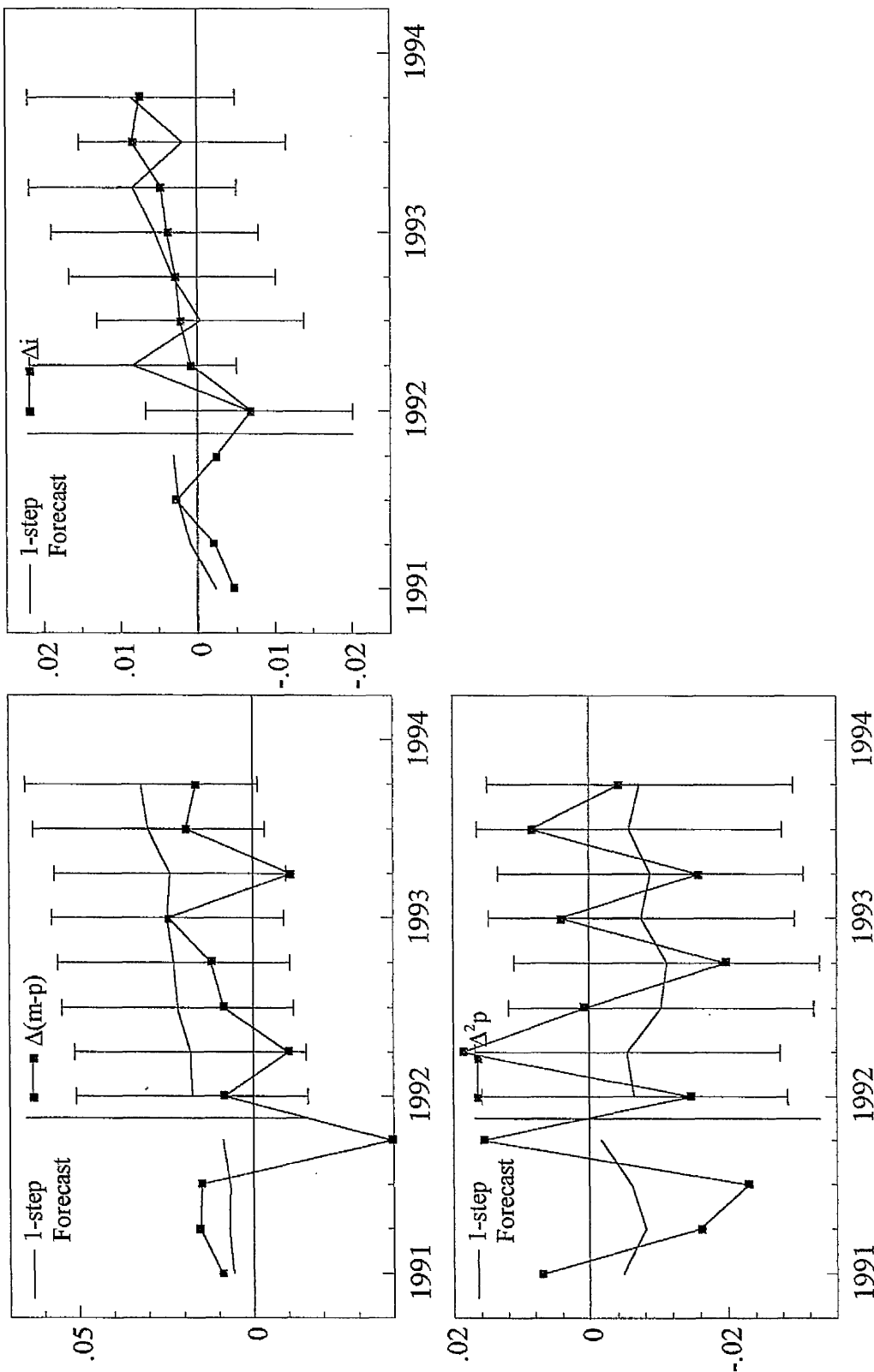
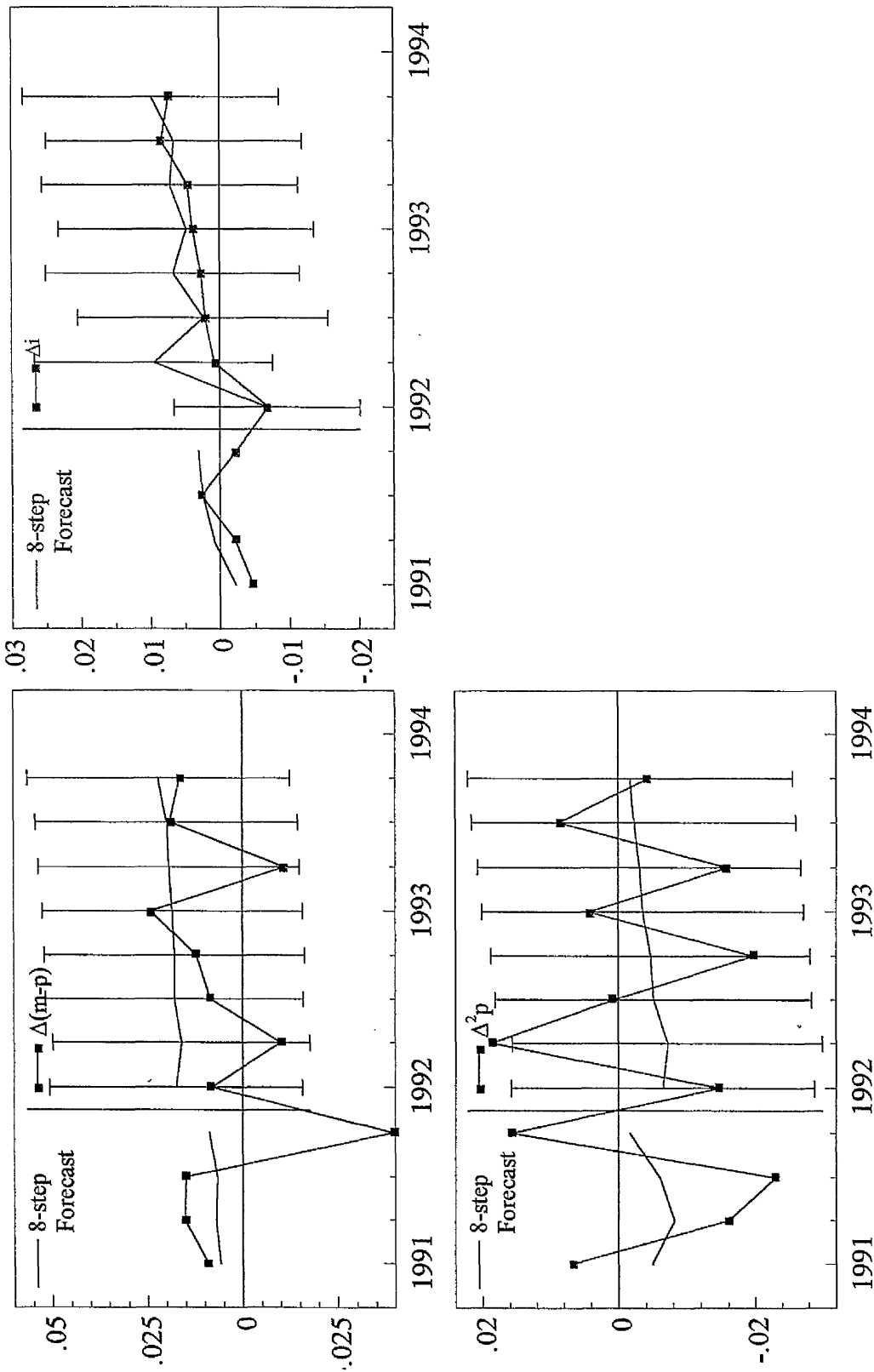


Figure 7.5: 1-Step Ahead Forecasts

Figure 7.6: 8-Step Ahead Forecasts



CHAPTER 8

MODELLING THE DEMAND FOR MONEY IN THE NETHERLANDS

8.1 Introduction

The main objective of monetary policy conducted by the Nederlandsche Bank has been to regulate the value of the Netherlands' monetary unit in such a manner as will be most conducive to the nation's prosperity and welfare and in so doing seek to keep the value as stable as possible.¹ In practice, this means that inflation should be resisted. In this respect two monetary factors have been seen as important: the growth of the money stock and the movements in the exchange rate of the Dutch Guilder. In the absence of any capital and exchange controls, and where the domestic market is small relative to international financial markets, money supply policy could not always be reliable. Thus the principal monetary policy has been to maintain a fixed exchange rate with the Deutsche Mark (DM). The chief motivation for the DM-peg is the generally good performance of the dominant German economy, especially in terms of inflation.

The Netherlands has a well developed and sophisticated financial market which has traditionally been open to the rest of the world, in line with the structure and needs of the Netherlands' export oriented economy, and Amsterdam has long been characterized as an international financial centre. This is reflected by among other things a large amount of cross-border deposits (CBDs) held at Dutch banks by both residents and nonresidents. German residents especially hold DM deposits at Dutch banks in order, it is said, to evade tax requirements in their country. At the same time, foreign currency holdings of Dutch residents at banks abroad are large. These holdings are sensitive to exchange rate expectations and to institutional

¹ European Commission (1995), "The Economic and Financial Situation in the Netherlands", No.1.

changes in both Germany and the Netherlands. The exclusion of these deposits from the traditional monetary aggregates means that these latter may not reflect the true amount of money demanded and this may lead to instability in the traditionally defined monetary aggregates as argued in Chapter 3. Thus, as in previous chapters, an extended monetary aggregate for the Netherlands is defined and its stability properties are examined. The chapter is organized in a similar fashion to other country chapters. The next section describes monetary policy and economic developments in the Netherlands. The evolution of CBDs is described in section 8.3. Section 8.4 surveys existing studies on Dutch money demand function. Empirical results are presented in section 8.5. Finally section 8.6 concludes.

8.2 Economic Developments

The post-war period, up to the early 1970s had been marked by largely uninterrupted growth. The discovery of large gas reserves led the expansion in industry to continue, particularly in chemicals and petroleum refining, and the stock of wealth has increased considerably. During the 1970s, the Dutch economy both benefitted and suffered from its gas reserves. The increases in energy prices helped the Dutch economy to prosper from the exploitation of gas wealth. As a substantial part of this wealth passed into the hands of government in the form of royalties, taxes and profits, it permitted broader and more generous social programmes and led to an increase in public services generally. But there were unwanted side-effects. Although the appreciation of the exchange rate helped to divert the inflationary impact of the two oil-price rises, competitiveness declined in the export oriented and import competing sectors. The increased flow of gas revenues favoured consumption rather than investment. There was an expansion in services and a contraction of manufacturing. The advent of gas contributed to the weakening of the economic performance and the Netherlands suffered from the Dutch Disease.²

The Netherlands experienced a severe recession after the second oil-price rise

²OECD Country Surveys, The Netherlands, 1985-86.

in line with many other countries. Lower external demand was accompanied by a collapse of domestic demand, particularly investment. There was a reduction in output and there were record unemployment levels between 1980 and 1982. Part of the problem was the world recession and high interest rates, with their inevitable influence on an economy as open as the Netherlands. Between 1978 and 1982, domestic demand fell by 0.75 per cent annually. In 1982 a tightening of fiscal policy and a rise in the household savings ratio added to the depressed domestic demand.

The conduct of monetary policy has been constrained by the openness of the Dutch financial markets to world influences. The main monetary aim since 1983 has been to maintain a fixed exchange rate with Germany to help to overcome the recession. Several advantages to the Netherlands from the policy of a stable Guilder-DM rate can be mentioned. It has facilitated a high degree of price stability providing a nominal anchor for the smaller economy of the Netherlands. Moreover, the credibility incentive of this policy has been reflected in the gradual decline in the interest rate differential vis-a-vis Germany, something which was advantageous to the process of budgetary consolidation. Additionally, the fixed exchange rate between Dutch Guilder and DM gave financial markets confidence in the policy of the Dutch monetary authorities. However, the Dutch and German quasi monetary union meant abandoning an economic policy instrument, i.e. the exchange rate. Thus a larger burden was placed on other instruments, particularly on fiscal policy.

Money supply policies were restricted to monitoring the domestic part of the money supply, composed of bank lending to the private sector and long-term lending to public authorities less bank long-term liabilities (net money creation by banks) plus short-term lending to the public authorities (monetary financing of the deficit). It would be ineffective to target the total money supply in a small open economy with a fixed exchange rate. Dutch monetary policy can be seen to serve a double purpose: it maximizes the reduction of the liquidity ratio, which is defined as M2 divided by net national income, and the upward pressure on domestic long term interest rates. At the same time, it can be seen to take the pressure off the foreign exchange rate and

thereby reduce the risk of adverse exchange rate expectations. That, in turn, not only favours relatively low short term interest rates, but also makes less likely upward pressure on the domestic interest rates such as adverse exchange rate expectations could produce.

There have been improvements in the economic performance since 1983 partly due to fiscal policy adjustments to reduce the budget deficit, in combination with the exchange rate and the monetary framework outlined above. The 1983-1989 period can be characterized as a recovery period. Monetary policy was geared towards maintaining the close link between the Guilder and the Deutsche Mark. Even though economic growth increased at a rate not seen since 1976, and unemployment continued to decline, inflation remained subdued. The long term interest rate differential between the Netherlands and Germany declined after 1983. The Dutch long-term interest rates became level with German rates in 1986, fell slightly below them 1988, were slightly above them from 1989-1992 and have been at or near the same level ever since.³ However this could be partially due to the introduction of the withholding tax in Germany, which had an effect on German long-term interest rates in particular. The progressive narrowing of the differential in the long-term interest rates could be regarded as an indication of a large degree of credibility to the exchange rate commitment.

After seven years of good economic performance, the Dutch economy entered a period of slower growth and higher inflation in the late 1980s. There was a sharp rise in interest rates in 1989 both in the Netherlands and worldwide prompted by rising inflation in many countries and by German unification. The slowdown reflected sluggish domestic demand after the buoyant conditions prevailing previously. Up to mid-1991, the impact on economic activity was cushioned by vigorous export growth driven by expanding demand in Germany after unification. Furthermore, German unification also influenced the monetary conditions and exchange rate developments. The strong and shifting reactions of German financial markets were largely

³OECD Economic Outlook, June 1996.

transmitted to the Netherlands. When markets started to have less confidence in the DM as a result of economic difficulties surrounding German unification, the Guilder also suffered as it was considered a close substitute for the DM. As a consequence, the Guilder became less attractive and in 1991 there was a capital outflow of Guilder 9 billion. Throughout this turbulent period, the Guilder remained very close to its EMS central rate against the Deutsche Mark. Dutch interest rates remained relatively stable with respect to German rates, but this meant broadly matching their steep rise over this period. Figure 8.1 presents Dutch time series data, where (m-p) denotes real extended money, i real GDP, Δp inflation and R_l long term interest rates, where all variables except interest rates are in logarithms. Dutch long-term interest rates climbed to 9 per cent in late 1990, a level they had not reached since the early 1980s. Although they declined somewhat in 1991, they remained high both by historical standards and in relation to current inflation. However, a restrictive monetary policy together with the firm exchange-rate link with the Deutsche Mark meant that Dutch interest rates and inflation stabilised in 1992 in line with their German counterparts.

The Guilder-Deutsche Mark exchange rate remained stable during the European exchange rate turmoil of 1992 and 1993. Since then Dutch monetary authorities have continued to peg the Guilder to the Deutsche Mark in a monetary framework. "There seems to be a sufficient amount of evidence to suggest that the disciplinary mechanism provided by the Guilder's Deutsche Mark peg has worked reasonably well in the Netherlands in the sense that inflation and interest rate differentials relative to Germany are at present, and have been for an extended period of time, negligible. This suggests that Dutch monetary policy seems to have enjoyed a credibility bonus from the Deutsche Mark peg."⁴ Given the present high degree of commitment, in both monetary and economic policy in general, to the Deutsche Mark peg any significant discrepancy in the overall Dutch monetary policy vis-a-vis the German one seems highly unlikely in the foreseeable future. Thus, it can be plausibly

⁴"Netherlands", Country Studies, Commission of the European Communities Directorate General for Economic and Financial Affairs, No:8, 1992, pp.12.

argued that Dutch inflation and long-term interest rates will be almost fully determined by the corresponding German rates.

8.3 Evolution of CBDs

Although Dutch banks have been successful in building up an additional client base abroad, they are rapidly losing Dutch clients to foreign banks.⁵ Dutch non-bank residents have increased their holdings of deposits with non-Dutch banks markedly since the late 1980s. Hence, the extended monetary aggregate based on the residency of holder criterion, which is obtained by adding the foreign currency deposits held with banks abroad by residents (CBD 6) and Guilder deposits held abroad by Dutch residents (CBD 2), is the broadest monetary aggregate in the Netherlands among three extended monetary aggregates defined in Chapter 2. Figure 8.2 presents the development of the components of the extended monetary aggregate obtained using the residency of holder criterion in the Netherlands.⁶ The striking feature of the analysis is the fact that foreign currency deposits held by residents with banks abroad (CBD 6) are the largest component of CBDs. Although CBDs continually increased, there was a sharp rise in 1989 when the tax treatment of interest on deposits held with domestic banks was tightened. Due to a sharp increase in net money creation by banks, cash reserve requirements were activated and it was agreed with the banks that, for the period July 1989 to June 1990, their net money creation would be limited to 5 per cent. Excess lending would be penalized by a ten per cent reserve requirement. This led to a capital outflow, as banks abroad not subject to reserve requirements could attract deposits through more competitive interest rates. Thus the foreign and Guilder deposits held abroad by Dutch residents (CBD 6 and CBD 2) increased considerably in this period. Moreover, after German unification there was a further increase in these components, especially in CBD 6, perhaps because of the

⁵"Netherlands", Country Studies, Commission of the European Communities Directorate General for Economic and Financial Affairs, No:8, 1992, pp.59.

⁶See Chapter 2 for the definitions and calculation of the extended monetary aggregates.

decreased attractiveness of the Guilder associated with diminished confidence in the DM. Additionally, foreign currency deposits held at domestic banks (CBD 5) have shown a considerable increase. Thus German unification appears to have had a considerable impact on the evolution of Dutch CBDs, which has also been reflected in the extended monetary aggregates.

The fixed Guilder-DM exchange rate policy of the Dutch monetary authorities can be expected to have led Dutch residents to view both currencies as close substitutes. At the same time, German residents may prefer Dutch banks if they want to evade the withholding tax on interest income. Thus German residents have DM accounts with Dutch banks, which constitute a significant part of the foreign currency deposits held by nonresidents with Dutch banks. Thus monetary developments and institutional changes in both countries affect the decisions of both Dutch and German residents, making traditionally defined monetary aggregates even more sensitive to foreign economic variables.

8.4 Existing Studies

Even though there have been several studies concerning the Dutch money demand function, only a few of them are in English. Thus our background in this respect is relatively limited. Fase and Winder (1992) examine the macro-economic demand for money in the Netherlands and other EU member states. They investigate the differences and similarities between countries using a common economic framework and methodology. They analyse three monetary aggregates, M1, M2 and M3 employing Hendry's general to specific methodology for the time period 1977:1-1989:4. For all monetary aggregates, the income elasticity is a priori set equal to one. However, it is found that money is not homogeneous of degree one in prices. Although changes in both short-term and long term interest rates have significant influences, the parameters are subject to the restriction that only changes in the yield curve have an impact. When the stability properties of the estimated demand for money functions are considered, they report that the demand for money seems to be

more stable for broader definitions of the monetary aggregate.

Cuthbertson et al. (1992) estimate demand for M2 for the time period 1961:1-1976:4 using the Engle-Granger two step error correction method.⁷ Their estimated equation indicates price homogeneity as well as a unitary long run income elasticity. The current rate of inflation and short and long term interest rates are also found to be significant explanatory variables. Furthermore, they report an adjustment coefficient of 0.26, implying a high speed of adjustment to any long-run disequilibrium in the demand for money. The results of their stability analysis indicate the existence of a stable demand for money function.

The implications of currency substitution for the stability of demand for money function are investigated by Artis et al. (1993) and Filosa (1995). Both of them employ error correction modelling. But Artis et al. (1993) estimate the demand for M1, while Filosa (1995) the demand for M3H⁸. The results of Artis et al. (1993) suggest the existence of currency substitution between the Guilder and other EU currencies. Filosa (1995) reports that although the long-run price elasticity is found to be equal to one, the long run real income elasticity differs from one. The hypothesis of currency substitution is tested by specifying an indicator of expected depreciation vis-a-vis the US dollar and vis-a-vis the central parity of the Deutsche Mark following Bertola and Svensson (1993). It is reported that the expected depreciation vis-a-vis the Deutsche Mark negatively affects the demand for M3H in the Netherlands, indicating a substantial currency substitution. Finally, the stability analysis concludes in favour of a stable money demand function, as in previous studies.

Overall, the available previous studies conclude in favour of a well-established stable money demand function for the Netherlands, even though there are considerable differences of specification. The current rate of inflation, together with short and long term interest rates are generally significant explanatory variables. With

⁷See Chapter 4 for various techniques of money demand modelling.

⁸See Appendix 2, for the definitions of various monetary aggregates for each country.

the exception of Filosa (1995) these estimated money demand functions have unitary income elasticities. However, it is plausible that narrow measures of money show unitary income elasticity, but it is less likely for broad measures. Also Fase and Winder (1992) report that long run price homogeneity does not hold. Furthermore, there appears to be substantial currency substitution between the Guilder and the Deutsche Mark as reported by Filosa (1995), which justifies our estimation of a demand for extended money.

8.5 Modelling the Demand for Extended Money

As in the previous chapters, a four equation VAR model is estimated to explore the stability properties of the demand for the extended money function in the Netherlands. The variables are the extended M3H (M), real GDP at 1985 prices (I), consumer price index (P), and the long term interest rate (Rl). Among existing studies of the Dutch demand for money, only Filosa (1995) employs M3H, real GDP and long-term interest rates in the estimation. However, his analysis focuses on testing directly for currency substitution by using an indicator of expected depreciation against major EU currencies. Seasonally adjusted quarterly data is available for the time period 1978:1-1993:4. Estimation is carried out over 1978:3-1993:4, after allowing lags, yielding 62 observations. The results of the stationarity tests are in line with the findings for previous countries: apart from the price level, which is $I(2)$, all variables are found to be integrated of order one. Thus we have a system of four stochastic variables real extended money ($m-p$), interest rates (Rl), inflation (Δp) and real income (i), with a constant and trend.⁹

The analysis started from an augmented VAR with four lags on all variables. The simplification tests, presented in Table 8.1, indicated that a two lag model is sufficient. The scaled residuals of the initial model, shown in Figure 8.3, indicates that there are outliers in income equation in the first and second quarters of 1979, which could be attributable to the oil price rise. Thus two dummy variables for oil price

⁹For a brief discussion about the inclusion of trend in the estimation, see Chapter 5.

Table 8.1: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-26.05	-27.58		
2	3	-26.73	-27.92	1 → 2	F(16,119) = 1.07 (0.38)
3	2	-27.41	-28.26	2 → 3	F(16,132) = 1.20 (0.27)
				1 → 3	F(32,145) = 1.14 (0.29)

Note: p-values are in parentheses

Table 8.2: Residual Correlations and Lag Length Statistics for VAR (2)

Residual Correlations

	(m-p)	Rl	Δp	i
Rl	0.214	-	-	-
Δp	-0.136	0.157	-	-
i	0.074	0.221	-0.116	-

Lag Length and Dynamics

	(m-p)	Rl	Δp	i
$F_{s=1}(4,45)$	7.49** (0.00)	12.7** (0.00)	11.1** (0.00)	10.0** (0.001)
$F_{s=2}(4,45)$	1.06 (0.38)	0.43 (0.78)	0.59 (0.66)	0.17 (0.95)
$ \mu $	0.32	0.09	0.09	0.09

Note: * and ** denote significant at the 5% and 1% levels.

shock, D1979:1 and D1979:2, taking the value of one for the first quarter of 1979 and second quarter of 1979 respectively, are included in the analysis. Furthermore, as argued in the previous sections, German unification appears to have influenced monetary conditions in the Netherlands to a great extent. Due to the apparent decreased confidence in the Deutsche Mark, the Guilder also weakened, leading to a capital outflow in 1991. This was reflected in the sudden increase in the foreign currency deposits of residents held at banks abroad, which is the one of main components of the extended monetary aggregate. Thus an impulse dummy (D1991:1) as well as a step dummy (S1991:1), are included in the estimation to account for the effects of German unification. These are the same dummy variables as in German money demand model of Chapter 5. The unification step dummy is conditioned in the long-run to see if German unification has long-run implications for the Dutch extended money demand function. As the main monetary policy of the Dutch monetary authorities is to peg the Guilder to the Deutsche Mark, it could be anticipated that any significant development in Germany might affect the Dutch economy in the long-run.

Hence, a two lag model with four dummy variables, a trend and a constant is chosen as the final model. The residual cross-correlations and lag-length statistics of the model are presented in Table 8.2. It appears that there is a large negative residual correlation between inflation and the real extended money and all first lags of all variables are significant. Although the second lags are not significant, a VAR(1) is not considered as lag 2 is the minimum lag that allows a long-run as well as a short-run structure. The long-run matrix has only one large eigenvalue and three eigenvalues are close to zero, which indicates that there could be one cointegrating vector. Additionally, diagnostics of the model are presented in Table 8.3. Even though there is a fourth order autocorrelation problem in the interest rate equation and a problem of normality in the income equation as well as in the system, none of the tests is significant at the 1 per cent level.

Table 8.3: Goodness of Fit and Diagnostic Test Results

	(m-p)	Rl	Δp	i	VAR
$\hat{\sigma}$	1.38%	4.09	0.54%	0.88%	
$F_{ar}(4,44)$	0.85 (0.49)	2.75* (0.04)	1.36 (0.26)	1.86 (0.13)	
$F_{arch}(4,40)$	1.00 (0.41)	1.03 (0.39)	1.20 (0.32)	0.43 (0.78)	
$F_{het}(19,24)$	1.17 (0.34)	0.63 (0.85)	0.77 (0.71)	0.70 (0.78)	
$\chi^2(2)$	2.78 (0.24)	2.52 (0.28)	3.74 (0.15)	6.14* (0.04)	
$F_{ar}^v(64,115)$					0.98 (0.52)
$F_{het}^v(190,190)$					0.66 (0.99)
$\chi_{nd}^{2v}(8)$					19.1* (0.02)

Note: * denote significant at the 5% level and p-values are in parentheses.

After estimating the VAR(2) model, cointegration analysis is performed. The cointegration analysis, given in Table 8.4, suggests that there is only one cointegrating vector.¹⁰ This cointegrating vector, which is presented in Figure 8.4 with the remaining non-stationary vectors, can be interpreted as the excess demand for extended money, with a large negative long-run effect from inflation. However, the long-run interest effect is quite small with the wrong sign. Furthermore, the unrestricted long-run income elasticity is surprisingly high, at 8.15. As in previous chapters, unit income elasticity and exogeneity restrictions are imposed. Additionally, the examination of the long-run matrix and the adjustment coefficients indicate that

¹⁰For cointegration analysis and identification of cointegrating vectors, see Chapter 4.

Table 8.4: Cointegration Analysis

r	1	2	3	4
λ	0.37	0.32	0.19	0.15
Max	29.0	24.0	13.5	10.1
Tr	76.6**	41.5	23.6	10.1

Eigenvectors β						
	(m-p)	Rl	Δp	i	Trend	S1991:1
(m-p)	1.00	-0.025	2.57	-8.15	0.033	-0.046
Rl	99.4	1.00	-199.6	-106.0	-1.04	5.41
Δp	0.383	-0.006	1.00	-0.966	-0.001	0.012
i	-0.266	-0.041	2.53	1.00	0.0006	-0.17

Adjustment Coefficients α				
(m-p)	0.032	-0.0001	-0.12	0.11
Rl	-0.92	0.028	-0.29	3.49
Δp	-0.008	0.0003	-0.08	-0.02
i	0.013	0.0013	0.068	0.012

there is no significant effect from long-term interest rates on real extended money. These restrictions are accepted when jointly tested, yielding $\chi^2(5)=13.2$ which is not significant at the 1% level. Thus the cointegrating vector, which can be defined as the long-run demand for real extended money, is estimated as follows:

$$CI = (m-p)_t - i_t + 0.77 \Delta p_t - 0.015 \text{Trend} + 0.019 \text{S1991:1}$$

The cointegrating vector is very similar to that of Germany except that there is no evidence that the long-term interest rate affects the demand for real extended money. Apart from not being affected by interest rates, the long-run demand for extended money function is very similar to those of other countries considered in this

study.¹¹ Income has a long-run unitary elasticity, and inflation has a considerable negative effect, whereas the trend, assumed to capture the effects of financial innovation in this period, has a positive influence on the demand for money. Furthermore, German unification has a negative effect on the Dutch demand for extended money, which could be due to the decreased confidence in the Guilder, and the following capital outflow as mentioned in previous sections.

Another explanation could be that extension of the traditionally defined aggregates could make the extended monetary aggregate insensitive to domestic interest rates. This could be reasonable for the Dutch traditional and extended monetary aggregates, as the ratio of CBDs to the national monetary aggregate is the greatest in the Netherlands, among the five countries considered. In order to see if long-run interest rates have any significant effect on the traditionally defined monetary aggregate, M3H, the previous analysis is replicated with real M3H (m_h-p) replacing the extended monetary aggregate. The results of the specification indicated a two lag model. Furthermore, the same dummy variables are included in the analysis, after examining the scaled residuals.¹² The results of the cointegration analysis, presented in Table 8.5, and the eigenvalues of the long-run matrix indicate that there are three cointegrating vectors.

To identify the first cointegrating vector, first the weak exogeneity of the interest rates, income and inflation for the parameters of the long-run demand for money function is tested. This is accepted with $\chi^2(3)=7.81$ ($p>0.05$). In order to test if the long-run interest rates have a significant effect on real money, we test the hypothesis that $H: \beta_{12}=0$. This hypothesis is rejected when tested jointly with that of weak exogeneity, yielding $\chi^2(4)=13.32$ ($p>0.00$). Thus our analysis indicates that when the traditional money is extended by the relevant CBDs, to obtain the extended monetary aggregate, this aggregate becomes insensitive to the interest rate changes. This could be due to the fact that CBDs, originally measured in US dollar, may be

¹¹See Chapter 11 for a comparison of the results for each country.

¹²In order to save space, we do not report the whole analysis.

insensitive to the domestic interest rate changes. Thus even though the traditional money is interest elastic, when CBDs are converted to Guilder and added to the traditional aggregate, the total would seem to be insensitive to the interest rate changes.

Table 8.5: Cointegration Analysis for the Alternative Model

r	1	2	3	4
μ	0.44	0.32	0.25	0.15
Max	36.7**	24.2	17.7	10.3
Tr	89.1**	52.5**	28.1*	10.3

Eigenvectors β						
	(m_h-p)	Rl	Δp	i	Trend	S1991:1
(m_h-p)	1.00	0.07	-1.24	-3.32	-0.016	0.09
Rl	65.91	1.00	-129.3	-67.0	0.4	5.04
Δp	-2.78	-0.062	1.00	12.1	-0.03	-0.39
i	-0.53	0.02	-1.99	1.00	0.0007	0.04

Adjustment Coefficients α				
(m_h-p)	-0.026	-0.001	0.004	-0.03
Rl	-0.18	0.025	1.162	-2.00
Δp	-0.001	0.0007	0.006	0.060
i	-0.008	0.001	-0.009	-0.078

After this brief discussion on the interest elasticity of traditional and extended money demand functions, we return to the modelling of the extended money. The $I(0)$ system is modelled as an parsimonious VAR where the information set used consists of $\Delta(m-p)_{t-1}$, ΔRl_{t-1} , $\Delta^2 p_{t-1}$, Δi_{t-1} , and CI_{t-1} , together with dummy variables and the constant. It is observed that none of the variables in the system contributes

to the explanation of the inflation and interest rate equations. Hence, they are assumed to be exogenous and a two equation system is estimated. After the weak exogeneity of $(R_t, \Delta p_t, i_t)$ for the parameters of the cointegration vector is examined, the conditional factorization is performed. The resulting equations are estimated by full information maximum likelihood (FIML) and are shown in Table 8.6. The test of overidentifying restrictions does not reject at the 1 per cent level ($\chi^2(15)=26.68$), so the model parsimoniously encompasses the PVAR.

Table 8.6: FIML Model Estimates

$$\Delta(m-p)_t = -0.08(CI)_{t-1} - 0.02(D1991:1) - 0.30$$

(-4.25) (-1.84) (-4.08)

$$\Delta i_t = -0.003(\Delta R)_t - 0.06(D1979:1) + 0.07(D1979:2) + 0.004$$

(-1.40) (-5.88) (7.26) (3.14)

t ratios are in parenthesis

Table 8.7: Model Statistics

Model Diagnostic Tests

$$F_{ar}^m(16,100) \quad 0.61$$

(0.86)

$$F_{het}^m(51,116) \quad 1.14$$

(0.26)

$$\chi_{nd}^{2m}(4) \quad 1.56$$

(0.81)

FIML Residual Correlations

	$\Delta(m-p)_t$	Δi_t
$\Delta(m-p)_t$	1.4%	0.09
Δi_t	0.08	1.01%

The short-run estimates of the model indicate that the demand for extended money equation does not seem to be affected by any of the variables, except the long-

run disequilibrium in the money demand. German unification seems to affect the demand for extended money in the short run as well as in the long run. Furthermore, the adjustment coefficient, although small, is very close to that of Germany's. Additionally, the weak exogeneity of income interest rates and inflation, for the parameters of the money demand function is satisfied. The short-run estimates indicate that the dummy variables included in the estimates successfully capture the outliers. The output equation is affected by differenced interest rates and the two oil-shock dummies. Furthermore all diagnostics are satisfactory, as presented in Table 8.7.

In order to test the constancy of the model one-step forecast analysis is performed for the time period 1992:1- 1993:4 as in previous chapters of country estimation. Figure 8.5. reports one-step model based forecasts. The constancy of the model is accepted with almost every forecast lying inside the individual 95 per cent confidence bars and the overall test statistic $F(16,51)=0.49$ ($p>0.9405$). Figure 8.6 presents a sequence of one through eight steps ahead from 1992:1 onwards with error bars for 95 per cent confidence intervals where the forecasts converge to their conditional means.

8.6 Conclusion

Since the mid-1980s the primary objective of the Dutch monetary authorities has been to have a stable relation between the Dutch guilder and the Deutsche Mark. The Dutch authorities decided that this was the best policy option for a small open economy like the Netherlands to control inflation, given Germany's anti-inflationary monetary policy reputation and the close integration of financial and commercial markets between the two countries. This policy appears to have led Dutch and, to a certain extent, German residents to see both currencies as substitutes, see Filosa (1995). Furthermore, any disturbances or institutional changes in the German financial system seem to have affected the traditionally defined Dutch money demand. Thus to define an extended monetary aggregate including relevant cross-border

deposits could internalize this spill-over effects.

Thus, in this chapter the demand for extended money in the Netherlands was analysed and its stability properties were investigated. A four equation VAR model, with two dummy variables for oil-price rise and two dummy variables for German unification, was estimated. Then cointegration analysis was performed, which indicated that there is only one cointegrating vector. After the imposition of the identification restrictions, a unique cointegrating vector was obtained which can be interpreted as the long-run demand for extended money. Similar to previous country estimates, except that of Germany, the long-run money demand function has a unit income elasticity, with negative effects from inflation. However, it appears that long-term interest rates do not affect the demand for extended money. In order to test if this is the same for the traditional money, a VAR model was estimated where the traditional broad monetary aggregate replaced the extended monetary aggregate and cointegration analysis was performed. The hypothesis that interest rates do not have any effect on the demand for traditional money was rejected, thus suggesting that the addition of relevant CBDs to the traditional money renders the extended monetary aggregate insensitive to the changes in interest rates. Furthermore it was found that German unification has both long-term and short-term effects on the demand for extended money.

The model indicates that the short-run demand for extended money is affected by long-run disequilibrium in the demand for money as well as by German unification. The adjustment coefficient is very close to that of the German money demand function, indicating the close relationship between the two countries. Furthermore, the equation for output confirms the inclusion of the oil-shock dummies, which have strong effects on output. Additionally, even though interest rates do not affect money demand, they have a negative but weak effect on output. Finally, the results of stability analysis suggest that the demand for extended monetary aggregate, defined according to the residency of holder criterion, appears to be stable over the sample period.

Figure 8.1: Dutch Time Series Data

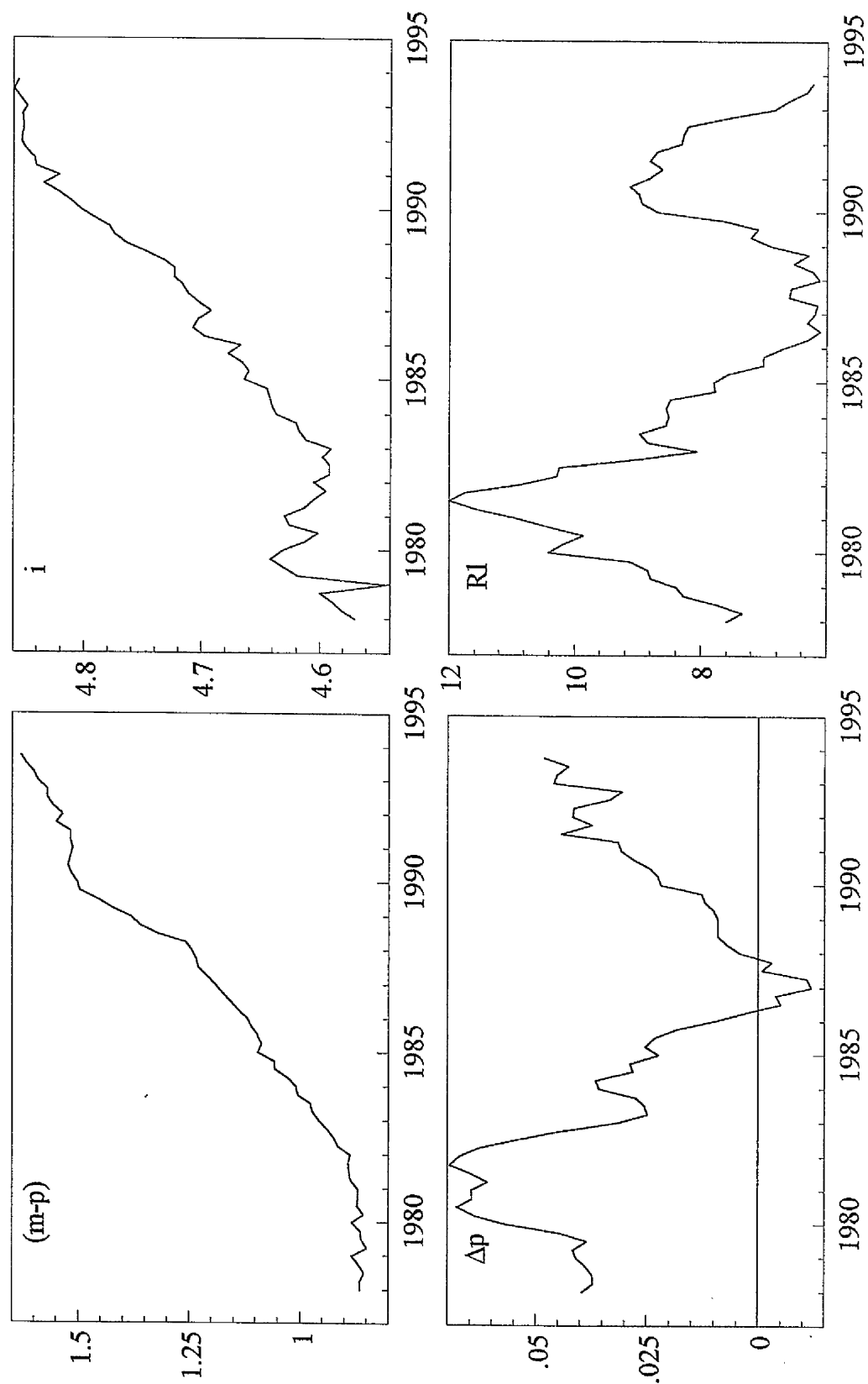
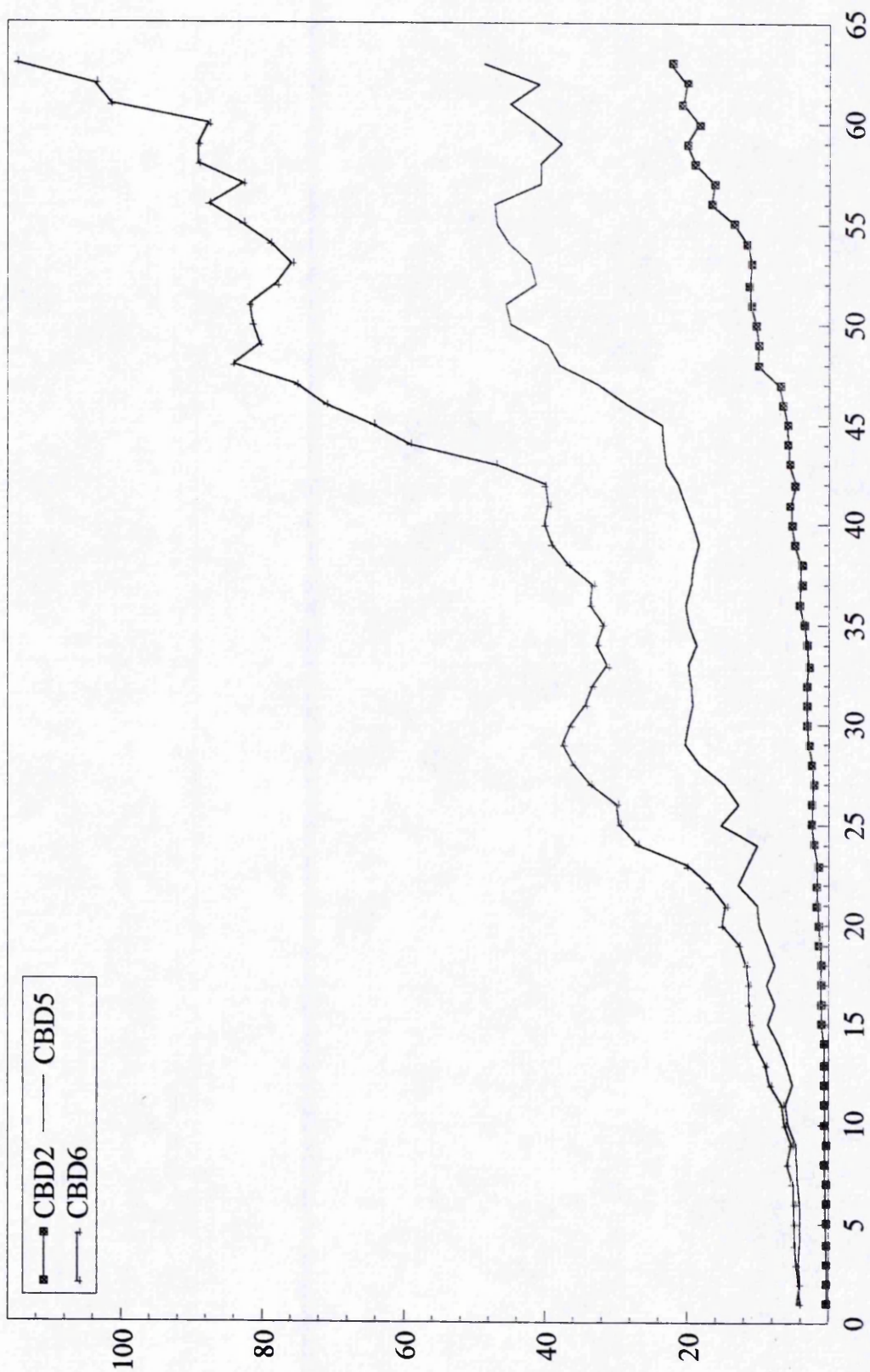


Figure 8.2: Evolution of CBDs (in billions of Guilder)



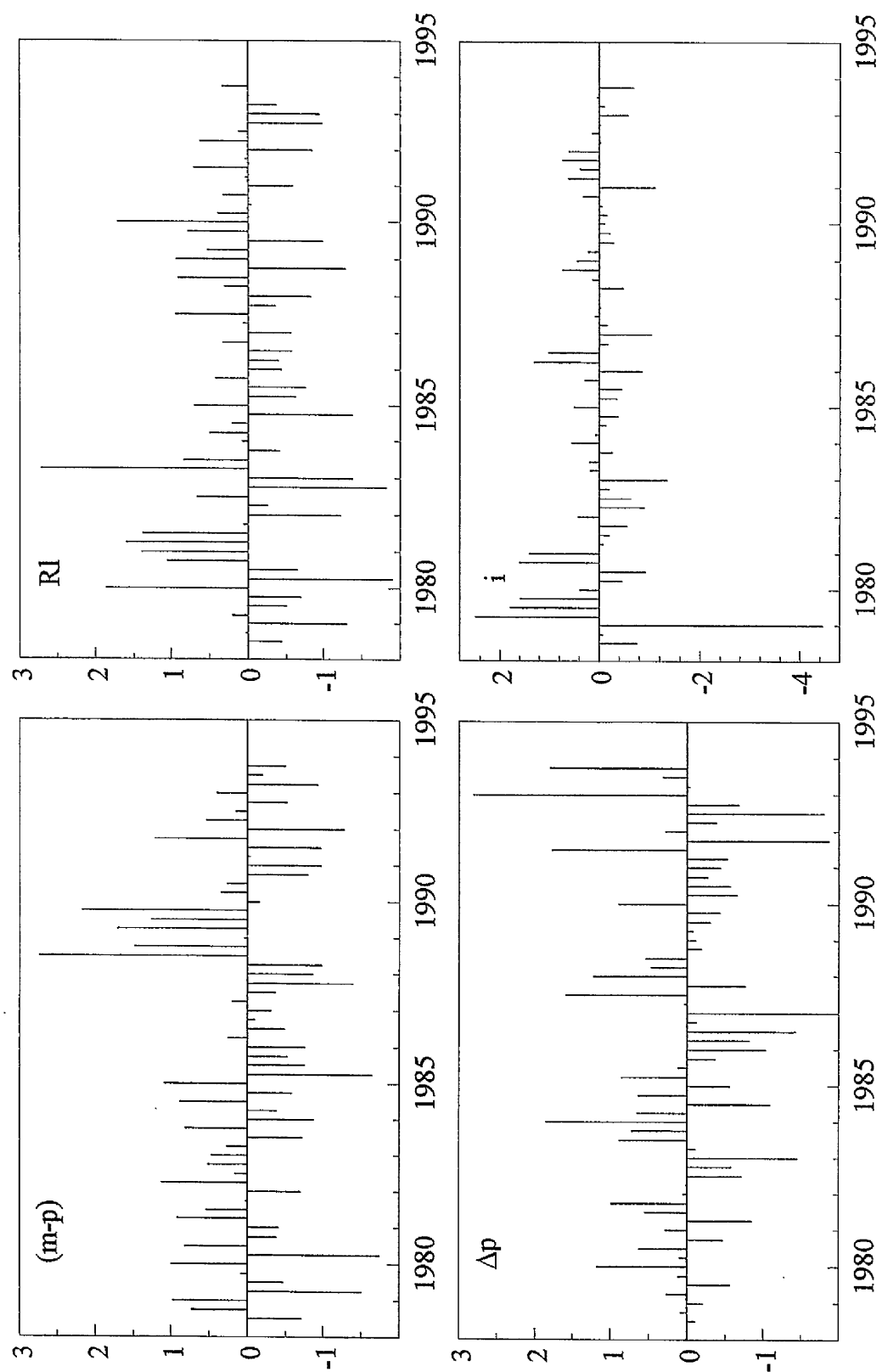


Figure 8.3: Scaled Residuals of the Initial Model

Figure 8.4: Cointegration Vectors

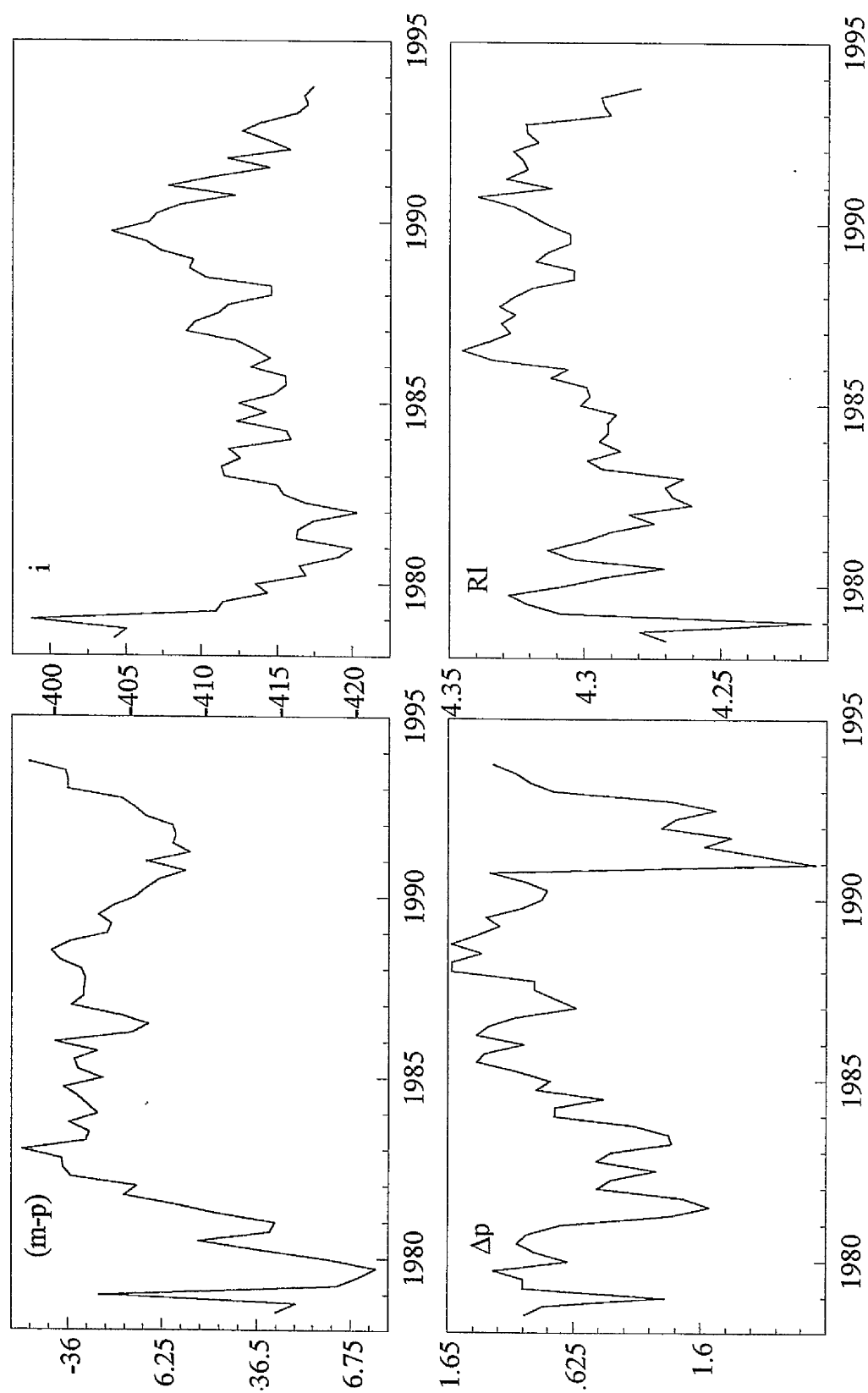


Figure 8.5: 1-Step Ahead Forecasts

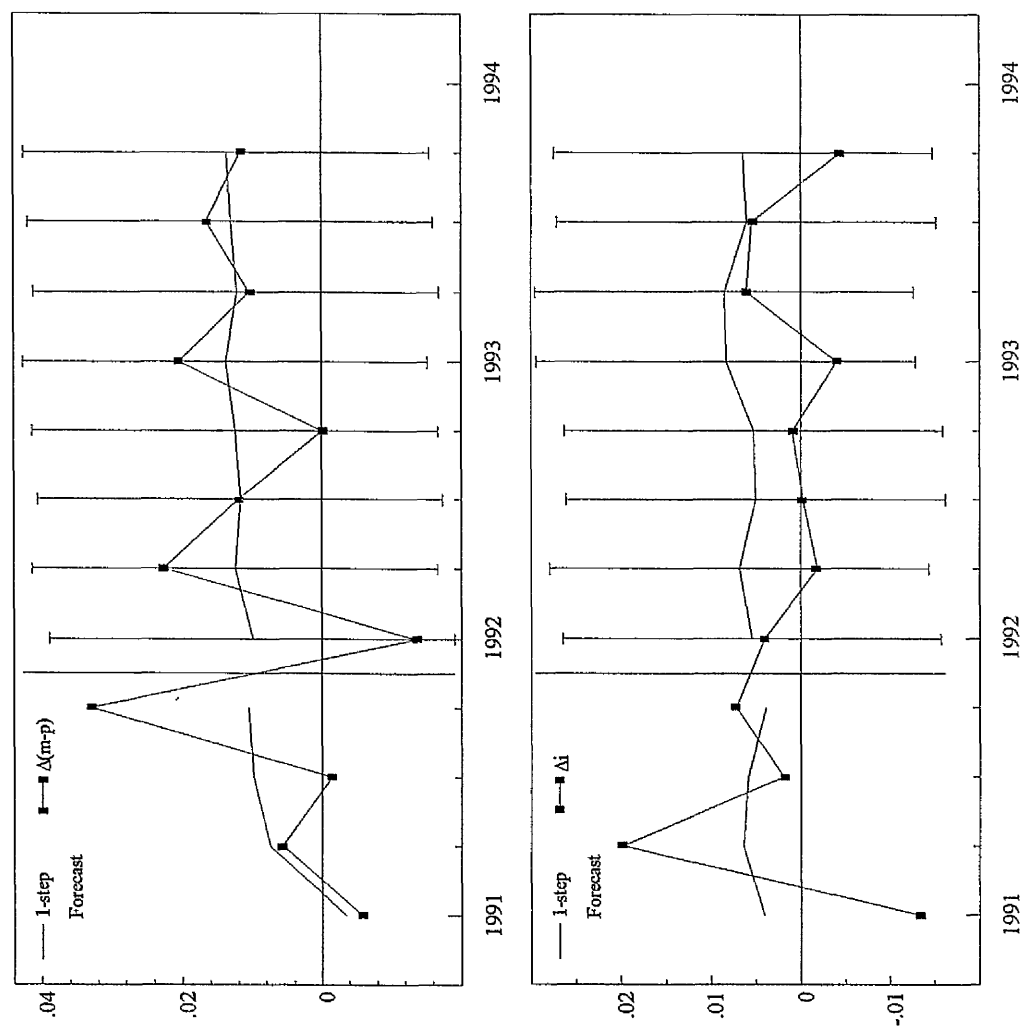
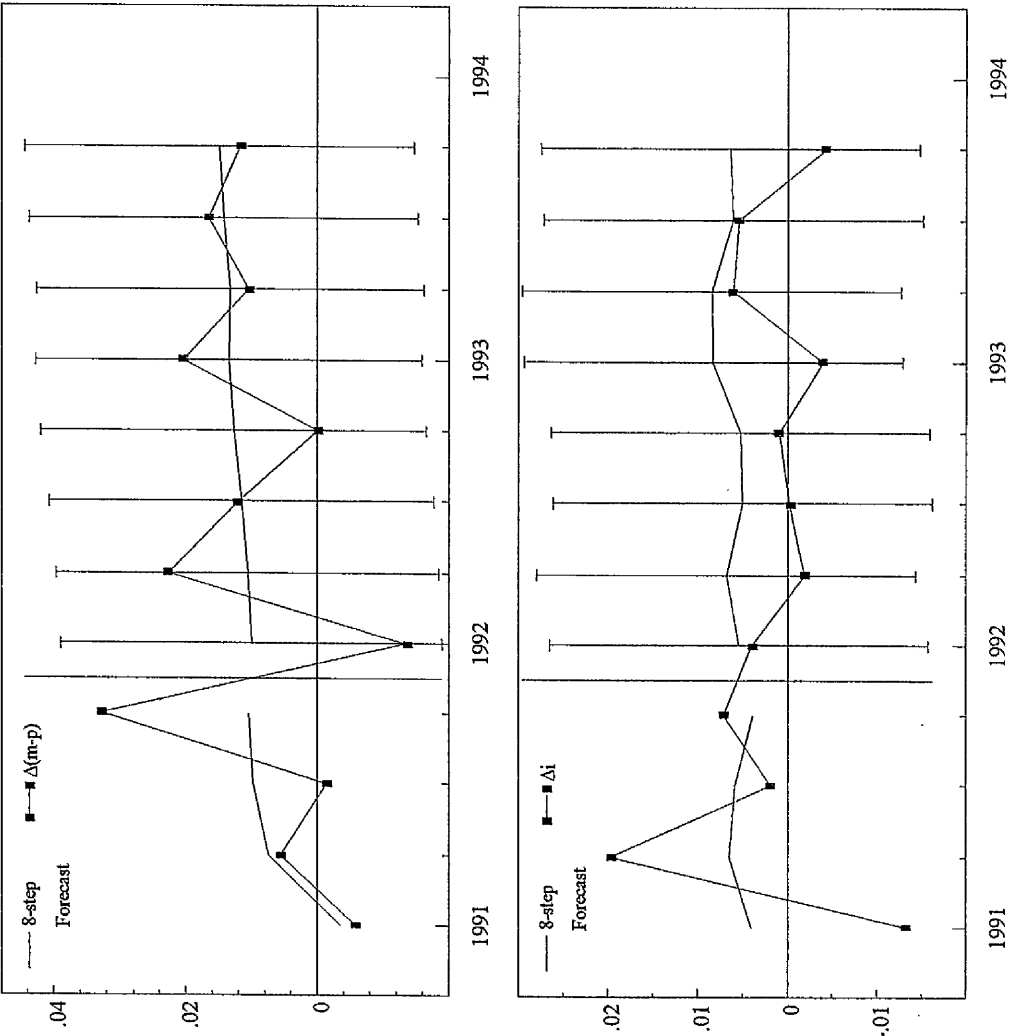


Figure 8.6: 8-Step Ahead Forecasts



CHAPTER 9

MODELLING THE DEMAND FOR MONEY IN ITALY

9.1 Introduction

The growth of the Italian economy over the last two decades has been broadly in line with that recorded by the EU area as a whole. After the recession and inflationary periods of the late 1970s, the economy grew steadily and employment rose during the 1980s. Since then, however, Italy has experienced a period of slow growth.

The policy mix that has prevailed since the early 1980s can be broadly characterized as the coexistence of a non-accommodating stance of monetary and exchange rate policies with a stance of fiscal policy that has kept the course of public finances on a potentially unsustainable path. Nonetheless fiscal position has improved dramatically to meet the requirements of the Maastricht Treaty in recent years. In the first half of the 1980s, monetary policy was very restrictive and played an important part in the disinflationary process but, the real exchange rate was allowed to depreciate considerably. However, after 1988 monetary policy had to be partially eased by means of the financial market reforms, particularly as regards the financing of the public sector.

Two of the major problems of the Italian economy have been high inflation and the persistence of large fiscal deficits accompanied by a high debt/GDP ratio. The monetary authorities have resorted to the issue of new financial instruments aimed at reducing the financing costs of the Treasury. Initially ordinary treasury bills, and subsequently longer term bonds were sold to the public. The restrictive monetary policy prior to 1988, was successful in reducing inflation. Figure 9.1 presents graphs of real extended money ($m-p$), GDP at 1985 prices (i), the inflation rate (Δp) where p is the consumer price index, and the long term interest rates (RI), where all variables except the interest rates are in logarithms. As can be seen from Figure 9.1, inflation fell from its peak of 19.2 per cent in the second quarter of 1980, to 4.32 per cent in the fourth quarter off 1986. But the progressive reduction of inflation meant

that the government debt was increasing in real terms and resulted in heavier interest payments due to high interest rates. "The perceived fragility of the Italian Financial situation, linked to the very large stock of debt outstanding and the high degree of liquidity of typical debt instruments, undoubtedly played a role in the exchange-rate crisis of September 1992."¹

Parallel to the developments in other EU countries, there were financial innovations and deregulations in Italy in 1980s. However, according to Dooley and Spinelli (1989), the need to finance a large budget deficit has been one of the main reasons for financial innovation and also for the abolition of exchange controls. Attempts by the monetary authorities to issue competitive securities forced the commercial banks to provide new types of financial instruments. At the same time, in accordance with EU requirements, all exchange controls were abolished by 1990. As in other EU countries, these developments provided new investment opportunities for Italian residents. They can now hold deposits in various currencies in Italy, or at banks abroad in the form of cross-border deposits. As argued in Chapter 3, exclusion of these deposits from the traditionally defined monetary aggregates may result in underestimation of the true money demanded and may cause instability in the traditional money demand functions. Thus, in this chapter an extended monetary aggregate is defined for Italy, and its economic properties are investigated.

The chapter is organized similarly to the previous country chapters. Recent economic developments and monetary policy in Italy are reviewed in section 9.2. Section 9.3 discusses the evolution of CBDs, while the existing literature on Italian money demand function is discussed in section 9.4. The demand function for extended money in Italy is estimated in section 9.5. Finally, section 9.6 concludes.

9.2 Economic Developments and Monetary Policy

At the end of the 1970s the Italian economy experienced a period of substantial growth led firstly by exports then by a rapid advance in domestic demand. With

¹ European Union (1993), "Economic and Financial Situation in Italy", No.1, pp.6.

continuing growth, employment increased and unemployment stabilized. But these developments were accompanied by a deterioration in the current account balance. Furthermore, the second oil-price rise led to an increase in inflation, something which has been the major problem in the Italian economy since the early 1970s. As can be seen from Figure 9.1, the year on year increase in the consumer price index rose to more than 19 per cent in 1980.

The monetary authorities acted to bring down the rate of inflation and maintain competitiveness. Previously, competitiveness had been maintained by periodically allowing the Lira to depreciate. However, this policy had two drawbacks: firstly, rising import prices sooner or later meant a further parity change; secondly, by helping uncompetitive firms to remain in business the exchange rate depreciation reduced the incentive for these firms to make the necessary efforts to rationalise and improve productivity. This is why it became one of the main objectives of the monetary authorities to keep the exchange rate stable within the EMS, since this was considered to be one of the most effective ways of fighting inflation.²

Monetary policy had been progressively tightened since mid-1979 by the traditional instrument of bank credit control and the raising of interest rates. However, whilst tightening credit controls and imposing heavier penalties in the event of exceeding the limits, the authorities accepted the development of other forms of financing for enterprises, particularly on international financial markets, either directly or through Italian banks. As in many other EU countries, both short and long-term interest rates were raised substantially during 1980-1981 (as can be seen in Figure 9.1) reaching a peak in 1981:2. With inflation slowing down markedly at the same time, real interest rates were very high, something quite exceptional for Italy. The decline in inflation continued until 1987, when the rise in consumer prices was nearly 5 per cent, the lowest rate for almost 20 years, but still above the European average.

The reduction of inflation was largely attributable to external influences. The Lira had appreciated in real terms since 1985, worsening Italy's competitive position.

²OECD Economic surveys, Italy, 1981.

The main source of disequilibrium had been the public sector deficit. Even though the public sector borrowing has always been high, in 1987 government debt was at almost 100 per cent of GDP. Up to the beginning of 1980s, increases in inflation had the effect of reducing government debt in real terms. However, since then the reduction in inflation had the consequence that government debt in real terms grew and this meant heavier interest payments. Previously the mounting debt burden had been partially masked by inflation and the monetisation of part of the debt. Real interest rates were generally negative and below those in other countries. However, by 1988 real interest rates overtook the rate of growth of GDP and interest burden has since risen steeply due to the rise in nominal the interest rates and the heavier debt burden resulting from disinflation.

The stubbornness of inflation since 1987 suggests that monetary policy may not have been sufficiently restrictive to counter the substantially faster rise in wage costs. With the phasing out of exchange controls, it becomes harder to control monetary aggregates and monetary targeting serves to send to the markets a message of stability and to set the nominal framework for economic activity.³ The overshooting of monetary aggregates from 1988 was due to large inflows of foreign capital that could not be fully sterilized. Financing a large budget deficit with minimum recourse to money creation meant a policy of high interest rates which contributed to inflows of foreign capital, swelling money reserves and strengthening the Lira.

Since the end of the 1980s the Italian economy has been in a period of slow growth. High inflation and large budget deficits continued to be serious problems. "Between the beginning of 1990 and ERM suspension in September 1992, the environment of monetary policy underwent significant modification as a result of two factors: the move to the narrow ERM band (January 1990) and the removal of exchange controls (July 1990)".⁴ These two changes had the combined effect of a

³European Union (1993), "Economic and Financial Situation in Italy", No.1.

⁴European Union (1993), "Economic and Financial Situation in Italy", No.1, pp.17.

substantial loss in monetary autonomy, and hence a growing conflict between exchange rate policy and monetary control. In the late 1989 the authorities had allowed the Lira to depreciate by letting the interest rate differential with Germany fall. The Lira then moved to the narrow band, keeping its lower intervention limit unchanged. This implied a modest effective devaluation of the Lira and the loosening of exchange rate policy. Afterwards the Lira moved to the upper limit of its fluctuation margin, leaving no room for a restrictive monetary policy stance. The Lira was generally weaker in the early 1990s and the conflicting aims of monetary policy became evident: the need to keep interest rates high to control inflationary pressures, and to keep them low to reduce the burden of interest payments to the public. Hence, even when the Lira began to depreciate in its band, the monetary authorities did not use all opportunities available to them for a disinflationary monetary policy because of budget deficit constraints. This was one of the main reasons for the monetary crisis of September 1992, which resulted in the suspension of the Lira from ERM.

From September 1992 onwards, the Italian monetary authorities have no longer been constrained in terms of raising interest rates by the ERM and the Banca d'Italia has attached more weight to achieving the M2 growth target of 5 to 7 per cent. It was also announced that the Banca d'Italia would closely monitor Lira-denominated lending to Italian residents by both foreign and domestic branches of Italian banks. However, monetary policy is still constrained by the fiscal side. A greater emphasis on reducing inflation could lead to higher real interest rates, thus jeopardizing short-term economic growth prospects and worsening the budget deficit problem. On the other hand, tolerating a higher level of inflation could be regarded as a signal that the underlying budgetary adjustment was being slowed.

In summary, the restrictive monetary policy of the early 1980s was successful in reducing inflation. However, the inability to carry out structural fiscal adjustment led to an uninterrupted rise in the debt/GDP ratio. When the ongoing process of European financial and monetary integration required assigning monetary policy to the exchange rate target, the Italian monetary authorities had to give up pursuing a

restrictive monetary policy. Thus, inflation resurged in the period 1988-91, which was characterized by the stabilization of the nominal exchange rate inside the ERM. Eventually, the continued weakness in Italy's public finances, among other things, led to the turbulence in September 1992, resulting in the Lira's suspension from the ERM. Since then, there has been improvements in Italian economy. The budget deficit which has been brought down and may be even close to 3 per cent of GDP in 1998. Inflation is now below 3 per cent and interest rates have come down.

9.3 The Evolution of Cross-Border Deposits

The evolution of the components of CBDs in Italy appears to be largely a consequence of the financial innovations which took place in the late 1980s. The main reason for the financial innovation in Italy has been to finance the large budget deficits since the late 1970s, as pointed by Dooley and Spinelli (1989). This led the authorities to issue new forms of financial instruments which are more competitive with the liabilities of the existing depository institutions, forming the basis of financial innovation in Italy. These developments in turn forced banks to defend their market shares by issuing new financial instruments. The new instruments have shown a growing degree of competition and substitution with money since they are liquid yet offer high yields. Moreover, the process of financial innovation has been also influenced by the EMS discipline⁵, tightened in January 1990 with the entry of the Lira into the narrow band of the exchange rate mechanism and the complete liberalization which took place in July 1990 with the abolition of the remaining direct exchange controls. But, as regarding the EMS discipline the situation has changed after the Lira was suspended from the ERM in September 1992.

In 1977 the Government started to finance public spending through longer term bonds and Treasury floating rate certificates (CCT) which were introduced in addition to the long-term treasury bills. In 1981, to foster the demand by the public,

⁵European Union (1993), "Economic and Financial Situation in Italy", No.1, pp.142.

CCT issues were reformed: a fixed spread over the treasury bill rate was introduced; the spread, in presence of falling nominal rates, favoured floating rate securities against shorter term assets.⁶ Although these developments allowed greater portfolio diversification, a strong substitution from monetary into real assets took place in the 1979-1981 period. In the disinflationary period of 1982-1986 there was an increase in government securities in the private sector's portfolios: the private sector's purchases of treasury bills amounted to almost 92 per cent of total net issues of this security. In addition to these new types of financial instruments, there were changes in Italy's financial regulations which enabled residents to buy EU securities from 1987; and investors to invest in foreign securities from 1989. Finally in 1990, all remaining exchange controls were abolished allowing residents to open current accounts abroad, and to acquire foreign securities with a residual life of less than six months.

The evolution of the components of CBDs in Italy appears to be largely a consequence of this financial liberalization. Figure 9.2 presents the evolution of CBDs, which are the components of the extended monetary aggregate defined on the residency of holder criterion. As can be seen from this figure, foreign currency held abroad by residents (CBD 6) has the largest share among CBDs. With the removal of foreign exchange control this component increased nearly four times. Furthermore Lira denominated deposits held abroad by residents (CBD 2) has increased by eight fold. Foreign exchange liberalization led to an immediate increase in foreign currency deposits of residents with domestic banks. Thus the extended monetary aggregate based on the residency of holder criterion has been the broadest monetary aggregate among the three possible extended monetary aggregates.⁷

⁶Angelini et. al. (1994), pp.14.

⁷For the definitions of alternative extended monetary aggregates, see Chapter 2.

9.4 Existing Studies

During the 1970s monetary policy was mainly based on administrative controls and on credit aggregates as intermediate targets.⁸ Monetary aggregates were given less emphasis. However, due to increased instability in the credit aggregates and increased financial innovation during the 1980s, monetary aggregates and their relevance for the conduct of monetary policy were given greater attention. Since 1980s studies on money demand became more frequent.

Several studies have investigated the stability properties of the Italian demand for money functions. Financial innovation has been seen as the main cause of instability in these functions and new econometric methods were devised to deal with it. Among others, Dooley and Spinelli (1989), Muscatelli and Papi (1990), and Hendry et al. (1994) examine the stability of the Italian demand for money functions focusing on financial innovation and the introduction of new instruments for the Treasury's funding. Dooley and Spinelli (1989) estimate demand for real M3 in Italy assuming that it depends upon real income, the yield on long-term private bonds, the inflation rate and a trend variable. The model is estimated for the sample period 1961:4 to 1983:3, then the stability analysis is performed. They report that "for Italy, money demand is found to have shifted downwards but by a magnitude that far exceeds what one would expect by just looking at the flow of new funds into those new assets which could be seen as close substitutes for money".⁹ Thus they conclude that financial innovation cannot directly explain the instability in the Italian M3 money demand function.

New econometric techniques, linked to the theory of integrated and cointegrated variables, were employed by, among others, Muscatelli and Papi (1990) and Angelini et al. (1994). New techniques allow them to improve the analysis of the properties of the money demand. Both studies note that the major element in the

⁸Angelini et al. (1994), pp.11.

⁹Dooley and Spinelli (1989), pp.108.

financial innovation process in Italy has been the introduction of a number of close money substitutes. Following Baba, Hendry and Starr (1987, 1992), learning about the new assets is modelled by weighting the rates of return on these instruments with logistic trends, then allowing the data to determine the shape and length of the learning process. Muscatelli and Papi (1990), then, employ the Engle-Granger two step procedure and estimate the demand for M2 in Italy for the time period 1963:1-1987:4. They impose price homogeneity and include real GDP as the scale variable and the own rate on M2 in addition to the learning adjusted interest rates. However, inflation is not included in the long-run equation. They report an income elasticity greater than unity. Following the general to specific modelling approach they obtain the short-run demand for money function with a low adjustment coefficient of 0.024, which could possibly indicate the misspecification of the cointegration vector. Their post sample stability tests indicate that the introduction of a single financial innovation term to model the learning process of economic agents following the introduction of new financial instruments leads to a model that is stable compared to previous studies.

Angelini et al. (1994) report that the structure of the demand for M2 in Italy in 1980s is different from that of 1970s. They indicate that over the period 1975-1979 net financial wealth, rather than the domestic demand, had a significant effect on money demand, whereas over the period 1983-1991 the opposite results are obtained. They argue that this is consistent with the interpretation given in the quarterly economic model of the Banca d'Italia (1986), where financial innovation is modelled as a transition from money as a store of value to money as a transaction medium through a change in the scale variable. In order to model this transition, they specify a logistic type model, where zero weights on net wealth in the post-1983 period and on domestic demand in the pre-1979 period are imposed. They estimate the model for the time period 1975:1-1990:4 with non-linear least squares so as to let the data determine which coefficients have changed over time. The estimated error correction model incorporates two equilibrium relations for money balances: the first holds until

1979 and the second is relevant after 1983. Although inflation and interest rates have the same short-run effects on money balances in both subperiods, the scale variable is net wealth in the first subperiod and domestic demand in the second subperiod. They continue the analysis using monthly data for the time period 1983:1-1990:12. Their results indicate that the new aggregate M2 is characterized by a stable relationship with the traditional variables of money demand functions, even though there is instability in the estimated model after the 1992 EMS crisis. However, they obtain negative wealth and domestic demand semi-elasticities for both their quarterly and monthly analyses.

The results obtained by Angelini et al. (1994) are evaluated by Rinaldi and Tedeschi (1996) who employ the same variables in their estimation. They adopt a system approach and present a small econometric VAR model using monthly data. The estimation period is 1983:1-1991:12, and the choice of the starting period reflects the considerations reported in Angelini et al. (1994), according to which by the mid-eighties the effects of financial innovation in Italy were becoming less severe. They employ Johansen's methodology and obtain three cointegrating vectors, one of which is interpreted as the long-run demand for M2. Contrary to the result obtained by Angelini et al. (1994), they obtain a money demand function with unit income elasticity with a negative effect from the treasury bill interest rate, and there is no effect from either inflation or a logistic trend. Their short-run money demand function estimates indicate that the adjustment coefficient for the money demand function is quite high (0.23), and stability is impaired only during the ERM crisis of 1992.

Additionally, the effects of currency substitution on the stability of the demand for money function are investigated by Artis et al. (1993) and Filosa (1995). Both studies employ error correction modelling. Artis et al. (1993) estimate the demand for M1 for the time period 1979:2-1990:2 and employ real GDP as the scale variable and long term interest rates as the opportunity cost variable. Their findings indicate an unstable money demand function with a negative income elasticity. Furthermore, they include expected exchange rate changes vis-a-vis other European

currencies and the US dollar in the specification and test for the existence of currency substitution. Their findings suggest the existence of currency substitution.

Filosa (1995) estimates demand for M2H (M2 extended)¹⁰ for the time period 1980-1991 using quarterly data. He reports that unless the process of financial innovation is modelled, a negative income elasticity is obtained. Thus, following Angelini et al. (1994) he includes a logistic trend to capture the financial innovation process which took place in the 1980s. An indicator of expected depreciation vis-a-vis the Deutsche Mark is used to capture currency substitution. The results indicate that although the long-run price elasticity is equal to one, the long-run income elasticity is only 0.5. Additionally, expected depreciation vis-a-vis other European currencies and the US dollar negatively affects the demand for M2H in Italy, suggesting a currency substitution effect as in Artis et al. (1993). Finally, the hypothesis of the stability of the estimated money demand function is not rejected.

The economic properties of the demand for money that emerge from the outlined studies differ. In the Muscatelli and Papi (1990) equation, the long-run elasticity of income is significantly greater than one, whereas Filosa (1995) reports an income elasticity of 0.5. Artis et al. (1993) find a negative income elasticity. Different scale variables were found to be affecting the demand for money in different periods: prior to 1979 it was net financial wealth, then it was domestic demand. However, it is generally argued that, unless financial innovation is modelled a stable money demand function cannot be obtained. This could be due to the fact that as financial innovation progressed alternative financial instruments became available to economic agents which could be substitutable for money. It is very likely that agents shift more to money substitutes as a result of high inflation, which, in turn, could lead to instability in the demand for money function.

¹⁰For the definition of various monetary aggregates, see Appendix 2.

9.5 Modelling the Demand for Extended Money

As in previous country chapters, a four equation VAR model is estimated to investigate the stability properties of the extended money demand function. However, there are some differences here regarding the estimation period and the variables chosen. In previous chapters, estimation was carried over the sample period 1978:1-1993:4, whereas Italian money demand function is estimated over the sample period 1980:1-1993:4. The shorter sample period is used due to the considerations reported in Angelini et al. (1994) and Rinaldi and Tedeschi (1996). It has been widely reported that over the 1975-1979 period the broad monetary aggregate in Italy was unstable and net financial wealth has a significant effect on money demand, rather than real income. This may explain why several studies reported negative income elasticities when the sample period includes the 1970s, like Artis et al. (1993).¹¹

After determining the sample period, the variables which will be employed in the estimation are determined. The monetary aggregate is extended M2, the scale variable is the GDP at 1985 prices, and the two proxies for the opportunity cost of holding money are long-term interest rates and inflation. In previous country chapters, the price variable employed was the consumer price index, with the exception of the UK. However, the consumer price index in Italy exhibits considerable volatility when compared to the GDP deflator, which led to serious autocorrelation problems in the estimation. Thus, the GDP deflator is employed as the price variable to deflate the nominal money and compute inflation for Italy, similarly to the UK money demand estimation of Chapter 7. The stationarity analysis indicated that apart from the price level, which is $I(2)$, all variables are integrated of order one. Thus we have a system of four stochastic variables real extended money ($m-p$), real income (i), inflation (Δp) and interest rates (RI) with a constant and trend.¹² Even though a logistic trend is considered, instead of a linear trend, to

¹¹ We also obtained negative income elasticity when the estimation is carried out over the period 1978:1-1993:4. These results are not reported here to conserve space.

¹²For the inclusion of trend in the VAR estimation see Chapter 5.

Table 9.1: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-27.58	-29.17		
2	3	-28.22	-29.46	1 → 2	F(16,107) = 1.22 (0.25)
3	2	-28.94	-29.83	2 → 3	F(16,119) = 1.12 (0.34)
				1 → 3	F(32,130) = 1.18 (0.25)

Note: p-values are in parentheses.

Table 9.2: Residual Correlations and Lag Length Statistics for VAR (2)

Residual Correlations

	(m-p)	Rl	Δp	i
Rl	-0.006	-	-	-
Δp	-0.200	0.146	-	-
i	-0.255	-0.353	0.012	-

Lag Length and Dynamics

	(m-p)	Rl	Δp	i
$F_{s=1}(4,43)$	3.91* (0.01)	12.68** (0.00)	15.38** (0.00)	15.67** (0.00)
$F_{s=2}(4,43)$	0.54 (0.70)	0.66 (0.62)	0.46 (0.76)	1.48 (0.22)
$ \mu $	0.48	0.12	0.06	0.06

Note: * and ** denote significant at the 5% and 1% levels, and p-values are in parentheses.

account for the financial innovation as in Angelini et al. (1994), the results, which are not reported here, did not show any significant effect from the logistic trend, in accordance with Rinaldi and Tedeschi (1996). Thus only a linear trend is included in the analysis to account for the financial innovations which occurred in the estimation period. The analysis started from an augmented VAR with four lags on all variables, as in all previous estimations. The simplification tests, as well as the Schwarz and Hannan-Quinn criteria, presented in Table 9.1, indicate that a two lag model is adequate. The scaled residuals of the system shown in Figure 9.3, suggest that the first three quarters of 1981 and second and third quarters of 1985 are outliers in the inflation and interest rates equations, which cause autocorrelation problems in the estimations. To determine which dummy variables to include, first we defined five dummy variables D811, D812, D813, which take the value of 1 for the first, second and third quarter of 1981, and D852 and D853 which take the value of 1 for the second and third quarters of 1985, respectively. It emerged that D811 and D813 have similar coefficients in the inflation equation, incidentally inflation reached to its peak at the first quarter of 1981. Furthermore, in the interest rate equation D811, D852 and D853 appeared with very close coefficients. Thus, we defined two dummy variables for the inflation and interest rate equations, so that we reduced the number of dummy variables which are included in the estimation. They are D8113 which takes the value of one in the first and third quarters of 1981, and D8523 which takes the value of one in 1981 quarter 2, and in the second and third quarters of 1985. Even though there is no economic reason for the inclusion of these dummy variables, we should note that there has been devaluation of the Lira against its central EMS rate and increases in discount rate in both 1981 and 1985 due to which these outliers could be attributable. Finally, we also included D894, which is the dummy variable for banks' strikes at the turn of 1989 and takes the value of one in the fourth quarter of 1989, influencing the real money equation. Thus a two lag model with three dummy variables, a trend and a constant is chosen as the final model.

In Table 9.2 residual correlations and lag-length statistics are presented. It

Table 9.3: Goodness of Fit and Diagnostic Test Results

	(m-p)	Rl	Δp	i	VAR
$\hat{\sigma}$	1.08%	7.51	0.36%	0.52%	
$F_{ar}(4,39)$	0.55 (0.69)	0.37 (0.28)	2.95* (0.03)	1.40 (0.25)	
$F_{aroh}(4,35)$	0.93 (0.45)	0.37 (0.82)	0.37 (0.82)	0.75 (0.56)	
$F_{het}(18,24)$	0.77 (0.70)	1.36 (0.23)	1.89 (0.07)	0.38 (0.97)	
$\chi^2(2)$	2.09 (0.35)	2.86 (0.23)	5.48 (0.06)	0.47 (0.78)	
$F_{ar}^v(64,96)$					1.19 (0.21)
$F_{het}^v(180,152)$					0.70 (0.98)
$\chi_{nd}^{2v}(8)$					12.4 (0.13)

Note: * denote significant at the 5% level and p-values are in parentheses.

appears that there are large negative residual correlations between real extended money and inflation, and between income and interest rates. The first lags of all variables are highly significant. Even though the second lags are not significant, we did not consider a VAR(1), because lag 2 is the minimum lag that allows a long-run as well as a short-run structure. There is only one large eigenvalue, implying that the rank of the long-run matrix could be one. Furthermore, the goodness of fit measures, presented in Table 9.3¹³, indicate that even though there is some indication of a problem of autocorrelation of fourth order in the inflation equation, it is not significant at 1% level and all other diagnostics are satisfactory.

¹³All statistics are as defined in Chapter 4.

After the VAR model is adequately specified, the cointegration analysis is performed. The results of the cointegration analysis, given in Table 9.4 indicate one cointegrating vector. This can be interpreted as the excess demand for extended money, with negative long-run effects from inflation and the long-term interest rates.¹⁴ But the unrestricted long-run income elasticity is very low at 0.40. Table 9.4 also presents the adjustment coefficients. The first column of the adjustment matrix $\alpha' = (-0.23, -22.9, -0.035, -0.05)$ can be interpreted as the weights with which the excess demand for extended money enters into the four equation system. As in

Table 9.4: Cointegration Analysis

r	1	2	3	4
λ	0.41	0.28	0.24	0.04
Max	29.6	18.4	15.9	2.32
Tr	66.3*	36.7	18.2	2.32

Eigenvectors β					
	(m-p)	Rl	Δp	i	Trend
(m-p)	1.00	0.009	1.64	-0.40	-0.009
Rl	9.08	1.00	-555.5	33.78	-0.715
Δp	0.76	-0.0007	1.00	-0.04	-0.0101
i	0.11	0.005	-0.96	1.00	-0.0007

Adjustment Coefficients α				
(m-p)	-0.23	0.0004	-0.331	0.0248
Rl	-22.96	-0.046	1.706	5.136
Δp	-0.035	0.0001	0.094	0.0418
i	-0.050	0.0001	0.102	-0.0763

¹⁴See Chapter 4, for cointegration analysis and imposition of identification restrictions.

previous chapters weak exogeneity of interest rates, inflation and income for the parameters of the long-run demand for money function is tested. When jointly tested, the unit income elasticity and weak exogeneity restrictions are barely accepted yielding $\chi^2(4)=10.15$ ($p>0.037$) which is not significant at the 1% level. Thus the cointegrating vector, which can be defined as the long-run demand for real extended money, is defined as follows:

$$CI = (m-p)_t - i_t + 3.13 \cdot \Delta p_t + 0.002 \cdot RI_t - 0.005 \cdot \text{Trend}$$

Even though the cointegrating vector has a unit income elasticity as in all other country estimates, except Germany, the inflation and interest rate elasticities are quite different from previous country estimates: the inflation elasticity of the Italian demand for extended money function is higher, the interest semi-elasticity is lower than those of other countries.¹⁵ Furthermore, the trend has a positive effect on the demand for extended money, similar to other countries. Our results differ from the long-run estimates of other Italian studies in many respects. Firstly, a unitary income elasticity is obtained in contrast to Muscatelli and Papi (1990), Angelini et al. (1994), Artis et al. (1993) and Filosa (1995). The demand for money is affected by both inflation and long-term interest rates, whereas Rinaldi and Tedeschi (1996) reports that inflation does not affect the long-run demand for M2. Many studies employ the own rate on M2 or the treasury bill rate, however in this study consistent long-term interest rates are employed across countries. This could be the reason for the low interest rate semi-elasticity obtained in this study. It is possible that the own rate of interest on M2 is more relevant than the long-term interest rates.

After determining the cointegrating vector, the $I(0)$ system is modelled as parsimonious VAR, where the information set used consists of $\Delta(m-p)_{t-1}$, ΔRI_{t-1} , $\Delta^2 p_{t-1}$, Δi_{t-1} , and CI_{t-1} and the dummy variables. It is observed that none of the variables in the system contributes to the explanation of the inflation equation. Hence, inflation is assumed to be exogenous and a three equation system is estimated. After

¹⁵See Chapter 11, for a comparison of demand for extended money functions of five countries considered in this study.

examining the weak exogeneity of $(i_t, \Delta p_t, Rl_t)$ for the parameters of the cointegration vector is examined, the conditional factorization is performed. The resulting equations are estimated by FIML and are shown in Table 9.5. The test of overidentifying restrictions does not reject ($\chi^2(19)=27.63$ ($p>0.09$)), so the model parsimoniously encompasses the PVAR.

Table 9.5: FIML Model Estimates

$$\Delta(m-p)_t = -0.003(\Delta Rl)_{t-1} - 0.95\Delta^2 p_t - 0.24(CI)_{t-1} + 0.016(D894) - 0.91$$

(-2.05) (-2.81) (-3.92) (2.05) (-3.87)

$$\Delta Rl_t = 0.34(\Delta Rl)_{t-1} + 1.87(D8523) - 0.17$$

(2.97) (3.89) (-1.50)

$$\Delta i_t = 0.14(\Delta i)_{t-1} + 0.009(D894) + 0.003$$

(1.27) (2.55) (4.10)

t ratios are in parentheses

Table 9.6: Model Statistics

Model Diagnostic Tests

$$F_{ar}^m(36,115) \quad 1.23$$

(0.20)

$$F_{het}^m(96,182) \quad 1.07$$

(0.33)

$$\chi_{nd}^{2m}(6) \quad 3.29$$

(0.77)

FIML Residual Correlations

	$\Delta(m-p)_t$	ΔRl_t	Δi_t
$\Delta(m-p)_t$	1.06%	0.06	-0.20
ΔRl_t	0.04	0.55%	-0.24
Δi_t	-0.21	-0.30	8.50%

The short-run estimates of the model indicate that the demand for extended money is negatively affected by lagged differenced interest rates and the acceleration of inflation. However, income does not appear in the short-run equation. Furthermore, the adjustment coefficient is the largest when compared to that of other countries'. Indeed, it is very close that of the aggregate equation of Chapter 10. This suggests that the speed of adjustment to any long-run disequilibrium in the demand for money is higher in Italy compared to other countries. Among other country estimations, only Italy along with Germany has interest rates as an argument in the short-run money demand function, which may indicate the effectiveness of monetary policy. Additionally, the weak exogeneity of income, interest rates and inflation for the parameters of the money demand function is also satisfied. The short-run estimates indicate that the dummy variables included in the estimates successfully capture the outliers. The output equation is affected by the lagged differenced value of itself, and the banks' strike dummy. The D8523 dummy has a high significance in the interest rate equation. Furthermore all diagnostics are satisfactory as shown in Table 9.6.

In order to test the constancy of the model, a one-step forecast analysis is performed for the time period 1992:1- 1993:4 as in previous chapters. Figure 9.5. reports these one-step forecasts. The constancy of the model is accepted with almost every forecast lying inside the individual 95 per cent confidence bars and the overall test statistic $F(24,45)=1.78$ ($p>0.04$). Figure 9.6 presents a sequence of one through eight steps ahead from 1992:1 onwards with error bars for 95 per cent confidence intervals. The forecasts converge to their unconditional means for almost every equation.

9.6 Conclusion

The structural imbalances in the public sector finances, especially the huge budget deficits, led the Italian authorities to introduce new types of financial instruments, with longer maturity, thus giving impetus to financial innovation in Italy. Meanwhile,

exchange controls were eased and then abolished in 1990. All these developments opened new investment opportunities for Italian residents in Italy as well as in other European countries. This is reflected by the sudden increase in CBDs held by Italian residents immediately after 1990, following the abolition of all exchange controls. Excluding these CBDs may undermine the significance of the traditionally defined monetary aggregate as a monetary policy indicator. Therefore, in this study it is proposed to redefine the monetary aggregates so as to include CBDs as extended monetary aggregates.

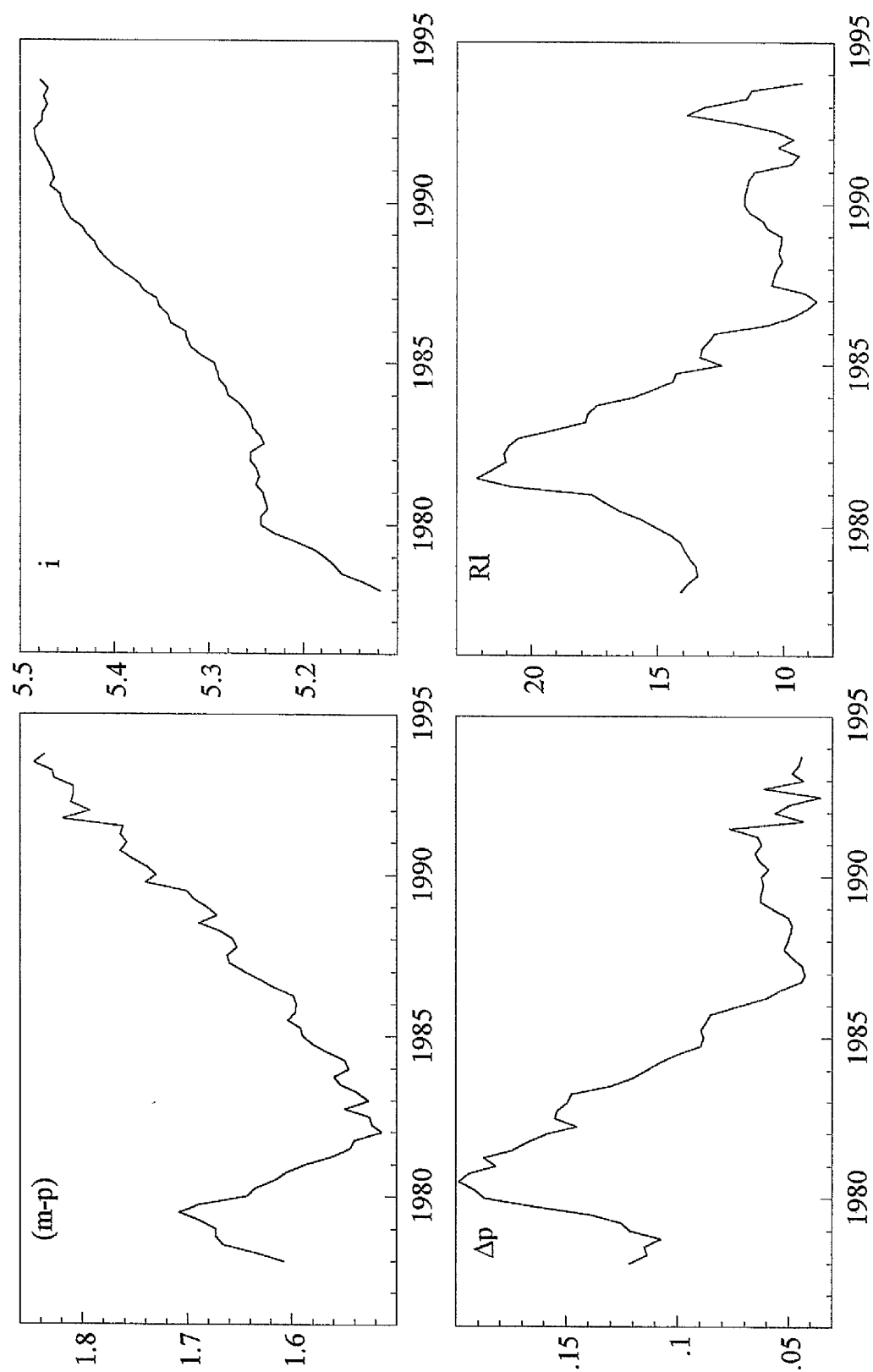
In this chapter, as in previous country chapters, the demand for extended money, based on the residency of holder criterion, is estimated as a function of real GDP, long-term interest rates and inflation in a VAR framework. The start of the sample period is chosen as 1980:1, as Angelini et al. (1994) and Rinaldi and Tedeschi (1996) reported that over the 1975-1979 period the broad monetary aggregate was unstable and net financial wealth has a significant effect on money demand, rather than real income. The cointegration analysis indicated that there is one cointegrating vector, which can be interpreted as the long-run demand for extended money. Similar to other country studies, except Germany, there is a unit income elasticity and there are negative effects from inflation and long-term interest rates. The short-run estimates of the model reveal that the adjustment coefficient is higher than that of any of the other country estimates, and very close to that of the aggregate estimate.¹⁶ Furthermore, the stability analysis suggest that the demand for money is stable.

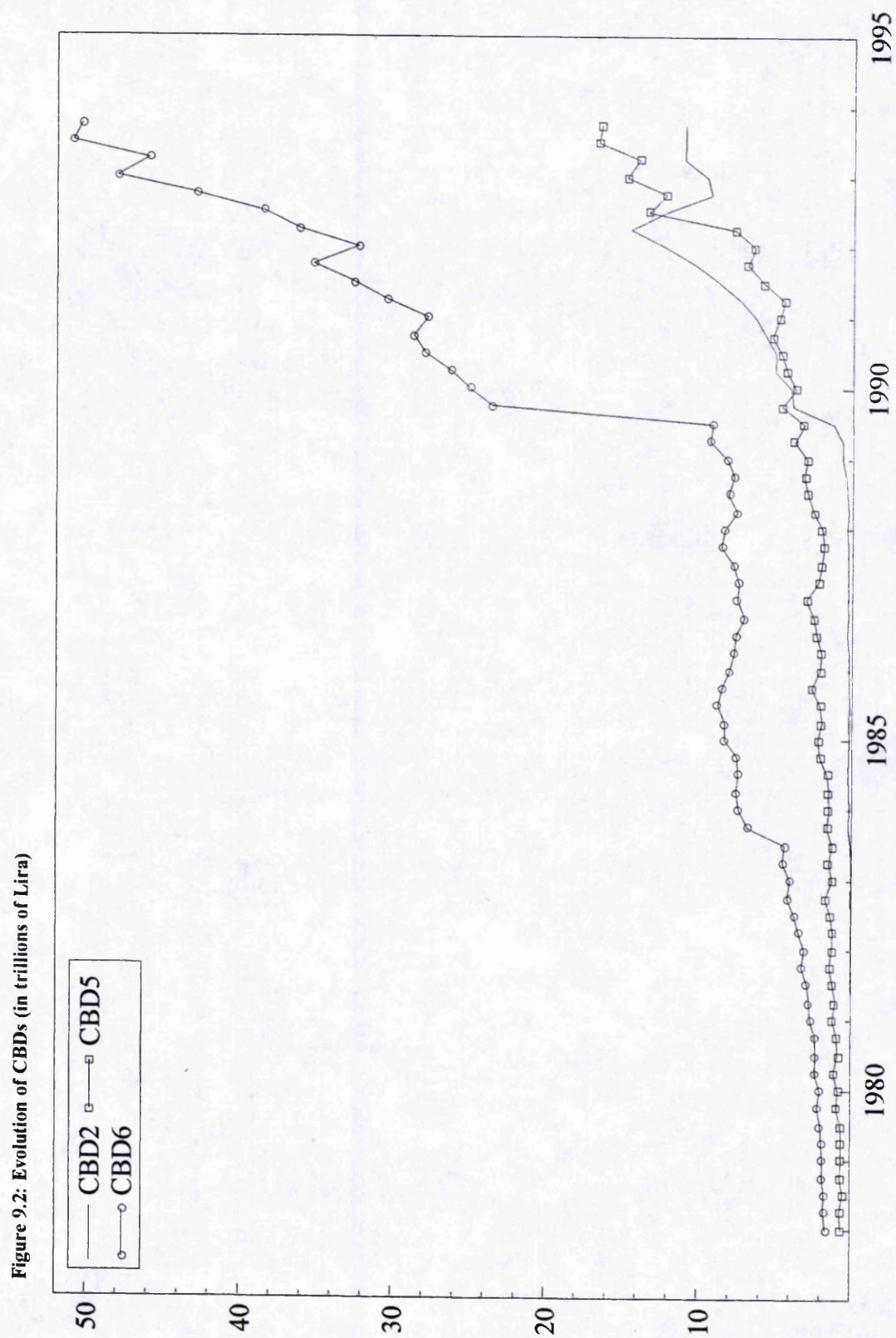
When compared with other studies of the Italian money demand function, it can plausibly be argued that this chapter provides a money demand function which has better economic and stability properties than that of other studies. It has a positive income elasticity, whereas some studies obtained negative values such as Artis et al. (1993) and Angelini et al. (1994). The proxies for the opportunity cost of holding money have the correct signs. The adjustment coefficient of the short-run

¹⁶For a detailed comparison of the money demand functions of five countries and the aggregate one, see Chapter 11.

money demand function is quite high and very close to that of Rinaldi and Tedeschi (1996), even though they specified the demand for M2 without any effect from inflation. Finally, the existing studies report mixed results concerning the stability of the demand for money functions in Italy. Generally, they are found to be unstable. Even when they show stability over the sample period, it is impaired during the ERM crisis of 1992. However, our estimates suggest that the demand for extended money is stable throughout the period. This could be due to the fact that CBDs, which have shown volatility during the ERM crisis, are included in the monetary aggregate, thus justifying the estimation of an extended monetary aggregate.

Figure 9.1: Italian Time Series Data





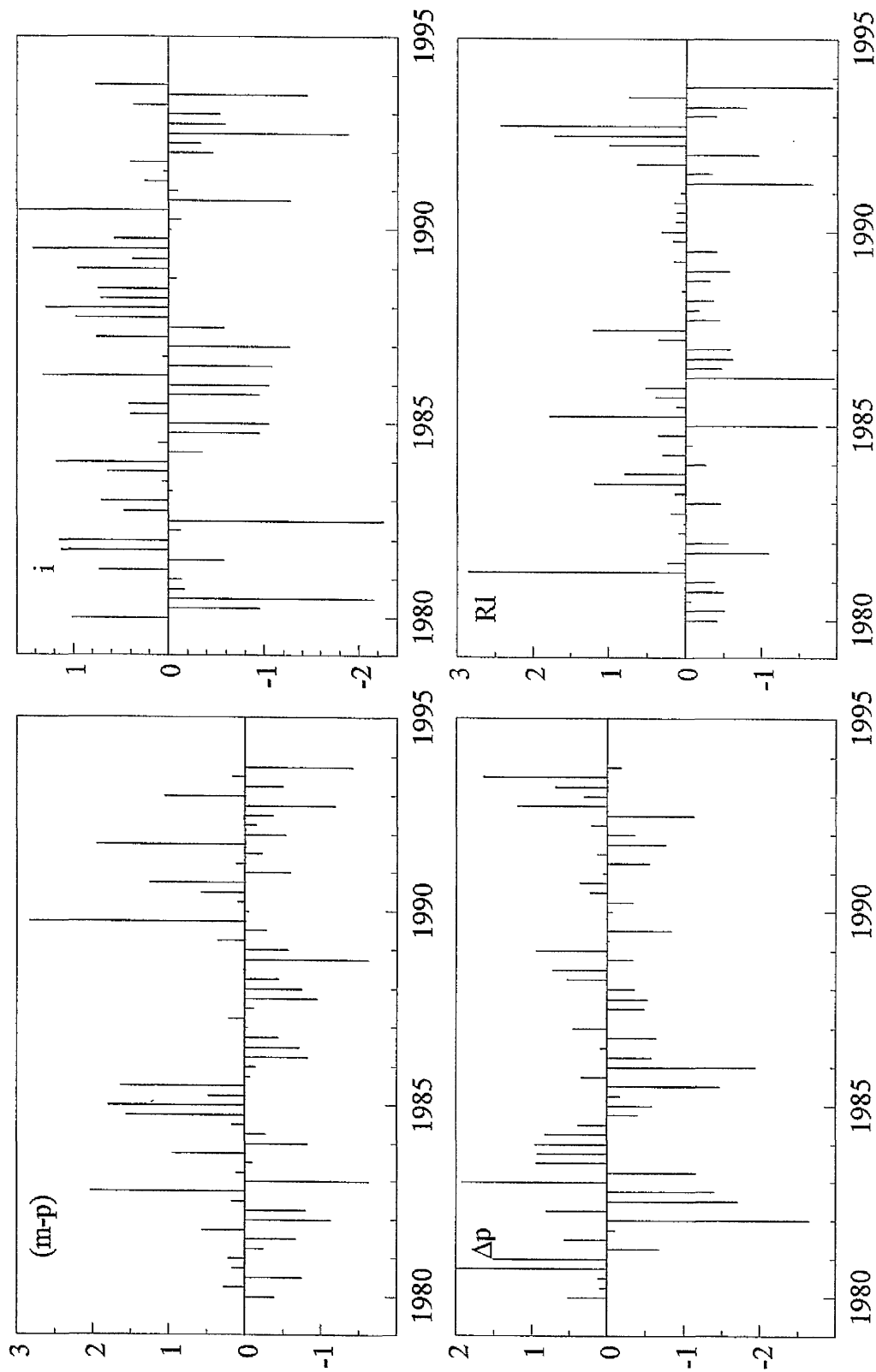
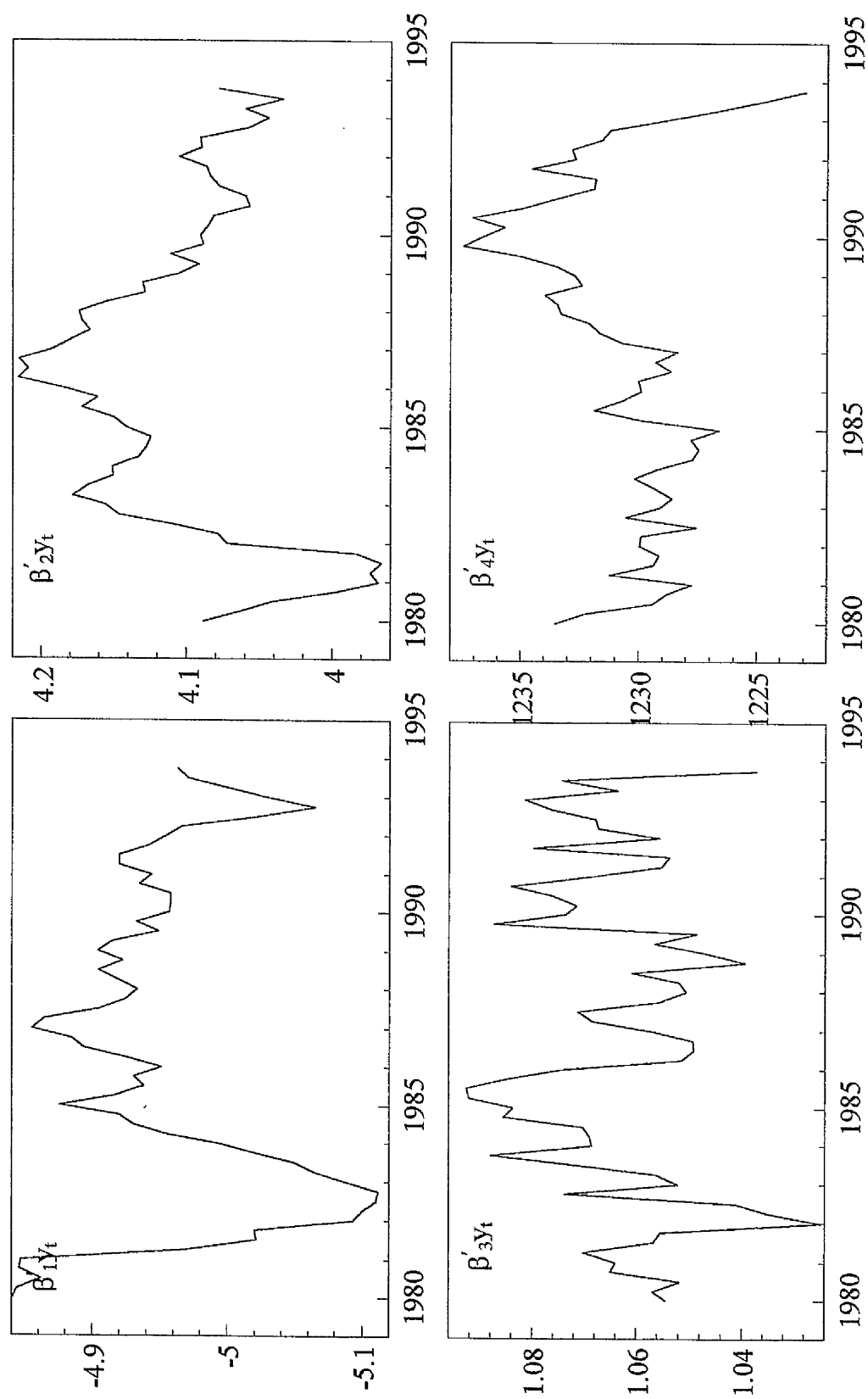


Figure 9.3: Scaled Residuals of the Initial Model

Figure 9.4: Cointegration Vectors



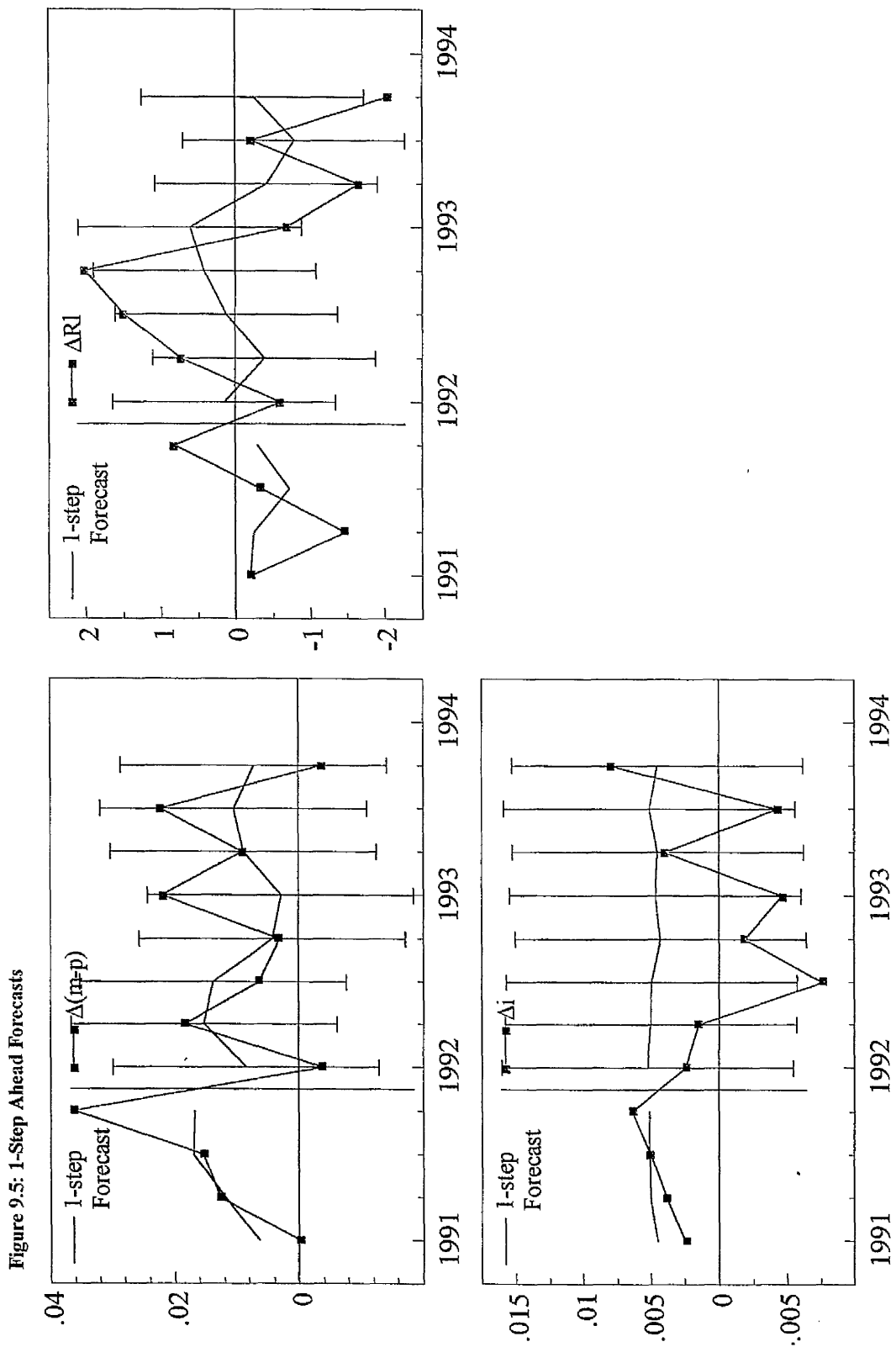
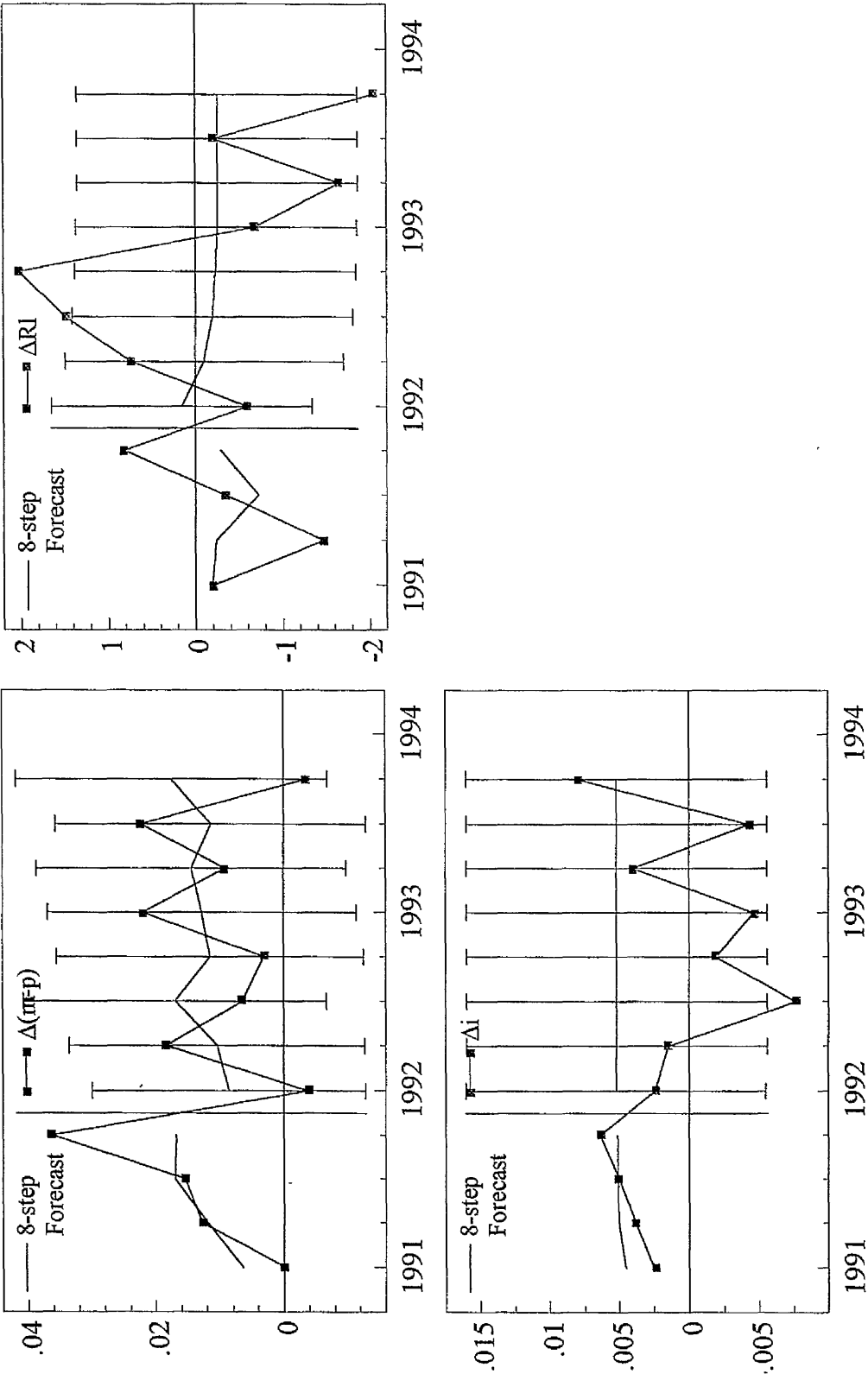


Figure 9.6: 8-Step Ahead Forecasts



CHAPTER 10

MODELLING THE DEMAND FOR MONEY IN THE EU

10.1 Introduction

The increased degree of integration of the European Union (EU) economies, together with the process of financial liberalization and the abolition of exchange controls within EU area are likely to lead some people, large companies and firms to allocate their monetary holdings across more than one currency. As the substitution of money and other assets denominated in various currencies tends to increase and EU residents shift among currencies in response to exchange rate expectations or foreign interest rate changes, and international spillover effects from one country to another tend to be increasingly strong, foreign economic variables can be expected to have a direct effect on the demand for national money. These factors may therefore strengthen the links between the money demand functions of closely integrated EU countries. However, since foreign economic variables are rarely included in national money demand functions either because of the high collinearity between the domestic and foreign variables or because there are difficulties in identifying the relevant foreign variables, conventional national money demand functions may become unstable. But, on the other hand, an EU-wide money demand function may overcome this problem by internalizing the spillover effects between the EU countries and hence a stable area wide demand for money function may be obtained. It has been widely argued that the stability of an EU-wide demand for money function could make the EU-wide money stock a more important determinant of inflation in the EU than the domestic money stocks, which could in turn justify the implementation of more effective monetary control through a European Central Bank (when it is established) than by national central banks. In that case, a broad monetary aggregate for the EU could be used as an intermediate target variable for a European money supply policy.

Moreover, if the degree of currency substitution increases, this would have implications for the appropriate speed of transition to monetary union. The degree

of currency substitution may increase further during the approach to EMU, which would make it difficult for individual monetary authorities to conduct monetary policy at the national level, with exchange rates likely to be increasingly sensitive to shocks and to changes in expectations. Currency substitution implies that economic agents in different countries allocate their total holdings of money balances across more than one currency. This allocation of money balances usually takes the form of cross border deposits. In recent years, as capital markets have become more integrated especially in the EU countries, cross border banking activities and their effects on monetary aggregates have increased. Since traditionally defined monetary aggregates do not include cross border deposits, they may not reflect the true amount of money demanded. Thus, in this study an extended monetary aggregate is defined, which includes some cross border deposits¹. In previous chapters, the national demand for this extended monetary aggregate for each of five EU countries has been estimated and stability properties examined. The aim of this chapter is to estimate an area-wide extended money demand and to investigate its stability properties. Section 10.2 summarizes alternative aggregation methods. Section 10.3 presents a brief discussion of the existing studies on the area-wide demand for money in the EU. The derivation of the aggregate data is explained in section 10.4. Estimation results are given in section 10.5. Finally section 10.6 concludes.

The empirical findings of this chapter suggest that there is a stable money demand function in the EU. In order to check the robustness of the results, the estimation is performed using two sets of data where the variables are aggregated by using two different methods: first by using fixed base-period weights, and then using moving average weights. The outcomes of both estimations indicate the existence of a stable demand for money function in the EU, which is essentially insensitive to the aggregation method. Furthermore, the structures of the demand for money functions obtained using different aggregation methods show similarities to the individual

¹For the definition of cross-border deposits and the calculation of the extended monetary aggregates, see Chapter 2.

country estimates, especially that of Germany. This indicates that aggregation bias, which may occur due to different money demand structures of the five countries, is likely to be minimal in this study.

10.2 Aggregation Methods

In order to estimate an area-wide demand for money function the national variables which appear in the national money demand functions should be aggregated to the area level.² The main problem is to determine which exchange rates to use in aggregation. Four conversion methods can be used to derive the area-wide aggregates from national aggregates. The conversion factor can be based on

- 1) The exchange rate in a base year,
- 2) Current exchange rates at each period,
- 3) Purchasing power parity (PPP) in a base year,
- 4) Continuous purchasing power parity (PPP).

The first approach, using fixed base period exchange rates, has been used by McKinnon (1982) and Spinelli (1983) to study the determination of money and prices at the world level under flexible exchange rates, and Artis et al. (1993) to estimate an area-wide demand for money in the EU. The main advantage of this method is that fixed base-period conversion means the measurement of aggregate variables is unaffected by nominal exchange rate changes. However the base year is chosen arbitrarily and von Riet (1993) argues that depreciating countries with relatively high rates of inflation are given a disproportionate weight. The second approach has been used by Monticelli and Strauss-Kahn (1992). They argue that money balances are demanded for both store of value and transaction purposes. "In this context, current and future actual purchasing power, in terms of foreign goods and assets, is appropriately measured by current exchange rates. Furthermore, current exchange rates provide a consistent market evaluation of stocks of financial assets across countries. Finally, intra-EU spill-over effects are transmitted through variables

²See Chapter 3 for advantages and disadvantages of aggregation.

expressed at current exchange rates".³ This approach would be feasible if the exchange rates were irrevocably fixed, in which case the first and second approaches would clearly be identical. But the use of current exchange rates has a disadvantage in that, since exchange rates remain adjustable, a realignment of parities would have an abrupt effect on the calculated area-wide money supply.

Kremers and Lane (1990) and Lane and Poloz (1992) use the third approach and aggregate variables at 1985 purchasing power parity exchange rates. They argue that this method has some particularly attractive properties. First, the use of PPP yields country shares which reflect the relative size of each country's real economy. Secondly, it reflects money's purchasing power in the country in which it is spent. According to Monticelli and Strauss-Kahn (1992) this latter property is not correct in the context of the demand for money. They argue that international price differences also play a role in the holding of liquid assets. Since it may not always be possible to construct reliable PPP indices which require stringent assumptions, Artis et al. (1993) feel this is not the best method to choose. The third and fourth approaches would be equivalent if price rises in all EU countries were the same. In that case, the absolute purchasing power parity in the base year would be maintained throughout. However inflation differentials between the EU countries have not yet disappeared, requiring a distinction between the two approaches. Approaches 1 and 3 yield the same result if the exchange rates in the base year reflect their purchasing power parities. Approaches 2 and 4 would be identical if the real exchange rates are constant, but in both instances the two approaches lead to different results, as real exchange rates in the EU are not yet stable.

Previous empirical analyses of the EU-wide money demand function show that the results can be sensitive to the alternative aggregation methods. Von Riet (1993) notes that as there is no clear favourite, some reservations should be made as to the comparability of the results. In this study, the first approach is preferred considering the arguments of Artis et al. (1993). We do not use current exchange

³Monticelli and Strauss-Kahn (1992), pp. 352.

rates, because the aggregates constructed using this approach reflect variations of the exchange rates. Since international price differences are likely to affect economic agents' decision to hold several currencies, we agree with the criticisms made above of approaches 3 and 4. In order to see if the estimation results from data obtained using fixed exchange rates are robust, the estimation is carried out using a second set of data where the variables are aggregated by using moving average current exchange rates. In each case the aggregate data is obtained by converting every variable to the DM.

The European interest rates and price level are usually calculated through weighted aggregation of national interest rates and price levels, respectively, on the basis of fixed shares of currencies in the ECU basket. The GNP shares of countries in aggregate EU income can also be used as weights and this is preferred in this study. As in the aggregate money and GNP series, two different methods are used to aggregate interest rates and the price level. The first method is a fixed based weights aggregation where the income shares of each country at an arbitrarily chosen date, (which is the fourth quarter of 1989), are used for aggregation. The second method entails using moving average income shares of the countries as weights in obtaining the aggregate series.

10.3 Existing Studies on EU-wide Demand For Money

Considering the increased financial integration and exchange rate stability, which would be expected to stimulate currency substitution, recent empirical studies have investigated whether an EU-wide demand for money function is stable. The main emphasis of these studies is the desirability of monetary policy coordination within the area, if a stable demand for money function exists for the area. The principal results of previous empirical investigations of area-wide money demand functions for groups of EU countries are reported in Table 10.1. Basically, these studies are concerned with two issues: the existence of a stable money demand function for the

Chapter 10: Modelling the Demand for Money in the EU

Table 10.1: Studies on Area-Wide Demand for Money for EU

Authors	Monetary Aggregates	Group of Countries	Aggregation Method	Long-Run Parameters						ECM	Standard error ¹
				Price level	Real income	Short-term interest rate	Long-term interest rate	Rate of inflation	Currency substitution ²		
Kremers and Lane (1990)	M1	ERM-7	PPP 1985	1.00	1.00	-0.67		-1.40	0.08	-0.95	0.82
Fase and Winder (1992)	M1	EU-11	current	0.89	1.00	-1.51	-1.23	-1.23		-0.15	0.63
	M2			0.96	1.00	1.67	-2.60	-2.67		-0.09	0.58
	M3			0.97	1.00	1.48	-2.38	-2.31		-0.08	0.49
Artis et al. (1993)	M1	ERM-7	nominal 1980	1.00	0.99		-1.21		0.09	-0.73	1.17
	M2			1.00	1.20		-0.70		0.03	-0.38	0.52
	M3			1.00	1.29	-0.72			0.02	-0.44	0.50
Monticelli and Strauss-Kahn (1993)		ERM-9	current								
Monticelli And Papi (1996)	M1	EU-9	current	1.00	1.29	-0.90				-0.46	0.67
	M3			1.00	1.25	-0.49				-0.55	0.47
	Extended M3			1.00	1.51	-0.29				-0.31	0.56
Cassard et al. (1997)	M3	ERM-6	PPP-1985	1.00	1.48	-0.09				-0.09	0.54

¹Standard error ($\times 100$) of the residuals in the short run money demand equation.

²Kremers and Lane: US dollar-ecu exchange rate; Artis et al.: US dollar-ecu real exchange rate; Monticelli and Strauss-Kahn; changes in the US dollar-ecu exchange rate.

whole group or a subset of EU countries, and the comparison of the main features of area-wide and national money demand functions.

When the first issue is considered, most empirical studies support the hypothesis of the existence of a stable area-wide demand for money function. Fase and Winder (1992), Artis et al. (1993), Kremers and Lane (1990) conclude in favour of a stable European demand for money function. Fase and Winder (1992) test the stability of the aggregate demand for money functions on the basis of forecast errors of the national money demand functions. Residual variation is used as a measure of stability. Wide discrepancies in stability are found among different countries, but it is found, for all countries, that as the broadness of the monetary aggregate increases its stability also increases, in line with expectations. Artis et al. (1993) redefine ERM wide aggregates excluding one country at a time and examine their properties. Although stable demand for money functions are found, when France or Germany is excluded changes in parameters are observed. They argue that the properties of the aggregate are expected to depend on the behaviour of the underlying country specific money demand functions.

All studies share the same methodological technique, namely the two stage cointegration method, where an equilibrium relationship for the EU demand for money is postulated, with the demand for nominal money determined by the price level, real income and a short or long run interest rate. Kremers and Lane (1990) include inflation to represent the return on money. All studies are concerned with M1 or M2, except the study by Fase and Winder (1992) and Monticelli and Strauss-Khan (1992) which use M3. None of the studies include any CBDs in the monetary aggregates. The estimation period, in general, runs concurrently with the existence of EMS. Various combinations of countries are selected for the empirical studies. Kremers and Lane (1990), Artis et al. (1993), Lane and Poloz (1992) consider the seven EC countries which joined the EMS in March 1979. Lane and Poloz (1992) include three non-European G-7 countries to capture possible currency substitution outside as well as inside ERM. Monticelli and Strauss-Khan (1992) consider nine EU

countries including the UK and Spain. Fase and Winder (1992) present an analysis of the demand for money in all individual EC countries excluding Luxembourg. Alternative aggregation methods are used to convert national monetary aggregates to a common currency. Fase and Winder (1992) and Monticelli and Strauss-Khan (1992) prefer current exchange rates. Kremers and Lane (1990) and Lane and Poloz (1992) employ 1985 PPP exchange rates. Artis et al. (1993) use a fixed base exchange rate (base year 1980) calculated as average dollar exchange rate for each country.

In most of the studies the restrictions of unit income elasticity and homogeneity of the money demand function in prices are imposed. Kremers and Lane (1992) report non-rejection of the restrictions. Fase and Winder (1992), on the other hand, impose a unit price elasticity restriction. It is found that the price elasticity differs from one in most of the estimations. A weighted price elasticity for the whole EU aggregate is found to be less than one, implying that the long run EC demand for money is not homogeneous of degree one with respect to prices. An average income elasticity of one, or slightly higher, is obtained for the area-wide estimations. For instance Artis et al. (1993) obtain an income elasticity of 1.2 for M2 and Monticelli and Strauss-Khan (1992) obtain 1.3 for M3.

Some of the studies attempt to capture the influence of currency substitution. Monticelli and Strauss-Khan (1992) employ the change in the ECU rate vis a vis the US dollar. Artis et al. (1993) and Kremers and Lane (1990) use the level of the real or nominal ECU rate in dollars, respectively. "Currency substitution provides the rationale for including the exchange rate in the money demand function. However, it is arguable whether this involves a misinterpretation of the currency substitution literature. The objective of including the exchange rate is to capture the potential influence of expected movements in the value of currency on the demand for money. The implied expectation scheme has economic agents basing their expectations of future changes in the exchange rate on its current value".⁶ However, Lane and Poloz

⁶Papadopoulos and Zis (1997), pp. 73.

(1992) criticise the usage of the level of the exchange rate, arguing that it is inconsistent with rational expectations. Since the exchange rate is a nonstationary variable, it should not contain information about its future movements. Moreover, they also suggest that, if shocks affect both the exchange rate and the demand for money, then the relationship between the two may not reflect the influence of expected exchange rate changes.

In error correction modelling the dependent variable adjusts gradually to its equilibrium level and the coefficient of the error correction term represents the speed of adjustment in the model.⁷ The speed of adjustment has a particular importance for monetary policy. "As the process of adjustment towards a new equilibrium goes faster, European monetary policy can be wielded with all the more certainty about the end result".⁸ Kremers and Lane (1992) reports an adjustment coefficient of 0.95 for M1 at the EMS level. Similarly, Artis et al. (1993) find an adjustment coefficient of 0.73 for M1. But for M2 they report a value of 0.37, implying that the adjustment takes twice as long as for M1. Monticelli and Strauss-Khan (1992) report that for M3 about 30% of a deviation from equilibrium is eliminated in a quarter.

When the area-wide and the single country money demand equations are compared, it is commonly argued that the EU-wide money demand functions outperform most national equations. The standard errors of estimates are generally smaller than those of national money demand equations, as reported by Artis et al. (1993) and Cassard et al. (1994) for broad money, and Kremers and Lane (1990) for narrow money. Moreover, the coefficients of the error correction terms (ECM) in EU-wide money demand equations are generally found to be higher than those of single country money demand equations, implying that the deviations of demand for money from its long-run equilibrium level are eliminated faster when the area-wide demand for money is considered. "This feature is worth noting for two reasons. First, as discussed above, a high value of the ECM would suggest that the area-wide

⁷See Chapter 4 for the econometric modeling of the demand for money function.

⁸Von Riet (1993), pp. 69.

approach is an effective solution to the specification problem encountered in national equations: slow adjustment processes are difficult to justify and hint at mis-specified equations. Secondly, a relatively fast adjustment can make monetary management easier because it implies that impulses coming from monetary policy instruments are quickly transmitted to economic activity".⁹

Most of the studies conclude in favour of an EU wide money demand function, arguing that there appears to be a stable and well-specified European money demand function. Although currency substitution may lead to instability in national money demand functions, it may contribute to the success of aggregation in money demand estimates. Thus, a common monetary policy for the EMU seems to be feasible.

10.4 Derivation of the Aggregate Data

In this section the aggregate data are presented and their properties are discussed. Five countries are included in this study: France, Germany, the Netherlands, Italy and the United Kingdom. Although other EU countries were also considered for inclusion, the unavailability of data on the relevant cross-border deposits for these countries prevented this. As the five countries constitute the majority of the EU in terms of their GDP shares in the EU total, this analysis could be seen as one coming close to studying the demand for extended money for the EU as a whole.

The study is based on the extended monetary aggregates for each country, which are obtained by adding to the broad monetary aggregates deposits held by residents denominated in domestic currency but held with banks abroad, and deposits denominated in foreign currency, either held with domestic banks or banks abroad.¹⁰ Broad monetary aggregates were chosen so that data should be as comparable as possible across countries. The income variable is, depending on availability, either

⁹Monticelli and Papi (1996), pp.137.

¹⁰See Chapter 2, for a comparison of traditional measures of money and extended monetary aggregates and the rationale for the preference of the latter.

real GNP or real GDP at 1985 prices. Both income and monetary aggregates are seasonally adjusted at the national level. The consumer price index is used to deflate nominal money and to measure the rate of inflation. Finally, long term interest rates, defined as the 10-year government bond yield, are used to proxy the opportunity cost of holding money¹¹.

In the previous sections, four possible conversion methods were mentioned to obtain the area-wide aggregate from the national aggregates. As explained in Section 10.2, our preferred conversion method uses fixed base period exchange rates. With this method aggregate variables can be obtained without the influence of nominal exchange rate movements. However, as explained above, the major shortcoming of this approach is that the base period is chosen arbitrarily. In order to overcome this shortcoming and to evaluate the robustness of the estimates, an alternative conversion method is proposed: Moving average current exchange rates. The aggregates constructed using this method would not exhibit the fluctuations of the nominal exchange rates as much as if the current exchange rates were used. But at the same time, we would have the advantages of using current exchange rates as a conversion method, as mentioned by Monticelli and Strauss-Kahn (1992). Their reasoning was that it was preferable to use current exchange rates as intra-EU spill-over effects were transmitted through variables expressed at current exchange rates.

After determining the conversion methods, the remaining issue is to determine in which currency the aggregates should be expressed. In the literature, there is not a clear-cut preference. For example Artis et al. (1993) express area-wide aggregates in US dollars, whereas Monticelli (1993) and Monticelli and Strauss-Kahn (1992) convert each national variable to ECU. One of the reasons for not expressing variables in US dollar is because we did not want to import volatility inherent in the national currency -US dollar exchange rate which were observed in the 1980s. Furthermore, within Europe Deutsche Mark has been seen as an anchor currency. In

¹¹See Appendix 2, for a comparison of national monetary aggregates and the exact sources of references for all the data.

this study the DM is chosen as the currency in which the area-wide aggregates are expressed.

Each EU-wide aggregate is obtained using two conversion methods: the first is the fixed base period exchange rate, where the arbitrarily chosen base period is the fourth quarter of 1989. The second method uses moving average current exchange rates, which are average of four quarters up to the current quarter. Then by simply adding up the national variables, the area-wide variables are obtained. The EU-wide interest rate and price level are obtained as weighted averages of the national variables using two conversion methods where the shares of the national GNPs in the total income of the area are used as weights (where the income shares are 39.51 per cent for Germany, 28.86 per cent for the UK, 15.07 per cent for France, 7.14 per cent for Italy and 2.41 per cent for the Netherlands). The first method is to aggregate national interest rate and price level variables using the income shares of the fourth quarter of 1989; and in the second method a four quarter moving average of income shares are used as weights. This can be represented as follows:

$$\begin{aligned} I_{a,j} &= \sum_i I_i e_{i,j} \\ Rl_{a,j} &= \sum_i Rl_i w_{i,j} \\ P_{a,j} &= \sum_i P_i w_{i,j} \\ M_{a,j} &= \sum_i M_i e_{i,j} \end{aligned}$$

where I_a denotes area-wide income, M_a nominal money, P_a price index and Rl_a long-term interest rates, respectively. Here j refers to the aggregation method, either fixed base exchange rates or moving average current exchange rates, with which the weights are obtained; e denotes exchange rates, while w denotes income shares of each country in the total which can be represented as $w_i = I_i/I_a$.

The resulting data set is presented in Figures 10.1 through 10.4. All variables, except the interest rate are, in logarithms. Figure 10.1 shows real GNP in the EU, expressed in DM and derived on the basis of the three alternative methods mentioned above: i_{ma} , i_f and i_c denote real GNP obtained using moving average current exchange

rate method, fixed base-period method and current nominal exchange rates, respectively. As argued before, the volatility in the exchange rate is exhibited in the series obtained using moving average or current nominal exchange rates. The pattern of nominal appreciation of the DM is reflected in the downward movement of aggregate real GNP based on these two methods between 1981 and 1983, and 1985 and 1987. However, the aggregation at base-period exchange rates does not exhibit the volatility inherent in the current nominal exchange rates and resembles the individual national real GNPs, which were presented in previous chapters.

Figure 10.2 depicts the corresponding series for the real extended money stock, where $(m-p)_{ma}$, $(m-p)_f$ and $(m-p)_c$ denote real extended money obtained using moving average current exchange rates, fixed base-period and current nominal exchange rates, respectively. Figure 10.2 indicates that the behaviour of the real extended money series derived using different aggregation methods does not show any particular divergence between the series, except in the early 1980s, although volatility in the two series derived using moving average or current nominal exchange rates is greater than that obtained using fixed base-period exchange rates. The decline in the current rate series in the 1981-1983 period could be due to the appreciation of the DM.

Figures 10.3 and 10.4 present inflation and long-term interest rates in EU, which are aggregated using two different methods, as mentioned above. For both interest rates and inflation, the aggregates calculated using different methods are very similar. Although the late 1970s is characterized by high inflation, the decline in inflation between 1980 and 1986 is apparent. Increases in inflation occur in the late 1980s but later a renewed reduction is observed which, in part, could be attributed to the desire of the national monetary authorities to meet the criteria set by the Maastricht treaty. Figure 10.4 indicates that long-term interest rates reached historic highs in 1981, which is a feature shared by most national long term interest rates as well as interest rates in the US. The decline in interest rate has continued since then, even though there has been some volatility especially during the ERM crisis in the

early 1990s.

10.5 Modelling the Demand for Extended Money

The demand for money in the EU is analyzed employing aggregate data and relying either on fixed base-period exchange rates or moving average current exchange rates. As for the individual countries, a four equation VAR model is constructed where the variables are extended money, GNP at 1985 prices, the consumer price index (P) and the long-term interest rates (RI). As two conversion methods are employed to obtain the aggregate variables, as explained in the previous section, there are two sets of variables : variables obtained through fixed base-period weights aggregation M_f , I_f , RI_f and P_f ; and variables obtained through moving average weights aggregation M_{ma} , I_{ma} , RI_{ma} and P_{ma} . The seasonally adjusted quarterly data is available for the time period 1978:1-1993:4. The time period in this chapter, which is 1979:1-1993:4, is shorter than that of country estimates because the first four observations are erratic and caused serious autocorrelation problems in the preliminary estimates. This could be due to several factors. As described in Chapters 7 and 9, UK and Italian data show instability in that period. In the UK it was a period in which a tight wages and prices policy was initially successful but then collapsed, which was followed by the erratic behaviour of the strikes. For Italy the choice of the starting period reflected the considerations that until the early 1980s, the financial wealth, rather than domestic demand, had a significant effect on the money demand, but afterwards the opposite results were obtained. Furthermore, the late 1970s was a recovery period from the first oil price rise. Therefore, after allowing for lags, the estimation is carried out over 1979:3-1993:4, which yields 58 observations. All variables are in logarithmic form, except the interest rates, and denoted in lower case letters.

Prior to modelling the relationships between the variables, their univariate time series properties are established.¹² The results of the augmented Dickey-Fuller tests indicate that, apart from the price level and the nominal extended money, all

¹²The description of all variables and the results of unit root tests are given in Appendix 1.

variables considered by the study qualify as $I(1)$. These results are in line with the findings for the individual country series, where nominal money and the price level are found to be integrated of order two, whereas the real extended money defined as the log of M/P , is $I(1)$. As a major consequence of this result, the consumer price index cannot be included as an independent variable in the analysis but appears in transformed variables, such as inflation, Δp , and real money balances. In the following sections the results of the empirical analysis using aggregate data based on fixed base-period aggregation and that obtained through moving average current exchange rates are summarized. As mentioned in Section 10.2 above, the reason for using two different sets of data is to see if the estimates are sensitive to the aggregation method.

10.5.1 Fixed Base Period Estimates

As in previous chapters, the empirical analysis starts from the augmented VAR with four lags on all variables with the simplification tests performed to see if the lag length can be reduced. The results of the specification tests for the fixed base aggregated series are given in Table 10.2. It emerges from this table that the reduction by 16 parameters for eliminating lag 4 and the reduction by 32 parameters for eliminating lags 3 and 4 are acceptable on the overall F-tests, even though the first F test for eliminating lag 4 is marginal at the 5 per cent level. Furthermore, the Schwarz and Hannan-Quinn criteria also indicate the selection of the 2 lag system. Thus, a 2 lag model is chosen.

Figure 10.5 presents the scaled residuals of the initial model. The graphical analysis of the initial model suggests the inclusion of dummy variables for German unification $S1991:1$ which takes the value of 1 starting from 1991 first quarter and $D1991:1$ which is the impulse dummy which takes the value of 1 on 1991 quarter 1. The step dummy $S1991:1$ is conditioned in the long run analysis as German unification could have long run effects on the area-wide demand for money, whereas the impulse dummy $D1991:1$ is conditioned in the short run analysis. The dummy

Table 10.2: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-30.43	-31.99		
				1→2	F(16,113) = 1.70
2	3	-30.89	-32.10		(0.05)
				2→3	F(16,125) = 1.31
3	2	-31.54	-32.41		(0.19)
				1→3	F(32,138) = 1.54
					(0.04)

Note: p-values are in parentheses

Table 10.3: Residual Correlations and Lag Length Statistics for VAR (2)

Residual Correlations				
	$(m-p)_f$	Rl_f	Δp_f	i_f
Rl_f	0.052	-	-	-
Δp_f	-0.100	0.187	-	-
i_f	0.223	0.031	-0.287	-
Lag Length and Dynamics				
	$(m-p)_f$	Rl_f	Δp_f	i_f
$F_{s=1}(4,42)$	11.4** (0.00)	9.26** (0.00)	18.7** (0.00)	5.50** (0.001)
$F_{s=2}(4,42)$	1.07 (0.37)	0.09 (0.98)	1.77 (0.15)	4.09** (0.009)
$ \mu $	0.48	0.07	0.07	0.16

Note: * and ** denote significant at the 5% and 1% levels and p-values are in parentheses.

variable D8123 which takes the value 1 in the first three quarters of 1981 when there were outliers in the interest rate equation. In the first three quarters of 1981 interest rates reached their peak in the sample period in most countries. Figure 10.4 of the previous section also confirms that, in line with the other countries such as the US interest rates in the EU reached their highest in 1981. This dummy variable is included in almost all country estimates, whereas the dummy variables for unification are employed only for Germany and the Netherlands. Furthermore the trend also enters into the cointegration space, as otherwise it would induce a quadratic trend in levels, for which there is no evidence.¹³

Table 10.4: Goodness of Fit and Diagnostic Test Results

	$(m-p)_f$	R^2_f	Δp_f	i_f	VAR
$\hat{\sigma}$	0.66%	3.35	0.39%	0.45%	
$F_{ar}(4,41)$	1.92 (0.12)	3.13* (0.02)	0.39 (0.80)	2.86* (0.03)	
$F_{arch}(4,37)$	0.46 (0.76)	0.45 (0.77)	1.19 (0.32)	1.19 (0.33)	
$F_{het}(19,25)$	0.60 (0.86)	0.51 (0.93)	0.89 (0.59)	0.42 (0.97)	
$\chi^2(2)$	1.85 (0.39)	0.07 (0.96)	2.47 (0.28)	5.78 (0.05)	
$F^v_{ar}(64,104)$					1.37 (0.07)
$F^v_{het}(190,164)$					0.58 (0.99)
$\chi^{2v}_{nd}(8)$					12.0 (0.15)

Note: * denote significant at the 5% level and p-values are in parentheses.

¹³See Chapter 5 for a discussion of inclusion of trend in the cointegrating space.

Accordingly, a two-lag system with two unification and interest rate dummies and a trend is selected as the final model. The residual cross-correlation, lag-length statistics and summary statistics for the simplified model are given in Table 10.3 and Table 10.4, respectively. Table 10.3 indicates that there are relatively large positive residual correlations between real money and income; and between interest rates and inflation; and there is a large negative correlation between inflation and income. Furthermore, the lag-length statistics reveal that the first lags of all variables are significant, as well as the second lags of income, so that a two lag VAR model is appropriate for modelling. The long-run matrix has two eigenvalues close to zero, indicating that there could be one or two cointegrating vectors.

Table 10.4 presents the goodness of fit measures and residual diagnostics for the model. All statistics are as defined in Chapter 5. The test statistics in Table 10.4 suggest that although there is some indication of autocorrelation of fourth order in the interest rates and income equations, they are not significant at 1% level. Furthermore, all other diagnostics are satisfactory.

After determining the VAR model, cointegration analysis is performed in the four equation system. Table 10.5 gives the results, where λ denotes the eigenvalues, Max and Tr denote the associated maximum eigenvalue and trace statistics. Although Table 10.5 supports the hypothesis that there could be up to three cointegrating vectors, the reduced rank cointegration tests (not shown) indicate that the outcome obtained assuming a cointegration rank of one is very close to the unrestricted outcome unlike that of when the cointegration rank is set to two or three. Thus, it is assumed that there is one cointegrating vector. Figure 10.6 presents the cointegrating vector and remaining non-stationary components.

The first cointegrating vector can be interpreted as the excess demand for the extended money, with an unrestricted income elasticity of 1.67, which is relatively low compared to the individual country estimates. Table 10.5 also presents the adjustment coefficients, which can be interpreted as the weights with which the cointegration vectors enter the four equation system. They represent the average

Table 10.5: Cointegration Analysis

r	1	2	3	4
λ	0.44	0.38	0.30	0.12
Max	34.2*	28.4*	21.0*	8.06
Tr	91.9**	57.6**	29.1*	8.06

Eigenvectors β

	$(m-p)_f$	RI_f	Δp_f	i_f	Trend	S1991:1
$(m-p)_f$	1.00	0.0009	-1.09	-1.56	-0.004	-0.1179
RI_f	387.6	1.00	-5.86	-485.6	-2.86	6.48
Δp_f	-1.25	-0.039	1.00	3.50	-0.002	-0.07
i_f	-0.39	0.006	-1.15	1.00	-0.0006	0.005

Adjustment Coefficients α

$(m-p)_f$	0.114	-0.0006	0.016	0.031
RI_f	0.30	0.023	4.37	-2.80
Δp_f	0.001	0.0004	0.009	0.13
i_f	0.052	0.0004	-0.017	-0.121

speed of adjustment towards the estimated equilibrium state, such that a small coefficient indicates a slow adjustment. As in previous chapters, weak exogeneity of interest rates, inflation and income for the parameters of the long-run demand for money function is tested as described in Chapters 4 and 5. Although the unit income elasticity restriction is rejected, the exogeneity restriction is accepted yielding $\chi^2(3)=4.88$ ($p>0.1801$). Thus changes in income, inflation and interest rates will not react to disequilibrium errors but may still react to the lagged changes of extended money.

As a consequence of the above analysis the cointegrating vector is determined,

indicating that there is one stationary relationships between the four non-stationary variables of the system. The cointegrating vector is estimated as

$$CI = (m-p)_{f,t} - 1.44 * i_{f,t} + 0.003 * RI_{f,t} + 0.74 * \Delta p_{f,t} - 0.006 * Trend + 0.071 * S1991:1$$

The long run extended demand for money depends negatively on inflation and the interest rate and positively on income and the trend, which is assumed to capture the effects of financial innovations in the sample period. The extended money demand function has an income elasticity of 1.44, which is consistent with the findings of the other studies. For example Cassard et al. (1997) report an income elasticity of 1.48 for the core ERM money demand function, whereas Monticelli and Strauss-Kahn (1993) estimate an income elasticity of 1.29 for the aggregate of 9 ERM countries. Furthermore, German unification has a negative effect on the demand for extended money as in Germany and the Netherlands, even though a positive effect was expected. Thus it could be interpreted as a recession dummy, which could be attributable to the recession that took place in EU countries in the early 1990s.

The information set used consists of first lags of $\Delta(m-p)_{f,t}$, $\Delta RI_{f,t}$, $\Delta^2 p_{f,t}$, $\Delta i_{f,t}$, $CI1_{t-1}$ together with the unification and interest rate dummies, and an intercept. In order to enhance interpretability and to reduce its sample dependence, the system is modelled as an $I(0)$ parsimonious vector autoregression (PVAR). After examining the weak exogeneity of $(RI_{f,t}, \Delta p_{f,t}, i_{f,t})$ for the parameters of the first cointegration relation, conditional factorization is performed. It is observed that none of the explanatory variables in the income equation is significant, suggesting that none of the variables in the system contributes to the modelling of real income and income is exogenously determined. This could be plausible in that there may be other variables explaining EU-wide income which are not included in the model. Thus income is not modelled but is regarded as a conditioning variable.

The resulting VAR equations are estimated by FIML and given in Table 10.6. Since the test of overidentifying restrictions does not reject ($\chi^2_{or}(15) = 21.21$, $p > 0.1303$), the PVAR parsimoniously encompasses the unrestricted VAR(2). The striking feature of the estimates is that the extended money demand equation has a

Table 10.6: FIML Model Estimates

$$\Delta(m-p)_{f,t} = -0.85(\Delta^2 p)_{f,t} + 0.29(\Delta i)_{t,f} - 0.25(CI1)_{t-1} + 0.01(D1991:1) - 2.14$$

$$\begin{array}{ccccc} (-3.58) & (2.07) & (-6.46) & (1.97) & (-6.43) \end{array}$$

$$\Delta Rl_{f,t} = 16.7(\Delta i)_{f,t-1} + 0.20(\Delta Rl)_{f,t-1} + 0.82(D81123) - 0.16$$

$$\begin{array}{cccc} (2.18) & (1.68) & (3.23) & (-2.43) \end{array}$$

$$\Delta^2 p_{f,t} = 0.420(\Delta^2 p)_{t-1} + 0.45(\Delta i)_{f,t-1} - 0.002$$

$$\begin{array}{ccc} (4.53) & (5.67) & (-3.68) \end{array}$$

t ratios are in parentheses

Table 10.7: Model Statistics

Model Diagnostic Tests

$$F^m_{ar}(36,118) \quad 1.13$$

$$(0.29)$$

$$F^m_{het}(84,195) \quad 1.30$$

$$(0.06)$$

$$\chi^2_{nd}(6) \quad 3.95$$

$$(0.68)$$

FIML Residual Correlations

	$\Delta(m-p)_{f,t}$	$\Delta Rl_{f,t}$	$\Delta^2 p_{f,t}$
$\Delta(m-p)_{f,t}$	0.68%	0.10	0.04
$\Delta Rl_{f,t}$	0.16	3.89%	0.32
$\Delta^2 p_{f,t}$	0.45	0.23	0.43%

relatively high adjustment coefficient compared to the individual country estimates, giving strong evidence of the relative importance of the long run relations in the data generating process explained. The extended money demand equation depends negatively on the lagged changes in the change of inflation and positively on the changes in real income, the cointegrating vector and the unification dummy. The first

lag of differenced income affects the interest rate equation positively. Moreover, the dummy variable D8123 effectively captures the unexplained outliers in the interest rate equation. Additionally, the model statistics, given in Table 10.7, are all insignificant, matching the valid reduction from the parsimonious VAR. Furthermore residual correlations from the FIML model are also reported as correlations below the diagonal in Table 10.7, where the residual standard deviations are on the diagonal and the reduced form correlations are presented above the diagonal. Table 10.7 reveals low correlations between the structural residuals.

In order to test the constancy of the model one-step forecast analysis is performed for the time period 1992:1-1993:4. Figure 10.7 reports the one-step model based forecasts. The constancy of the model is accepted with almost every lag lying inside the individual 95 per cent confidence bars while the overall test statistic is $F(24,46)=1.17$ ($p>0.3083$), implying that the model is stable. Figure 10.8 presents a sequence of one through eight step ahead from 1992:1 onwards with error bars of 95 per cent confidence intervals. The forecast converge to their conditional means.

10.5.2 Moving Average Estimates

In this section estimation results of the model, where the variables are aggregated through moving average weights, will be summarized. The variables included in the model are extended real money and income which are aggregated using moving average current exchange rate, $(m-p)_{ma}$ and i_{ma} ; interest rate and inflation which are aggregated using moving average income shares of the countries, R_{ma} and Δp_{ma} . The empirical analysis starts from the augmented VAR with four lags on all variables. The results of the specification tests, which are presented in Table 10.8, indicate that the reduction by 16 parameters for eliminating lag 4, and the reduction by 32 parameters for eliminating lags 3 and 4 are acceptable on the overall F-tests, even though the first F test for eliminating lag 4 is marginal at the 5 per cent level. As the Schwarz and Hannan-Quinn criteria also indicate the selection of the 2 lag system, a 2 lag model is chosen.

Table 10.8: Specification Tests

Model	Lag-length	Schwarz	Hannan-Quinn	Model Reduction	F-tests
1	4	-29.35	-30.91		
				1→2	F(16,113) = 1.77
2	3	-29.79	-31.00		(0.04)
				2→3	F(16,125) = 0.86
3	2	-30.59	-31.46		(0.60)
				1→3	F(32,138) = 1.34
					(0.12)

Note: p-values are in parentheses.

Table 10.9: Residual Correlations and Lag Length Statistics for VAR (2)

Residual Correlations

	$(m-p)_{ma}$	Rl_{ma}	Δp_{ma}	i_{ma}
Rl_{ma}	0.083	-	-	-
Δp_{ma}	-0.031	0.168	-	-
i_{ma}	0.563	0.211	-0.094	-

Lag Length and Dynamics

	$(m-p)_{ma}$	Rl_{ma}	Δp_{ma}	i_{ma}
$F_{s=1}(4,41)$	10.3** (0.00)	15.1** (0.00)	21.0** (0.00)	18.52** (0.00)
$F_{s=2}(4,41)$	4.48** (0.00)	1.96 (0.11)	1.80 (0.14)	6.62** (0.00)
$ \mu $	0.35	0.002	0.002	0.13

Note: ** denote significant at the 1% level and p-values are in parentheses.

Figure 10.9 presents the scaled residuals of the initial model. The graphical analysis of the initial model indicates that there are some outliers at the beginning of 1980. Thus two dummy variables are included in the analysis to capture these outliers: D1980:4 and D1980:2 which are observed in inflation equation. As mentioned in the previous section, the early 1980s were characterized by high inflation, which is mainly attributed to increases in import prices, especially that of oil. Furthermore, as in the previous section two unification dummy variables are also included, which are S1991:1 and D1991:1, along with a trend to capture the effects of the financial developments occurring in that period. Accordingly a 2 lag system with a trend, two dummy variables for unification and two dummy variables for inflation equation is selected as the final model. Tables 10.9 and 10.10 present the residual cross-correlation, lag-length statistics and summary statistics for this model, respectively.

Table 10.9 indicates that there are relatively large positive residual correlations between real money and income; between interest rates and income and between interest rates and inflation, as in the previous section's estimates. As far as the lag-lengths are concerned, the first lags of all variables are significant, as well as the second lags in the equations for real money and income. Moreover, the interest rate and inflation have fairly significant second lags. These statistics indicate that a two lag VAR model would be appropriate for modeling. Furthermore, only one of the eigenvalues of the long run matrix is large, the remaining eigenvalues are smaller, suggesting that the rank of the long-run matrix is one.

Table 10.10 presents the goodness of fit measures and residual diagnostics for the model, where all statistics are defined as in previous chapters. Test statistics in Table 10.10 suggest that although there are problems of autocorrelation of fourth order in all equations except the inflation equation and there is an ARCH effect in the income equation, they are not significant at 1% level. Furthermore, there is no problem of autocorrelation in the vector estimations, and all other diagnostics are satisfactory.

Table 10.10: Goodness of Fit and Diagnostic Test Results

	$(m-p)_{ma}$	Rl_{ma}	Δp_{ma}	i_{ma}	VAR
$\hat{\sigma}$	0.89%	3.67	0.39%	0.67%	
$F_{ar}(4,40)$	3.07* (0.02)	3.63* (0.01)	0.52 (0.71)	2.66* (0.04)	
$F_{arch}(4,36)$	0.42 (0.78)	1.00 (0.41)	1.09 (0.37)	3.52* (0.01)	
$F_{het}(19,24)$	0.49 (0.94)	0.51 (0.92)	0.54 (0.91)	0.27 (0.99)	
$\chi^2(2)$	1.55 (0.45)	0.11 (0.94)	0.31 (0.85)	3.96 (0.13)	
$F_{ar}^v(64,100)$					1.18 (0.22)
$F_{het}^v(190,155)$					0.45 (0.99)
$\chi_{nd}^{2v}(8)$					16.3 (0.03)*

Note: * denote significant at the 5% level and p-values are in parentheses.

After establishing the initial model and its properties, cointegration analysis is performed. Table 10.11 gives the results of the cointegration analysis, where the notation is the same as in the previous section. All eigenvalues appear to be significant, and there are two relatively large and two relatively small eigenvalues. Thus Table 10.11 supports the hypothesis that there are one or two cointegrating vectors. The results of the reduced rank cointegration tests (not shown), however, indicate that the cointegration rank set at one yields an outcome very close to the unrestricted one compared with that when cointegration rank is set to two.¹⁴ Hence,

¹⁴See Chapters 4 and 5 for the determination of number of cointegrating vectors.

Table 10.11: Cointegration Analysis

r	1	2	3	4
λ	0.46	0.41	0.26	0.21
Max	36.75**	30.78*	17.57	14.28*
Tr	99.38**	62.63**	31.85*	14.28*

Eigenvectors β

	$(m-p)_{ma}$	RI_{ma}	Δp_{ma}	i_{ma}	Trend	S1991:1
$(m-p)_{ma}$	1.00	0.009	-0.015	-1.71	-0.005	0.015
RI_{ma}	7.44	1.00	-59.3	-20.1	-0.025	0.802
Δp_{ma}	-0.045	-0.0009	1.00	-1.93	0.004	-0.03
i_{ma}	0.983	0.0018	-4.18	1.00	-0.012	-0.047

Adjustment Coefficients α

$(m-p)_{ma}$	-0.19	-0.025	-0.001	0.07
RI_{ma}	5.08	1.03	-0.31	0.34
Δp_{ma}	0.08	0.05	0.0004	0.01
i_{ma}	0.09	-0.07	-0.001	0.04

it is accepted that there is only one cointegrating vector, which is presented in Figure 10.11 together with three non-stationary components. The cointegrating vector can be interpreted as the excess demand for the extended money, with an income elasticity of 1.71 which is very close to the one obtained in the previous section. Table 10.11 also presents the adjustment coefficients, which can be interpreted as the weights with which the cointegrating vector enters into the four equation system.

The weak exogeneity of interest rates, inflation and income for the parameters of the demand for money function is accepted yielding $\chi^2(3)=7.89$ ($p>0.0482$) which is significant at 4 per cent level, but acceptable at the 1 per cent level. However, the unit income elasticity restriction is rejected as in the previous section. As a consequence of the above analysis one cointegrating vector is determined, indicating

that there is only one stationary relationship between the four non-stationary variables of the system. The cointegrating vector is defined by

$$CI_t = (m-p)_{ma,t} - 1.77 * i_{ma,t} + 0.0151 * Rl_{ma,t} + 0.050 * \Delta p_{ma,t} - 0.0056 * Trend + 0.033 * S1991p1$$

This unique cointegrating vector can be interpreted as the long run demand for extended money. This long run demand for extended money depends negatively on interest rates and inflation and positively on income and trend. The income elasticity of the demand for extended money is slightly higher than that of the fixed based weight estimation of the previous section. Furthermore, the interest rate semi-elasticity of this section is higher than that of the previous section, whereas the inflation elasticity is lower. The effect from the trend on extended money demand, on the other hand, is almost the same. The difference in the cointegrating vectors of the two sections can be attributed to the different aggregation methods employed.

The information set used here consists of the first lags of $\Delta(m-p)_{ma,t}$, $\Delta Rl_{ma,t}$, $\Delta^2 p_{ma,t}$, $\Delta i_{ma,t}$ and CI_{t-1} together with the unification and interest rate dummies, and an intercept. In order to enhance interpretability and to reduce its sample dependence, the system is modelled as an $I(0)$ parsimonious vector autoregression (PVAR). The VAR equations, which are obtained after conditional factorization, are estimated by FIML and given in Table 10.12. Since the test of overidentifying restrictions does not reject ($\chi^2_{or}(19) = 21.10$, $p > 0.3311$), the PVAR parsimoniously encompasses the unrestricted VAR(2). Figure 10.9 shows the scaled residuals. The obvious feature of the graphs is the absence of any apparent outliers.

The estimates of this section show striking similarity to the estimates obtained using fixed based weights, especially for the interest rates and inflation equations. Although the coefficient of adjustment in the demand for extended money equation is lower than that of the previous section, it is considerably higher than those of individual country estimates, except the UK, giving strong evidence of the relative importance of the long run relations in the data generating process.

The extended money demand equation positively depends on the changes in the change of real income, the first cointegrating vector and the dummy variables for

Table 10.12: FIML Model Estimates

$\Delta(m-p)_{ma,t}$	$= 0.77(\Delta i)_{ma,t}$	$- 0.21(CI)_{t-1}$	$+ 0.021(D1991:1)$	$+ 0.019(D1980:4)$	$- 2.44$
	(4.677)	(-6.21)	(3.18)	(2.79)	(-6.19)
$\Delta RI_{ma,t}$	$= 9.16(\Delta i)_{ma,t-1}$	$+ 0.31(\Delta RI)_{ma,t-1}$	$+ 16.5(\Delta^2 p)_{ma,t-1}$	$+ 0.83(D1980:4)$	
	(1.56)	(2.51)	(1.60)	(2.04)	
				$-0.46(D1980:2)$	
				(-1.62)	
$\Delta^2 p_{ma,t}$	$= 0.44(\Delta^2 p)_{ma,t-1}$	$+ 0.19(\Delta i)_{ma,t-1}$	$- 0.006(D1980:2)$		
	(3.90)	(2.80)	(-1.66)		
$\Delta i_{ma,t}$	$= 0.28(\Delta i)_{ma,t-1}$	$+ 0.26(\Delta(m-p))_{ma,t-1}$	$+ 0.37(\Delta^2 p)_{ma,t-1}$	$- 0.001$	
	(2.41)	(2.61)	(2.19)	(-0.95)	

t ratios are in parentheses.

Table 10.13: Model Statistics

Model Diagnostic Tests

$F_{ar}^m(64,139)$	1.3 (0.10)
$F_{het}^m(130,264)$	0.94 (0.65)
$\chi_{nd}^{2m}(8)$	14.6 (0.06)

Residual Correlations

	$\Delta(m-p)_{ma,t}$	$\Delta RI_{ma,t}$	$\Delta^2 p_{ma,t}$	$\Delta i_{ma,t}$
$\Delta(m-p)_{ma,t}$	0.68%	0.09	-0.07	0.69
$\Delta RI_{ma,t}$	-0.05	4.01%	0.25	0.19
$\Delta^2 p_{ma,t}$	0.02	0.23	0.50%	-0.20
$\Delta i_{ma,t}$	-0.024	0.20	-0.14	0.75%

unification and interest rate. The effect of unification captured by the dummy variable for unification is stronger for this equation than in the previous section, with a high t-statistic. The first lag of differenced income affects the interest rate equation positively, the coefficient of which is very close to that obtained in the fixed base period weights estimates. Moreover, the dummy variables D1980:2 and D1980:4 effectively capture the unexplained outliers in the inflation equation. The basic difference of the short run estimates of this section from those of fixed base period weights estimates is that the variables in the model contribute to the estimation of the area - wide income equation, which depends positively on its first lag and the first lags of differenced real money and inflation. Additionally, the model statistics, given in Table 10.13, are all insignificant, matching the valid reduction from the parsimonious VAR. Furthermore residual correlations from the FIML model are also reported as correlations below the diagonal in Table 10.13, where the residual standard deviations are on the diagonal and the reduced form correlations are presented above the diagonal. Table 10.13 reveals low correlations between the structural residuals.

One-step forecast analysis is performed for the time period 1992:1-1993:4 to test the constancy of the model. Figure 10.11 reports the one-step model based forecasts. The constancy of the model is accepted with almost every lag lying inside the individual 95 per cent confidence bars and the overall test statistic $F(32,46)=1.43$ ($p>0.1307$) is significant at ten per cent level, implying that the model is stable. The forecasts converge to their unconditional means for all equations. Figure 10.12 presents a sequence of one through eight step ahead from 1992:1 onwards with error bars of 95 per cent confidence intervals. The forecast converge to their conditional means.

10.6 Conclusion

In this chapter the properties of an EU - wide money demand have been investigated with reference to extended monetary aggregates obtained by adding appropriate

CBDs to the broad monetary aggregate. But firstly, the aggregation methods, which could be used in aggregating national variables, are examined. The advantages and disadvantages of aggregation are also explored. The comparison of previous studies of EU - wide money demand functions, summarized in section 10.3, provides insights for the following empirical analysis.

The estimations were carried out using two different data sets, which are aggregated using fixed base-period or moving average weights. The VAR estimates from models using both fixed-base period weights and moving average weights indicate that there is one cointegrating relationship in the long run which measures the extended money demand in real terms as a function of income, inflation and interest rates. The two demand for money functions show striking similarities, with an income elasticity higher than unity, and negative effects from inflation and interest rates. Furthermore, the German Unification dummy captures the outlier strongly in the short run money demand equation. Even though the unification dummy has the correct sign in the short-run equation indicating that there has been an increase in the demand for money at that period, in the long-run it has a negative coefficient. Considering that there has been a recession in the EU countries in the early 1990s, this dummy variable could be attributable to this recession.

In the literature, two aggregation methods are generally used for income and money: fixed base period exchange rates and the current exchange rates. It is widely reported that the results are sensitive to the alternative aggregation methods. This could be due to the fact that the variables obtained using current exchange rates show greater volatility than those obtained using fixed- base period exchange rates, something which can be attributed to the variation in exchange rates. By using moving average current exchange rates the volatility in the exchange rates is smoothed. We expected to obtain similar results using variables aggregated using moving average current exchange rates and fixed-base period exchange rates. Thus our results indicate that the results are insensitive to the aggregation method, as far as the volatility in the exchange rate are corrected.

When the short-run equations are examined, it can be seen that the extended money demand equations have high adjustment coefficients, 0.26 and 0.21 for fixed base-period and moving average weight models respectively, which are larger than the individual country estimates. This supports the view that the area-wide money demand estimation is an effective solution to the specification problem encountered in the national equations. This also suggests a relatively faster adjustment to the deviations from the long-run equilibrium at the EU - wide level than at the national level, and suggests that impulses coming from monetary policy instruments would be quickly transmitted to economic activity. Furthermore, the empirical analysis also appears that the EU - wide demand for extended money function is stable, suggesting that an area - wide monetary policy would be economically effective.

Figure 10.1: GNP in the EU

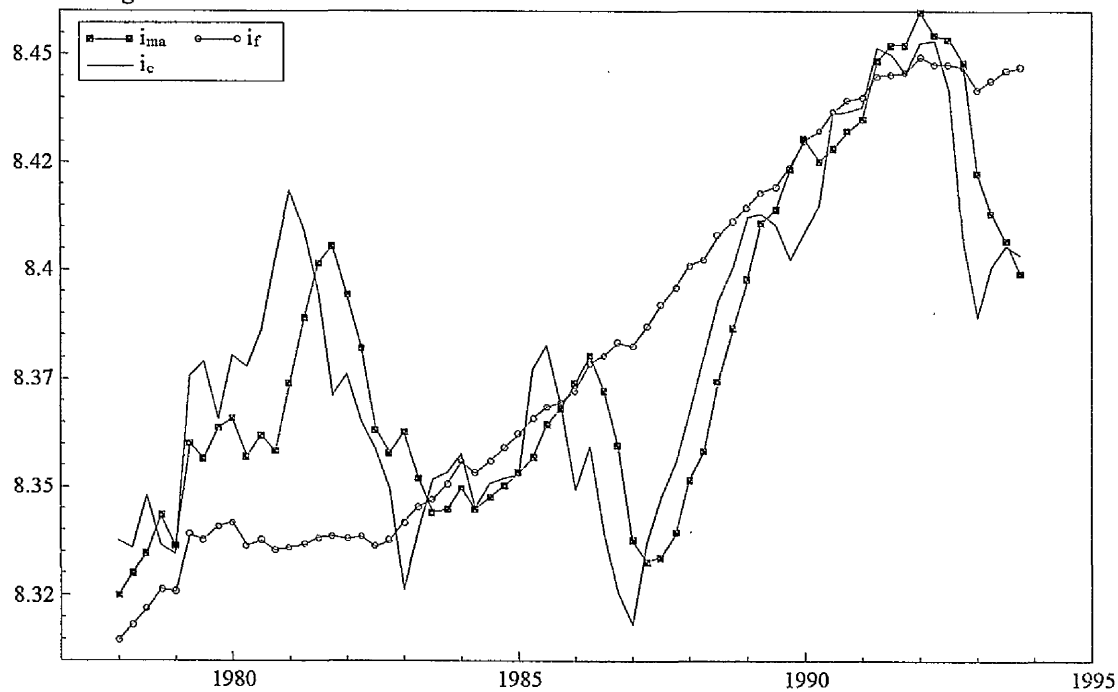


Figure 10.2: Real Extended Money in the EU

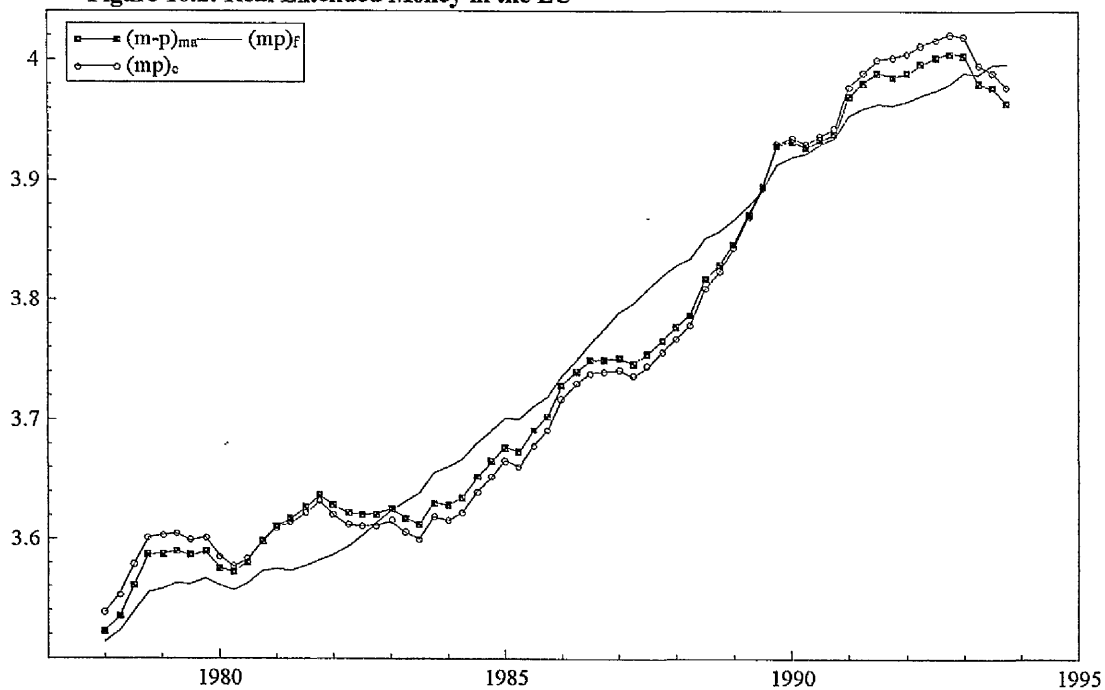


Figure 10.3: Inflation in the EU

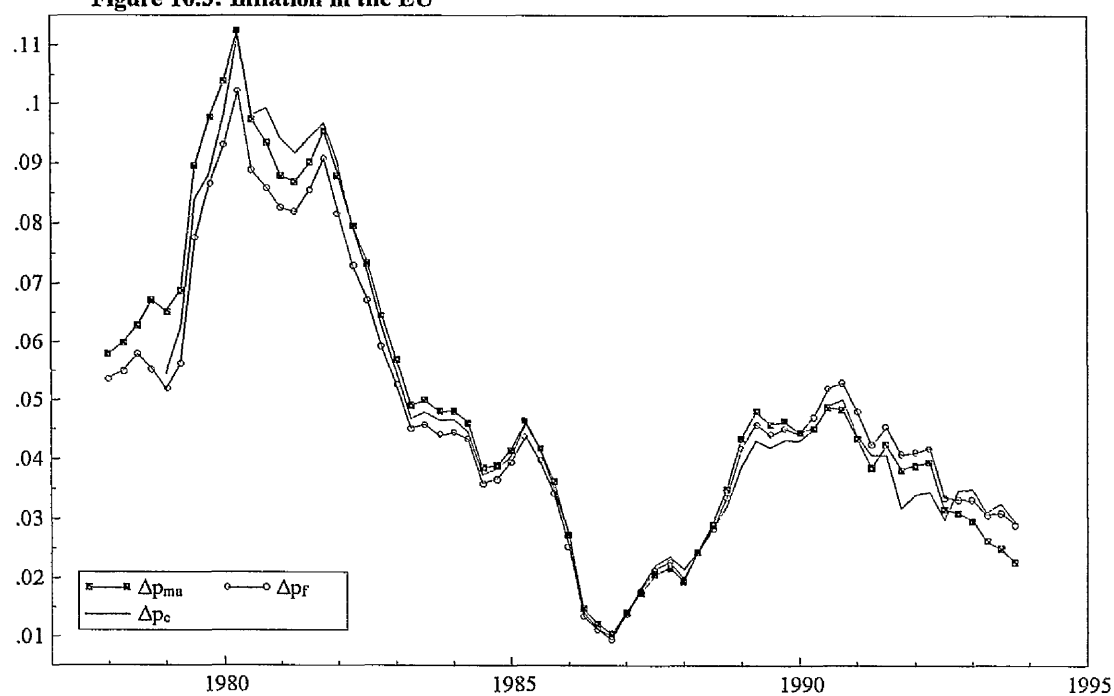


Figure 10.4: Long-term Interest Rates in the EU

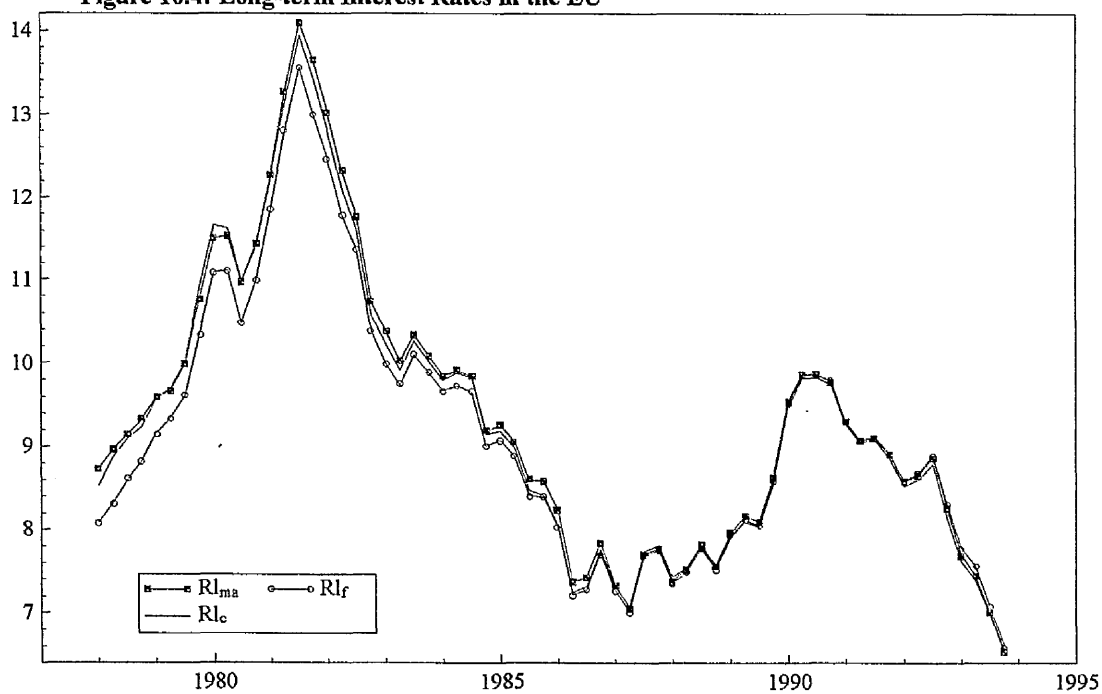


Figure 10.5: Scaled Residuals of the Fixed Base Model

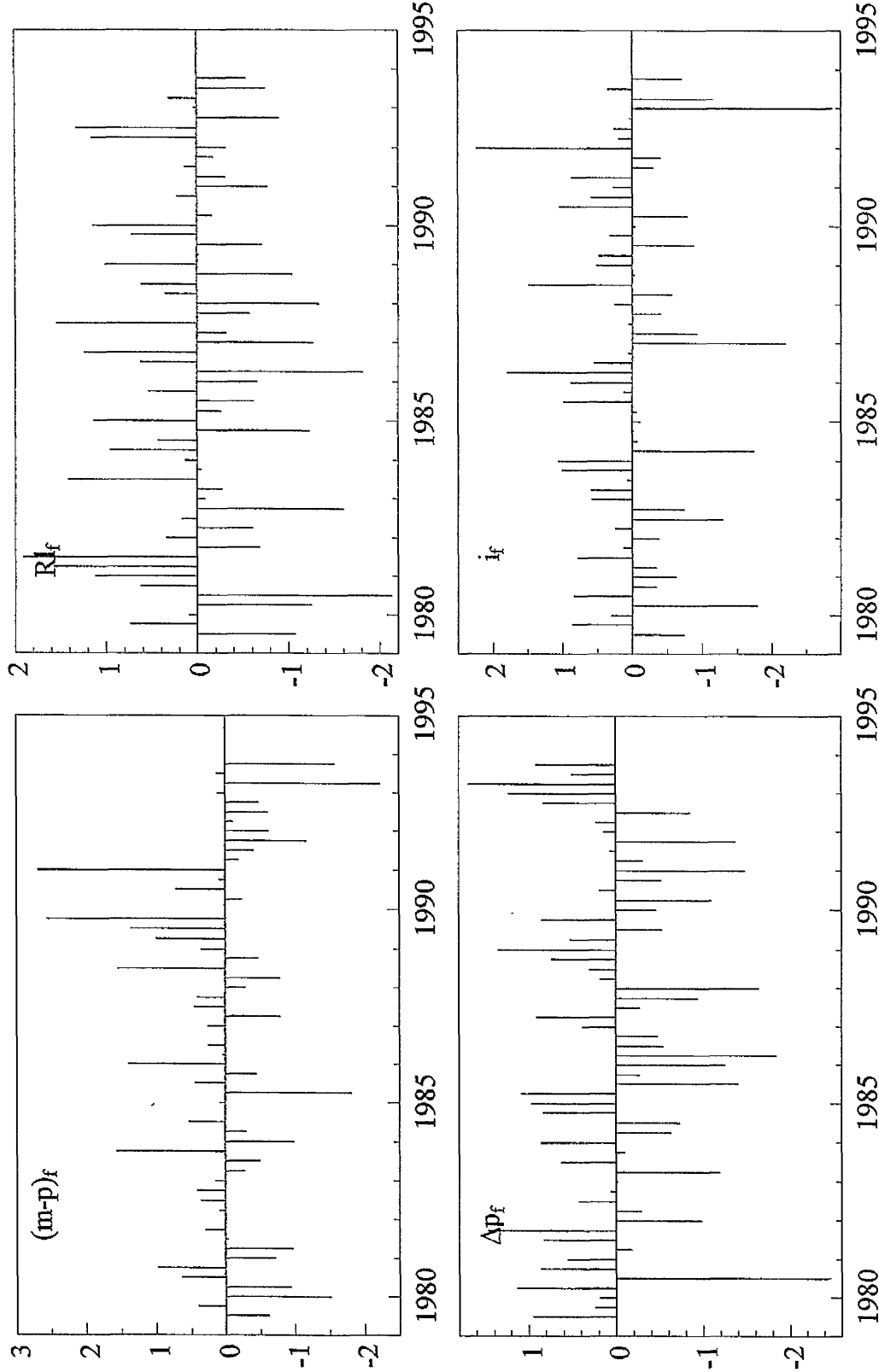


Figure 10.6: Cointegration Vectors of the Fixed Base Model

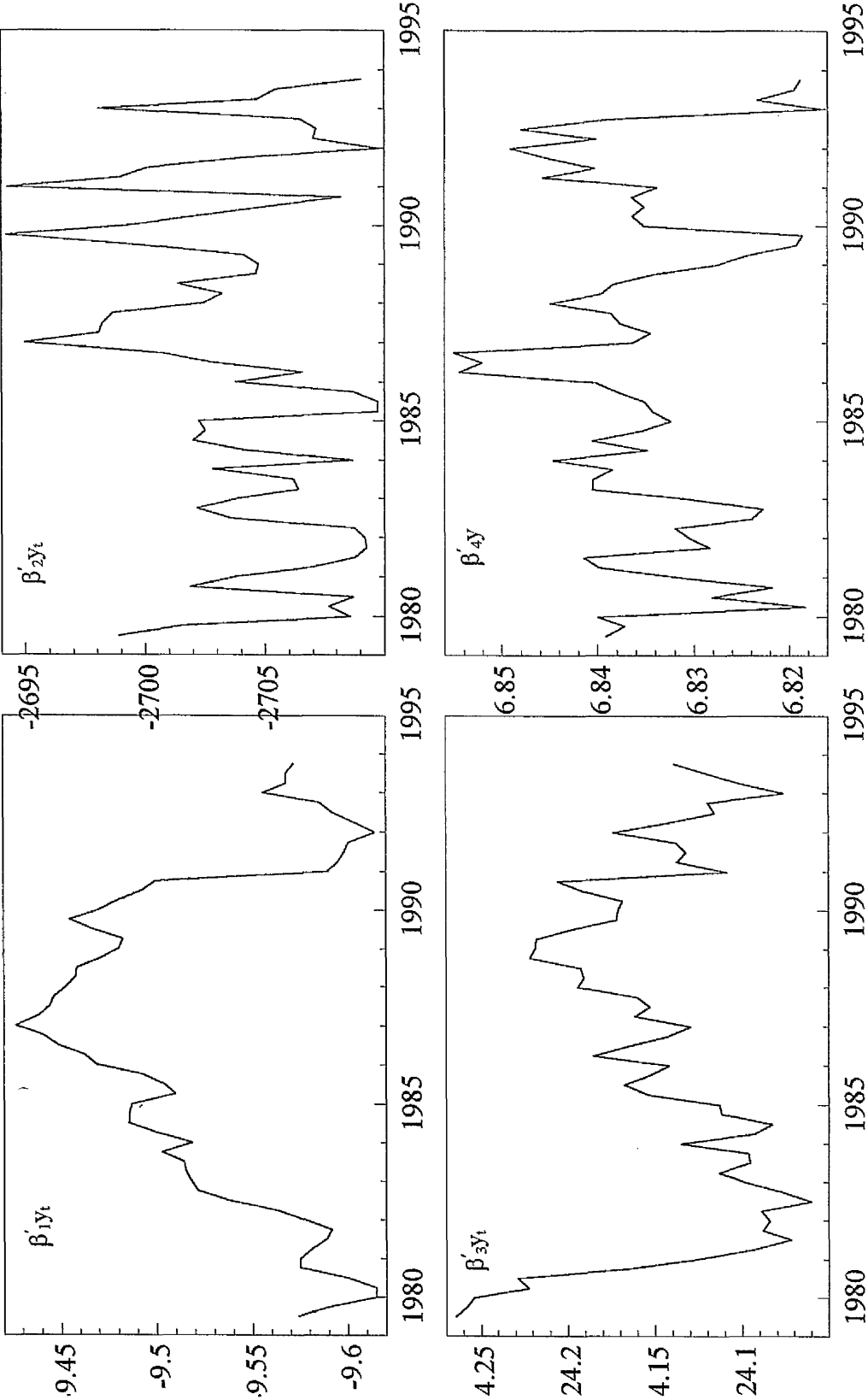


Figure 10.7: 1-Step Ahead Forecasts

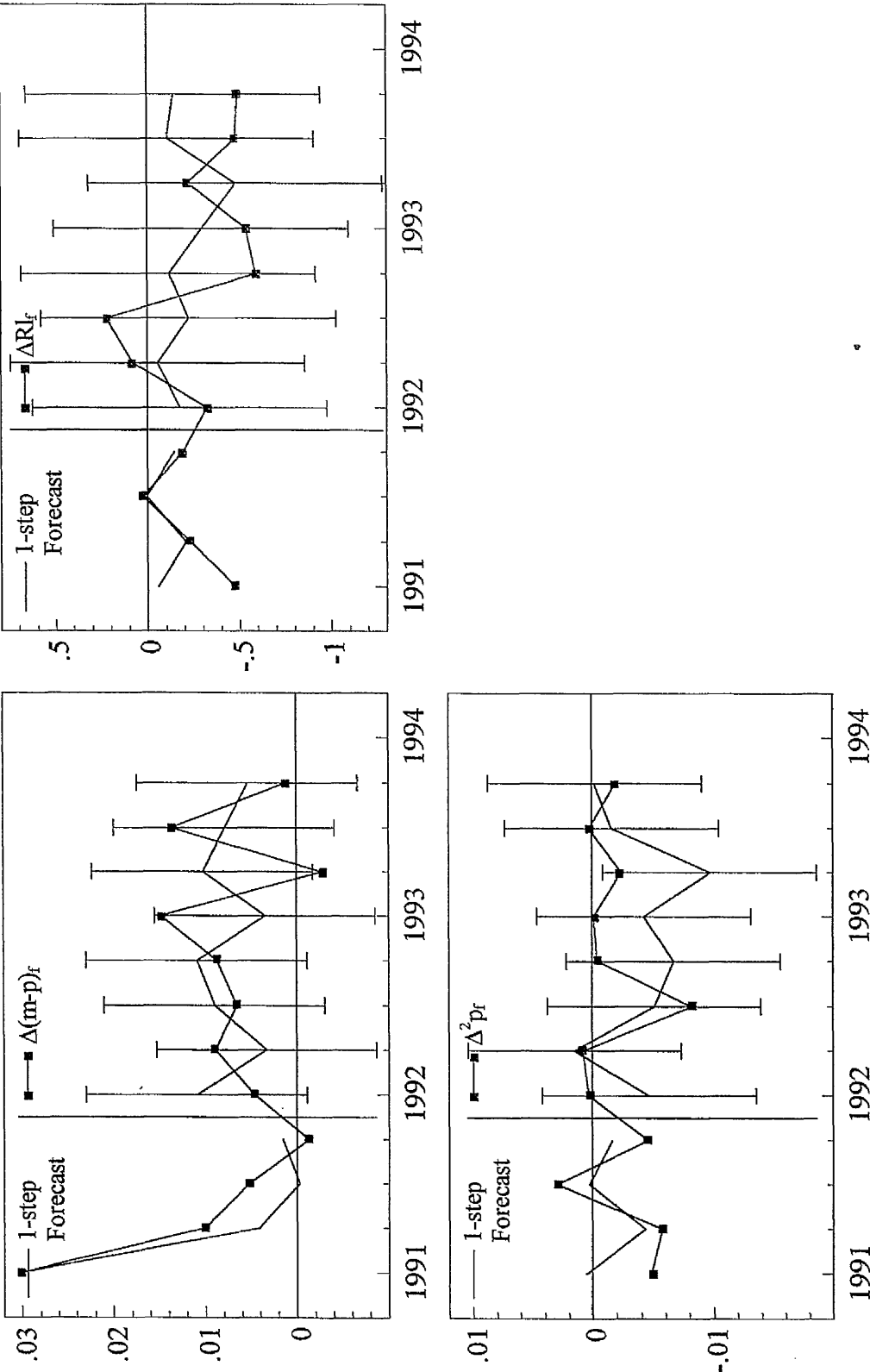


Figure 10.8: 8-Step Ahead Forecasts of the Fixed Based Model

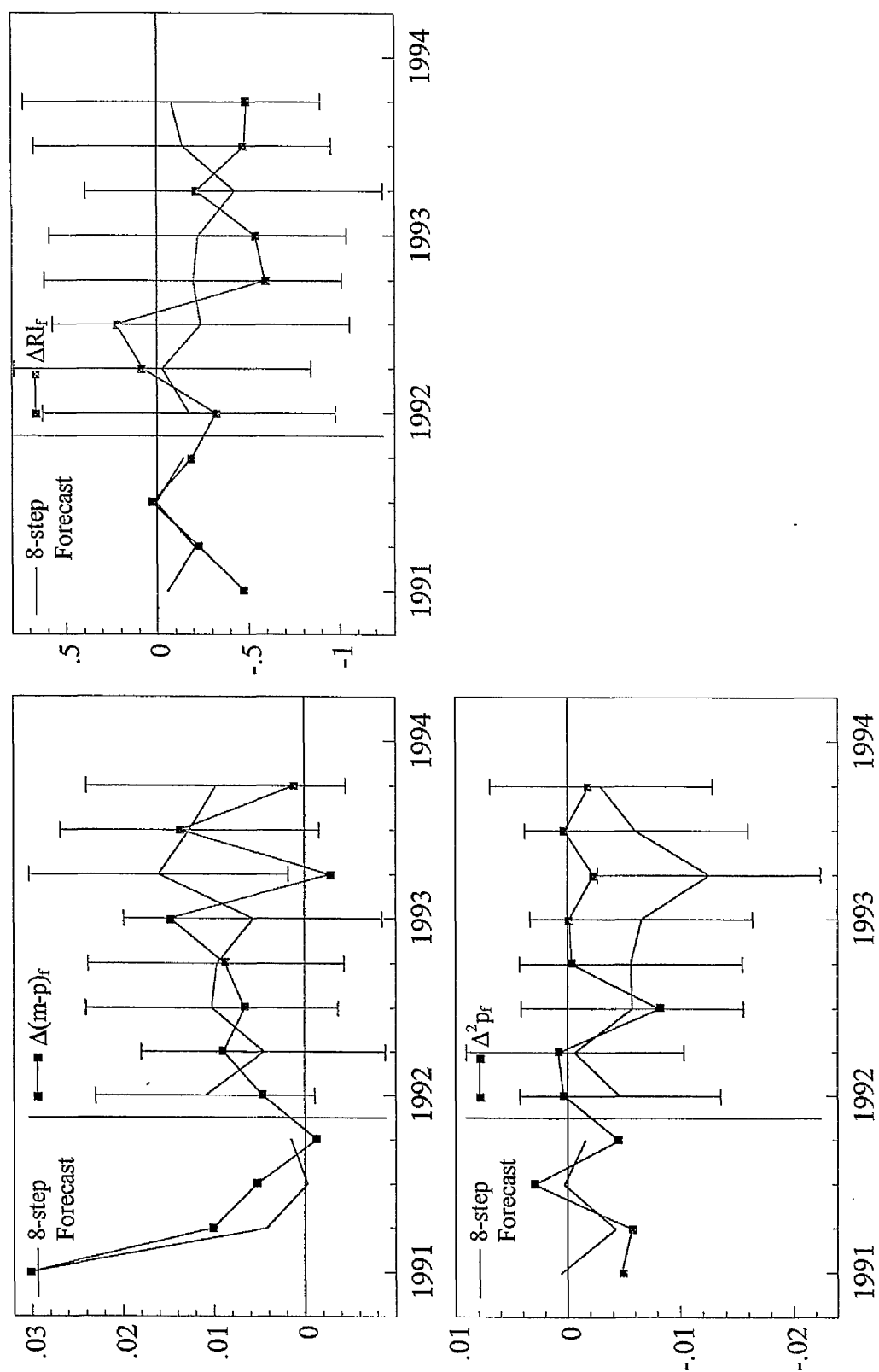


Figure 10.9: Scaled Residuals of the MA Model

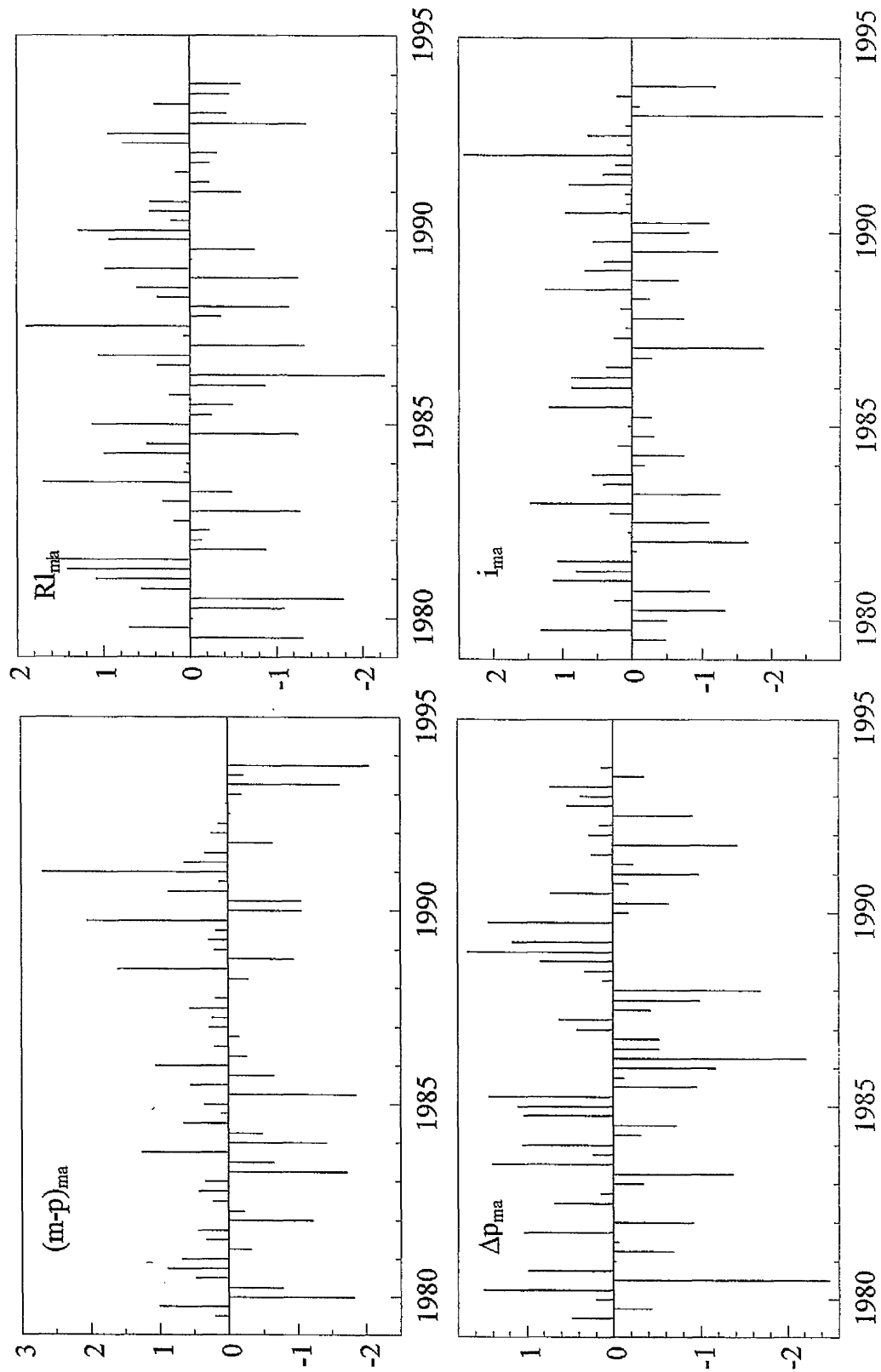


Figure 10.10: Cointegration Vectors of the MA Model

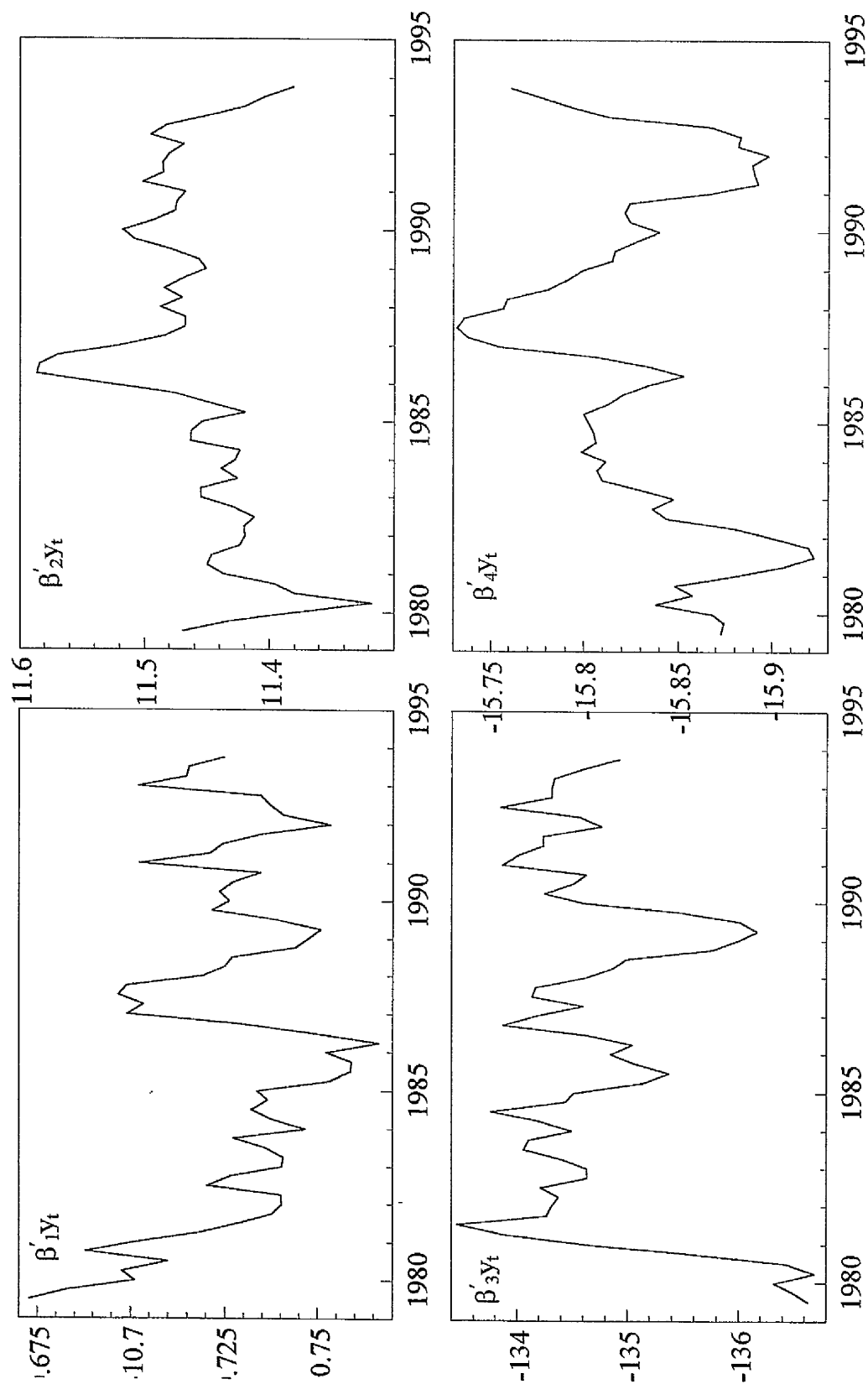


Figure 10.11: 1-Step Ahead Forecasts of the MA Model

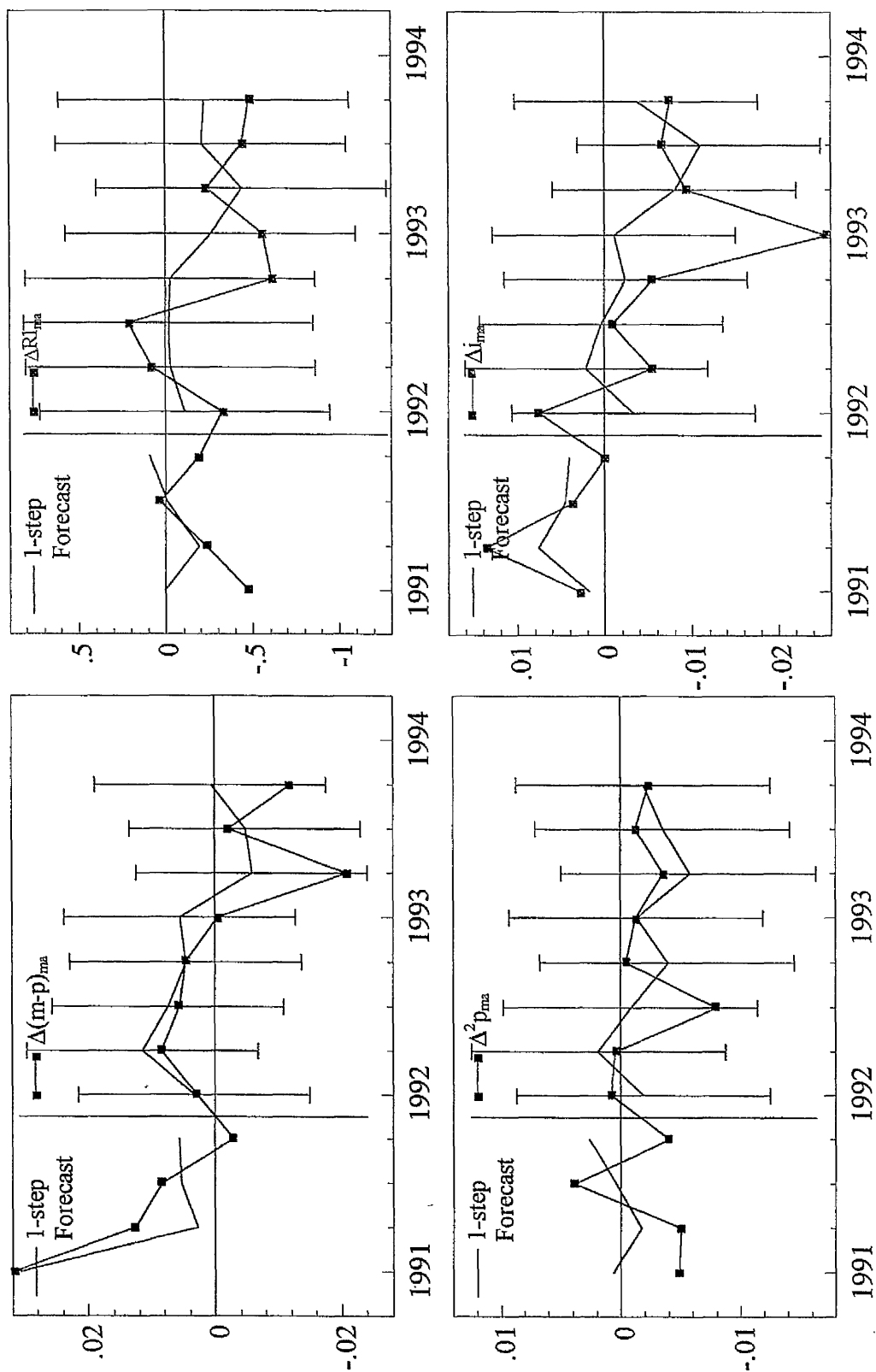
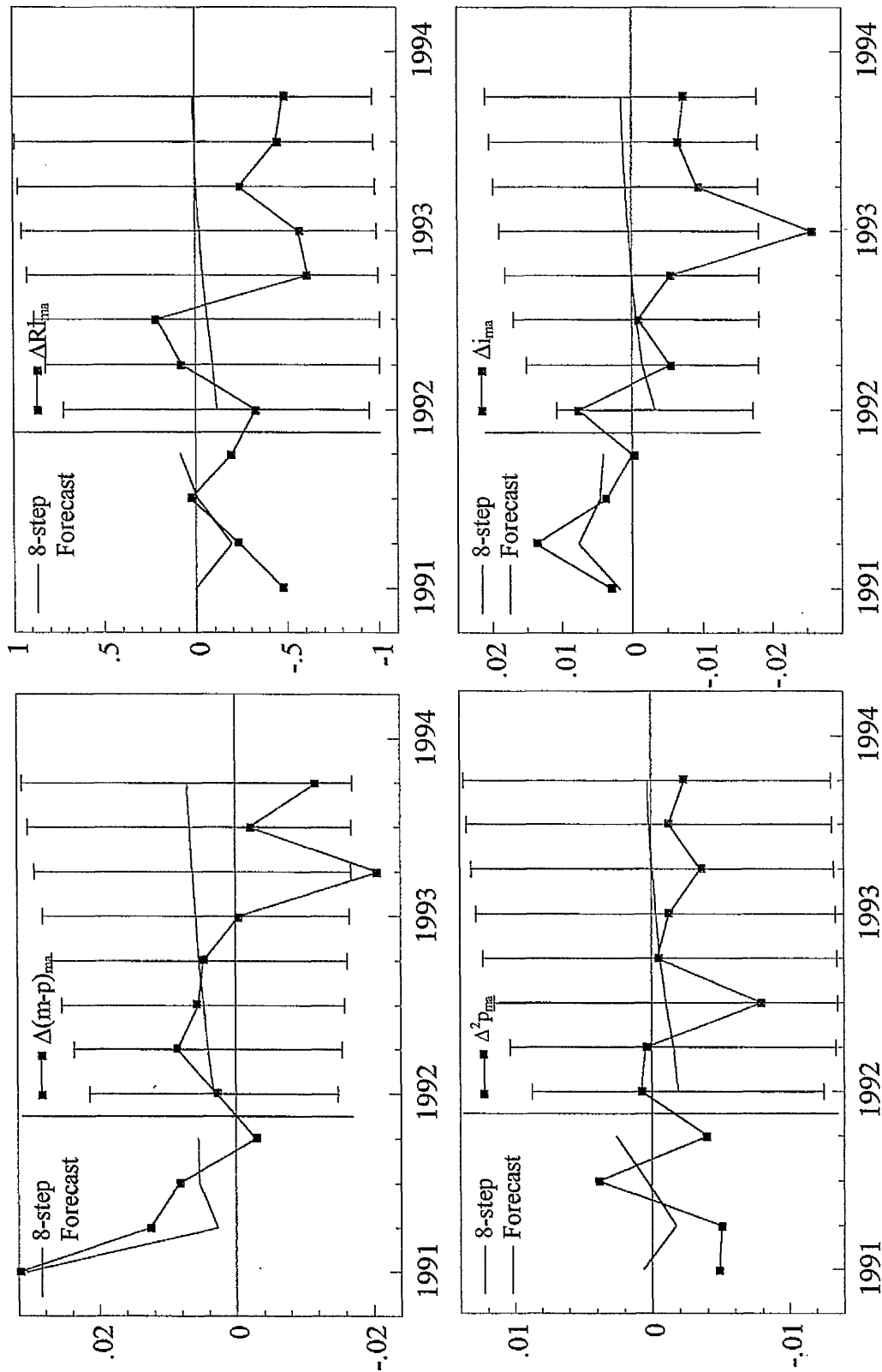


Figure 10.12: 8-Step Ahead Forecasts of the MA Model



CHAPTER 11

CONCLUSION

This chapter summarizes the results of the earlier chapters and reaches some broader conclusions. This thesis aimed to test the implications of currency substitution for the stability of the extended money demand for five EU countries as well as an area-wide demand for extended money. The main motivation of the thesis was the process of financial integration in EU countries and the increased degree of currency substitution, which is reflected by the increased amount of foreign currency deposits held by EU residents. It was argued that currency substitution may render the monetary policies of closely linked EU countries more interdependent than before and lead to instability in conventional national demand for money functions, but notwithstanding this an area-wide demand for money function could be stable. However, if an extended monetary aggregate is defined according to some criterion which include the relevant cross-border deposits (CBDs), these international policy interdependence effects can be internalized and a stable national demand for money function can be obtained.

Chapter 2 reviewed alternative approaches to currency substitution, and discussed some measurement issues. It also presented alternative models of currency substitution and discussed the implications of currency substitution. Although there is no agreement as to the precise definition of currency substitution, it can be broadly defined as the substitution of foreign currency and foreign currency denominated bonds for domestic ones. In EU countries currency substitution tends to be symmetric where agents choose to hold different currencies on the basis of whether they yield superior characteristics to other currencies. However in many less developed countries, where inflation is high, currency substitution is asymmetric in that foreign money, generally the US dollar replaces the domestic money. This extreme case of currency substitution is generally called dollarization. In these economies economic agents substitute the US dollar for the rapidly depreciating domestic currency, thus reversing Gresham's Law.

For currency substitution to have economic importance, it is not only necessary that residents should hold foreign currency balances, but that the level of these balances should change in response to changes in domestic and economic variables. It is argued that the increased amount of cross-border deposits since the late 1980s reflects increased currency substitution in EU countries. Among several alternative categories of CBDs, foreign currency deposits of residents held at domestic banks or banks abroad are of greatest importance as they reflect pure currency substitution. Since these CBDs are not included in the traditionally defined monetary aggregates, these latter may not reflect the true amount of money demanded in a country. Accordingly we redefined national monetary aggregates as extended monetary aggregates by including all holdings of foreign currencies as well as holdings abroad of the domestic currency. As economic agents cannot be resident in more than one country, this extended monetary aggregate should be free from any double counting or omissions.

Furthermore, alternative models of currency substitution were also presented in Chapter 2 where the implications of currency substitution were discussed. It was argued that flexible exchange rates would not insulate a country's monetary policy from external influences, if there is currency substitution. In a two country world, when the foreign country employs an expansionary monetary policy, inflation would be transmitted between the two countries. The degree to which inflation would be transmitted would be proportional to the degree of currency substitution between the currencies. Additionally, financial integration, especially in the EU countries, results in foreign economic variables affecting domestic money demand, thus strengthening the links between the money demands of these countries. This, in turn together with currency substitution, can be expected to lead to instability in the national money demand functions. Consequently, there would be a case for individual EU countries to cooperate and seek to control an area-wide monetary aggregate rather than to pursue independent monetary policies.

The advantages and disadvantages of cross-border monetary aggregation are

summarized in Chapter 3. It is argued that disadvantages stemming from assuming the same structure of national money demand functions may decline as financial integration in the EU continues. Furthermore the econometric modelling technique employed in this thesis allows the data to determine the long-run and short-run structure of the demand for the money function without assuming a priori the same structure for all individual country money demand functions. Chapter 4 gives an account of the vector autoregressive modelling which is employed in this thesis. Vector autoregressive modelling with cointegration analysis enables us to test a number of economic hypotheses about the behaviour of variables.

From Chapter 5 to Chapter 9 demand for extended money functions are estimated for Germany, France, the United Kingdom, the Netherlands and Italy respectively. The variables used for each country are extended money, real GDP, the consumer price index or GDP deflator and the long-term interest rate. An area-wide demand for extended money is estimated in Chapter 10, where the variables are obtained by aggregating national figures. Two alternative conversion methods are used in aggregating national variables. Quantity variables are converted using a) fixed base-date exchange rates, where the base period is the fourth quarter of 1989, and b) moving average current exchange rates. For interest rates and prices, the income shares of each country in the aggregate income are used as the weights. Income shares are also calculated by the two methods mentioned above. One of the objectives of using two different aggregation methods was to determine if the results are sensitive to the aggregation method.

Table 11.1 summarizes our estimates of the long-run demand for extended money functions in 5 EU countries as well as for the aggregate estimate using both aggregation methods. In all cases, seasonally adjusted data are available for the time period 1978:1-1993:4. The estimation period varies according to the lag-length of the VAR model (1978:3-1993:4 for France, the UK, the Netherlands; 1979:1-1993:4 for Germany). A slightly shorter sample period is preferred for Italy (1980:1-1993:4), and the area-wide estimation, (1979:3-1993:4), due to considerations reported in the

relevant chapters. In addition to the four stochastic variables mentioned above, a dummy variable representing German unification, which takes the value of 1 starting from 1991:1, is included in the German, and Dutch demand functions and in the area-wide money demand estimates. This assumes that German unification would have long-run effects on the demand for money functions. Furthermore, a trend is constrained in the long-run dynamics of the model on the assumption, discussed in Chapter 5, that it would capture the financial innovation that occurred in the estimation period. In Table 11.1 ECM denotes the adjustment coefficient in the short-run demand for money function. Moreover, the F-test statistic for stability analysis discussed in Chapter 4, is also given in each case.

A comparative analysis of the estimates presented in Table 11.1 indicates that all the extended money demand functions are homogeneous of degree one in prices. With the exception of Germany and the two aggregate estimations, all demand for money functions have unitary income elasticities. For single country estimates the long-run interest rate semi-elasticity ranges from -0.002 for Italy to -0.035 for Germany. The inflation elasticity in these country estimates ranges from -0.035 for Germany to -3.13 for Italy. However, surprisingly, the Dutch demand for extended money does not appear to depend on changes in the long-term interest rate. When the demand for traditional money is estimated for the Netherlands, it is observed to be sensitive to changes in long-term interest rates. Thus it would appear that the extension of traditional monetary aggregate may render the demand for the extended money insensitive to interest rate changes, as in the Netherlands. The trend variable which is supposed to capture financial innovation over the sample period, has a positive sign for all estimations and ranges from 0.0017 for France to 0.015 for the Netherlands. In the case of the Netherlands, the money stock grew at high rates, despite low and decreasing inflation. This would seem to be due to the combined effects of the policy of pegging the Guilder to the DM, deregulation of the Dutch financial markets, and the abolition of exchange controls and this is reflected in a comparatively high trend coefficient.

Chapter 11: Conclusion

Table 11.1: Estimates of the Long-Run Demand for Extended Money

Countries	Aggregation Method	Long-Run Elasticities			ECM			Stability F-Test
		Price level	Real income	Long-term interest rate	Rate of inflation	Trend	German Unification Dummy	
Germany		1	2.21	-0.035	-0.035	0.0018	-0.028	1.45 (0.11)
France		1	1	-0.008	-0.67	0.0017	-	1.46 (0.11)
UK		1	1	-0.013	-0.31	0.012	-	0.99 (0.48)
The Netherlands		1	1	-	-0.77	0.015	-0.019	0.49 (0.94)
Italy		1	1	-0.002	-3.13	0.005	-	1.78 (0.04)
Aggregate	Fixed-base exchange rates	1	1.44	-0.003	-0.74	0.006	-0.071	1.17 (0.30)
	Moving-average exchange rates	1	1.77	-0.015	-0.05	0.005	-0.033	1.43 (0.13)
Note: p-values are in parentheses.								

Estimates of German and Dutch demand for money functions include a unification dummy variable, as explained in Chapter 5. It is assumed that German unification could have long-run effects on both countries' demand for money functions as their monetary policies are closely linked. Even though the short-run functions report an increase in the money demand due to German unification, in the long-run demand for money functions the unification dummy has a negative coefficient for both countries, which may suggest that higher inflation rate encouraged substitution from broad money into real assets (Wolters et al. (1995)) This could also be due to the fact that European economies have been experiencing a recession since mid-1990 and the unification dummy coefficient could be attributable to this recession rather than German unification.

When the structures of the demand for money functions for individual countries are considered, it can be argued that apart from the Dutch money demand function, (which does not have any significant response to the long-term interest rates), other estimates show similarities. Even though the German money demand function has an income elasticity which is greater than one, it would not make a difference when the similarities of the structures of the demand for money function are concerned. Because VAR estimation and hypothesis testing in the context of cointegration analysis would allow the data to determine the structure of the demand for money functions. Thus the aggregation bias, which stems from assuming the same money demand structure for individual countries and is explained in Chapter 3, is expected to be small.

Examination of the area-wide demand for money reveals the dominance of Germany. In terms of share in the total income of these five countries, Germany has the largest share. The area-wide demand for money functions have income elasticities greater than unity, though not as large as that of Germany. In both equations the coefficients of the unification dummy variable are greater than that in the equation for Germany and with negative signs. This strengthens the assumption that the unification dummy coefficient could in fact be attributable to the recession in the European

Union countries which began in mid-1990. Furthermore, there is no substantial difference, except the inflation coefficient, between the area-wide demand for money estimates obtained using the two different aggregation methods. However, earlier studies which generally use fixed-base period and current exchange rate methods, report that estimates are sensitive to aggregation methods. It is possible that usage of the moving average current exchange rates instead of actual current-exchange rates, makes our estimates more reliable.

Table 11.1 also reports the adjustment coefficients of the short-run money demand functions, ECM, reflecting the speed of adjustment to any long-run disequilibrium. The adjustment coefficients of country money demand estimates range from 0.08 for the Netherlands to 0.24 for Italy. The area-wide demand equations have high adjustment coefficients, 0.25 and 0.21 for fixed base period and moving average weight models respectively, which are close to that of Italy, but higher than the remaining adjustment coefficients. This has important implications as mentioned in Chapter 10. Firstly, a higher adjustment coefficient for the area-wide demand for money indicates that deviations of the demand for money from its long-run equilibrium are eliminated faster compared to individual country demand for money functions. This could make monetary policy implementation easier on an area-wide level, because it implies that impulses coming from monetary policy instruments are quickly transmitted to economic activity. This could also justify the argument that countries whose economies are closely linked should pursue a joint monetary policy rather than pursuing national monetary policies. Secondly, a high value of the adjustment coefficient would suggest that the area-wide approach is an effective solution to internalize the spill-over effects between these countries, which could otherwise result in specification errors. Furthermore, stability F-tests presented in Table 11.1, indicate that all demand for money functions, country as well as area-wide, are stable at the 5 per cent level, as expected.

Our conclusions may now be summarised. We have provided the first study which investigates stability of the demand for extended money for five EU countries,

and for an area-wide extended monetary aggregate. Our findings would suggest that the demand for extended money in the five EU countries, as well as in the area as a whole, appears to be stable. Previous empirical studies in the five EU countries generally report instability in traditional money demand functions. The existence of apparently stable demand for extended money functions, thus, may indicate that including relevant cross border deposits in traditionally defined monetary aggregates improves the stability properties of the demand for money functions. This, in turn, strengthens the argument that currency substitution is likely to be one of the main reasons causing instability in traditionally defined aggregates.

The fact that the adjustment coefficient in the area-wide demand for money function is found to be greater than those of country estimates leads to several policy implications in the EU context. As this suggests that the adjustment to any long-run disequilibrium will be faster on an area-wide level, it would be more effective to pursue an area-wide monetary policy rather than pursuing national monetary policies. This is an important issue for the establishment of the European Monetary Union which necessarily involves a common monetary policy in the EU. The process of financial integration and the increased degree of currency substitution appear to make a common monetary policy feasible for EU countries from an economic point of view. Thus when the European Central Bank is established, it could realistically target an area-wide extended monetary aggregate as an intermediate target variable for a European money supply policy.

This thesis has investigated the monetary policy implications of currency substitution. Overall, we can plausibly argue that the integration of national and international financial markets, financial innovations and currency substitution lead to a more integrated Europe, where a common monetary policy could be feasible.

APPENDIX 1

DATA DEFINITIONS AND STATIONARITY ANALYSIS

This appendix provides definitions of all data used in the thesis (except those of CBDs which are explained in Appendix 2), along with the stationarity tests. All quantity variables are seasonally adjusted. Additionally the parameter stability Chow tests, which were used to see if German unification caused structural change in the German equations, are provided in section A1.3.

A1.1 Data Definitions

France

		Source
Broad Money	M3	OECD Quarterly Statistics
Real Income	Real GDP 1985 prices	IMF International Financial Statistics (IFS)
Price Index	Consumer Price Index (1985=100)	IMF IFS
Long-term interest rate	Government bond yield with 10 year maturity	IMF IFS

Germany

		Source
Broad Money	M3	Deutsche Bundesbank Monthly Bulletins
Real Income	Real GDP 1985 prices	IMF IFS
Price Index	Consumer Price Index (1985=100)	IMF IFS
Long-term interest rate	Government bond yield with 10 year maturity	IMF IFS

Italy

		Source
Broad Money	M2	Banca d'Italia Quarterly Bulletins
Real Income	Real GDP 1985 prices	IMF IFS
Price Index	GDP deflator (1985=100)	IMF IFS
Long-term interest rate	Government bond yield with 10 year maturity	IMF IFS

The Netherlands

		Source
Broad Money	M3H	The Nederlandsche Bank Quarterly Bulletins
Real Income	Real GDP 1985 prices	IMF IFS
Price Index	Consumer price index (1985=100)	IMF IFS
Long-term interest rate	Government bond yield with 10 year maturity	IMF IFS

The UK

		Source
Broad Money	M4	Office of National Statistics
Real Income	Real GDP 1985 prices	IMF IFS
Price Index	GDP deflator (1985=100)	IMF IFS
Long-term interest rate	Government bond yield with 10 year maturity	IMF IFS

A1.2 Stationarity Analysis

In this section of the study, conventional and seasonal unit root tests are applied to logarithms of the extended monetary aggregates (m), real extended monetary aggregates (m-p), consumer prices (or GDP deflator (p) for Italy and the UK)/, real income (i) and to the level of long term (RI).

Tables A1.1, A1.2, A1.3, A1.4, A1.5 and A1.6 present evidence relating to the Augmented Dickey Fuller tests for France, Germany, Italy, the Netherlands, the UK and the aggregate variables, respectively. The lag length is chosen according to the AKAIKE and SCHWARZ criteria. The second columns present results of the tests of integration of order one, and the third columns present tests of integration of order two. The results of the conventional unit root tests suggest that consumer prices are integrated of order two for all country as well as the aggregate, with the exception that Germany's price level which is stationary. However, when a longer sample period, 1960:1-1993:4, is considered, ADF tests indicate that they are integrated of order two as in other countries. Thus it is assumed that they are I(2) for the shorter sample period as well. Furthermore French GNP appears to be integrated of order two. But it is treated as if it is I(1) in the econometric analysis, because for 1960:1-1993:4 period unit root tests indicate that it is integrated of order one. Moreover, aggregate nominal money, obtained by fixed base period and moving average conversion methods, is integrated of order one. But real money balances, which are used in the estimations, are integrated of order two. All other variables are integrated of order one.

In addition to the conventional unit root tests, the tests suggested by Perron (1989), for variables which has a structural break, is applied to some of variables of Germany as German Unification in December 1990 causes breaks in the data. The results are presented in Table A1.7. Two different models are considered : one that permits an exogenous change in the level of series (model A) and the other permits an exogenous change in the level of series as well as in the rate of growth (model C). The following regressions, corresponding to models A and C, are constructed:

$$y_t = \mu + \Theta DU_t + \beta t + dD(TB)_t + \alpha y_{t-1} + \sum c_i \Delta y_{t-i} + e_t$$

$$y_t = \mu + \Theta DU_t + \beta t + \gamma DT_t + dD(TB)_t + \alpha y_{t-1} + \sum c_i \Delta y_{t-i} + e_t$$

where $DU_t = 1$ if $t > TB$, 0 otherwise; $DT_t = t$ if $t > TB$, 0 otherwise; $D(TB)_t = 1$ if $t = TB + 1$, 0 otherwise and TB denotes the break point. Model A is applied to monetary aggregates and model B is applied to real income. The results of P. Peron test suggests that we can reject the null hypothesis of unit root for all variables, in accordance with the conventional unit root tests.

Table A1.1: Unit Root Tests for France

Var	LAG	A-DF(X)	A-DF(DX)
m	1	-1.87	-1.94
p	1	-1.81	-1.06
y	1	-0.40	-2.23
y ^a	2	-2.33	-3.89*
m-p	1	-1.10	-4.06*
Rl	1	-2.38	-3.61*

Notes : Significant at 1% level (**), 5% level (*) and 10% level (+); and a denotes the longer sample period of 1960:1-1993:4.

Table A1.2: Unit Root Tests for Germany

Var	LAG	A-DF(X)	A-DF(DX)
m	1	-0.86	-5.30**
p	3	-3.79*	-1.49
p ^a	1	-2.47	-2.15
y	1	-1.34	-4.10**
m-p	1	-1.37	-4.35**
Rl	1	-2.41	-4.76**

Notes : Significant at 1% level (**), 5% level (*) and 10% level (+); and a denotes a longer sample period of 1960:1-1993:4.

Table A1.3: Unit Root Tests for Italy

Var	LAG	A-DF(X)	A-DF(DX)
m	1	-1.42	-5.37**
p	1	-1.94	-1.26
y	1	-2.22	-4.75**
m-p	1	-1.81	-5.22**
Rl	1	-2.18	-3.74*

Notes : Significant at 1% level (**), 5% level (*) and 10% level (+).

Table A1.4: Unit Root Tests for the Netherlands

Var	LAG	A-DF(X)	A-DF(DX)
m	1	-2.89	-6.48**
p	4	-1.55	-2.59
y	1	-1.87	-6.70**
m-p	1	-2.62	-4.56*
R	3	-2.69	-3.66*

Notes : Significant at 1% level (**), 5% level (*) and 10% level (+).

Table A1.5 : Unit Root Tests for the UK

Var	LAG	A-DF(X)	A-DF(DX)
m	1	-0.75	-3.27*
p	1	-2.79	-1.93
y	1	-1.04	-4.14*
m-p	1	-1.51	-3.54*
Rl	1	-2.53	-5.63**

Notes : Significant at 1% level (**), 5% level (*) and 10% level (+).

Table A1.6: Unit Root Tests for the Aggregate Variables

Var	LAG	A-DF(X)	A-DF(DX)
m_f	3	-0.50	-5.05**
m_{ma}	3	-2.10	-3.38*
p_f	1	-2.79	-2.93
p_{ma}	1	-2.14	-2.73
y_f	1	-2.44	-3.95*
y_{ma}	1	-2.55	-3.17*
$(m-p)_f$	1	-1.97	-3.68*
$(m-p)_{ma}$	1	-2.75	-3.39*
RI_f	1	-2.38	-4.59*
RI_{ma}	1	-2.45	-4.51*

Notes : Significant at 1% level (**), 5% level (*) and 10% level (+).

Table A1.7: P. Perron Tests for Unit Root

(a) Model A

	μ	θ	δ	d	α	c_1	c_4
m	0.53 (0.84)	-0.01 (-0.64)	0.0019 (1.16)	-.0004 (-.01)	0.91 ^a (9.33)	-0.07 (-0.7)	0.55 (5.92)
m-p	0.13 (1.23)	-0.02 (-1.83)	0.0016 (2.61)	0.0069 (0.31)	0.92 ^a (17.4)	-0.09 (-0.9)	0.60 (6.30)

(b) Model C

	μ	θ	δ	γ	d	α	c_1	c_4
y	0.75 (1.43)	.08 (0.90)	.0006 (1.71)	-.0010 (-.84)	0.15 (8.07)	0.89 ^a (12.3)	-0.045 (-0.65)	-

Note: a denotes significant at 1% level of significance and the figures in parentheses are t-ratios

A1.3 Parameter Stability Tests

Two types of Chow test are generally used to test for statistical parameter stability. The idea of these tests is that we have some known data T_1 , after which we believe a structural break may have occurred in the model. Assuming that the general model has the form

$$y_t = \beta'_1 x_t + u_t \quad (\text{A1.1})$$

where $u_t \sim N(0, \sigma^2_1): t < T_1$, and

$$y_t = \beta'_2 x_t + u_t \quad (\text{A1.2})$$

where $u_t \sim N(0, \sigma^2_2): t \geq T_1$. The total number of observation is $T = T_1 + T_2$. $T_1 = 1, \dots, T_1$ and $T_2 = T_1 + 1, \dots, T$.

The null hypothesis that the the model is structurally stable is

$$H_0: \beta_1 = \beta_2, \quad \sigma^2_1 = \sigma^2_2$$

which involves two separate hypotheses

$$H^1_0: \beta_1 = \beta_2$$

$$H^2_0: \sigma^2_1 = \sigma^2_2$$

A complication arises in constructing the tests of this hypothesis in the choice of T_1 . In order to estimate both models (A1.1) and (A1.2) we require $T_1 > k$ and $T - T_1 > k$, where k is the number of regressors in the model. This is simply a requirement that there are sufficient degrees of freedom in both subsample to estimate the models. But we need to consider a test statistic for the case where both $T_1 > k$ and $T - T_1 > k$ holds, and when it does not.

CASE 1: $T_1 > k$ and $T - T_1 > k$

In this case, we estimate the model over the whole period and each of the subsamples. Define RSS_T as the residual sum of squares for the model estimated over the whole sample period, RSS_1 as the residual sum of squares over the period with T_1 observations and RSS_2 as the residual sum of squares over the period with T_2

observations. Then under the nul hypothesis the test statistic c_1

$$c_1 = \left(\frac{RSS_T - (RSS_1 + RSS_2)}{RSS_1 + RSS_2} \right) \left(\frac{T-2k}{k} \right) \quad (\text{A1.3})$$

is distributed as $F(k, T-2k)$. c_1 is commonly known as the chow test.

CASE 2: $T_2 < k$

When there are not enough degrees of freedom to estimate β_2 or RSS_2 directly, a second version of the Chow test is possible:

$$c_2 = \left(\frac{RSS_T - (RSS_1)}{RSS_1} \right) \left(\frac{T_1 - k}{T_2} \right) \quad (\text{A1.4})$$

This is distributed as $F(T_2, T_1 - k)$ under the null hypothesis.

In Chapter 5 the second Chow test is used as the degrees of fredom in the second sub-sample is less than the number of regressors in each equation.

APPENDIX 2

THE DEFINITION OF MONETARY AGGREGATES IN THE FIVE EU COUNTRIES AND SOURCES OF CBDs

In this study, the broad monetary aggregates are used in order to sustain the consistency between the monetary aggregates of each country. The data is obtained from the publications of the central banks of respective countries or from OECD bulletins (France). This appendix presents an overview of national monetary aggregates. Furthermore, the definitions of CBDs and their sources are also reviewed.

A2.1 The Definitions of National Broad Monetary Aggregates

The national definitions of monetary aggregates in France, Germany, Italy, the Netherlands and the UK are given below.

A2.1.1 France

France has four officially defined monetary aggregates and the definitions of these are given below.

M1 consists of banknotes, coin and FF checkable sight deposits with the credit institutions, the Treasury and Post Office. It excludes foreign currency sight deposits.

M2 is equal to M1 plus FF interest-bearing non-checkable sight deposits with credit institutions and the Treasury, and non-checkable passbook savings account.

The M3 aggregate comprises M2 plus foreign currency denominated deposits, all non-negotiable term assets managed by credit institutions, the Treasury and the Post Office, negotiable debt instruments issued by credit institutions as well as units of securitised loan funds maturing less than five years and shares in short-term Undertakings for Collective Investment in Transferable Securities.

M4 consists of M3 plus Treasury bills and commercial paper and medium-term notes issued by non-financial companies. M4 includes FF and foreign currency deposits of both non-bank residents and non-bank non-residents (CBD1, CBD3, CBD5 and CBD7 of Table A2.1). Hence, this definition is close to the definition of extended monetary aggregate defined according to the criteria of location of the intermediary. Since M3 is the nationally targeted variable and the difference between M4 and M3 is small, national M3 is chosen for the analysis. Seasonally adjusted, quarterly M3 data is obtained from OECD Statistics Quarterly Bulletins.

A2.1.2 Germany

The official definitions of M1, M2 and M3 are as follows:

M1 consists of currency in circulation (excluding credit institution cash balances) and domestic nonbanks' sight deposits.

M2 is M1 plus domestic nonbanks' time deposits with less than four years to maturity.

M3 is M2 plus domestic nonbanks' saving deposits at statutory notice. Germany's M3 includes non-bank residents' DM and foreign currency deposits held in Germany. That is CBD1 and CBD5 of Table A2.1 is included in M3.

M3 extended is defined as M3 plus domestic non-banks' deposits with domestic credit institutions' foreign branches and foreign subsidiaries and bearer bonds in the hands of domestic non-banks. M3 extended includes a part of residents DM and foreign currency deposits held abroad, which comprise CBD2 and CBD6 of Table A2.1. Hence, the definition of M3 extended is close to that of extended monetary aggregate defined according to residence of holder criteria, which consists of residents domestic and foreign currency deposits held with banks at home or abroad (Sum of CBDs 1,2,5 and 6). M3 data is obtained from Bundesbank Monthly Reports and used in this thesis.

A2.1.3 Italy

Italy has three officially defined monetary aggregates: M1, M2 and extended M2.

M1 consists of currency in circulation, residents' current accounts with banks in lire and foreign currency, current accounts with the post office, net of those held by banks, current accounts with other bodies, banker's drafts issued by the Bank of Italy and by credit institutions.

M2 is equal to M1 plus residents' lire savings and time deposits with banks, certificates of deposit and savings accounts with the post office. Italy's M2 corresponds to the 'harmonized' definition of M3 within the European Union.

Extended M2 comprises of M2 and residents' deposits with foreign branches of Italian Banks. Italy's broad money M2 includes domestic and foreign currency deposits of non-bank residents. Hence, CBD1 and CBD5 are included in M2. Extended M2, on the other hand, includes domestic and foreign currency deposits of non-bank residents with branches of Italian Banks abroad. That is a part of CBD2 and CBD6 are included in extended M2. Accordingly, similar to Germany's M3 extended, Italy's extended M2 is close to the extended monetary aggregate defined based on the criterion of residence of holder. National M2 data is obtained from Bank of Italy Bulletins.

A2.1.4 The Netherlands

Netherlands has three officially defined monetary aggregates: M1 and M2.

M1 consists of notes and coin, and demand deposits with banks and giro institutions.

M2 is equal to M1 plus claims on central government and local authorities, short term time deposits, foreign currency deposits and liquid saving deposits.

M3H is the harmonized monetary aggregate and is equal to M1 plus short-term time deposits, short-term foreign currency deposits and short-term saving deposits.

This last definition includes domestic and foreign currency deposits of non-

bank residents, that is CBD1 and CBD5 of Table A2.1 are included. The national M2 data is obtained from Netherlands Bank Quarterly Bulletins. As the data of M3H is only available from 1983 onwards, the data is extended backwards applying the quarterly changes of M2 to M3H.

A2.1.5 The UK

UK currently has three officially defined monetary aggregates: M0, M4 and M3H, definitions of which are given below.

M0 comprises notes and coins in circulation outside the bank of England plus bankers' operational deposits with the Bank.

M4 consists of the UK non-bank, non-building society private sector's holdings of notes and coin and all sterling deposits at UK banks and building societies.

M3H is the 'harmonized' monetary aggregate applicable to the UK designed to facilitate comparisons among the member states of the EU. M3H comprises of M4 plus foreign currency deposits held by the non-bank non-building private sector with banks and building societies in the UK, and sterling and foreign currency deposits held by UK public corporations with bank and building societies in the UK.

Until December 1992, the UK had a nationally defined M2. But in December 1992, the definition of deposits which-along with notes and coin- comprises M2 was changed. Henceforth M2 comprises the UK non-bank non-building society private sector's holdings of notes and coin together with its sterling denominated retail deposits with the UK banks and building societies. M2 becomes a subset of M4, described as the retail component of M4, from December 1992.

Since M4 includes all sterling demand and time deposits of non-bank non-building private sector, it is preferred to other monetary aggregates in this study, as almost all of the CBDs are time deposits. M4 includes all sterling deposits held by residents with UK banks and building societies which corresponds to CBD1 of Table A2.1. But, as mentioned above, it does not include foreign currency deposits of

residents with UK banks and building societies (CBD5), although the nationally defined monetary aggregates of most other countries include these.

M3H, the harmonized monetary aggregate, on the other hand, includes foreign currency deposits held by residents with UK banks and building societies (CBD 5 of Table A2.1). Hence, this definition is close to M3 definition of Germany but not to Germany's extended monetary aggregate. M4 data, which is obtained from Office of National Statistics Bulletins is used in this thesis.

A2.2 The Extended Monetary Aggregates

In order to obtain the extended monetary aggregates, we add the relevant CBDs to the nationally defined broad money. But their definitions across countries are not standard. Therefore, we should first examine which CBDs they include; then calculate the extended aggregates. CBD2 and CBD6 are not included in the national monetary aggregates as they are held with banks abroad. CBD8 on the other hand refers to rest of the world's money, thus not relevant. Table A2.1 illustrates which remaining CBDs are included in national monetary aggregates for each country.

Table A2.1: Composition of National Monetary Aggregates

Country	National Money	CBD1	CBD3	CBD5	CBD7
France	M3	*	-	*	-
Germany	M3	*	-	*	-
Italy	M2	*	-	*	-
Netherlands	M3H	*	-	*	-
UK	M4	*	-	-	-

* this component is included in the monetary aggregate.

- this component is not included in the monetary aggregate.

From Table A2.1, it can be seen that all of the national monetary aggregates

include national currency deposits of the residents held with domestic banks. Furthermore, none of them contains non-residents deposits either in domestic or foreign currency, all aggregates, except that of the UK, contain the foreign currency deposits of residents with domestic banks. Thus except the monetary aggregate of the UK, all extended monetary aggregates based on the residency of holder criterion are obtained by adding CBD2 and CBD6 to the national aggregate. For that of the UK, CBD2, CBD5 and CBD6 should be added to M4.

A2.3 Definition and Sources of CBDs

Data concerning cross border deposits(CBDs) are obtained from BIS quarterly "International Banking and Financial Market Developments" Statistical Annex. Definitions of various CBDs and their respective sources are given below.

CBD1 denotes national currency deposits of residents with domestic banks and is already included in national definitions of the monetary aggregates.

CBD2 refers to national currency deposits held by non-bank residents with banks abroad. This data are obtained from Table 5b External Positions of Reporting Banks vis-a-vis Individual Countries vis-a-vis the Non-bank Sector (Liabilities), figure corresponding to bracketed country entry.

CBD3 comprises national currency deposits of non-bank non-residents with domestic banks, data of which are obtained from Table 4b Currency Breakdown of Reporting Banks' Cross Border Positions vis-a-vis Non-banks, domestic currency liabilities or Table 2d External Positions of Banks in Individual Reporting Countries in Domestic Currency vis-a-vis the Non-bank Sector. The figures from these two tables are identical.

CBD 4 refers to national currency deposits of non-bank non-residents with banks abroad. CBD 4 data are obtained from Table 4b Currency Breakdown of Reporting Banks' Cross Border Positions vis-a-vis Non-banks, foreign currency liabilities + Table 4d Currency Breakdown of Reporting Banks' Local Positions in Foreign Currency vis-a-vis the Non-bank Sector - Table 5b External Positions of Reporting

Banks vis-a-vis Individual Countries vis-a-vis the Non-bank Sector (Liabilities), Figure corresponding to bracketed country entry.

CBD5 denotes foreign currency deposits of non-bank residents with domestic banks.

CBD 5 data are obtained from Table 3b Local Positions in Foreign Currency of Banks in Individual Reporting Countries vis-a-vis the Non-bank Sector.

CBD6 refers to foreign currency deposits of non-bank residents with banks abroad.

CBD 6 data are obtained from Table 5b External Positions of Reporting Banks vis-a-vis Individual Countries vis-a-vis the Non-bank Sector (Liabilities), difference of main figure given and the figure corresponding to bracketed country entry.

CBD7 is the foreign currency deposits of non-bank non-residents with domestic banks of which data are obtained from Table 2f External Positions of Banks in Individual Reporting Countries in Foreign Currencies vis-a-vis the Non-bank Sector.

CBD8 is foreign currency deposits of non-bank non-residents with banks abroad.

This is included here for completeness but none of the extended monetary aggregates consider this component, as it covers all deposits in the rest of the world.

Extended monetary aggregates for any country can be obtained by adding and/or subtracting relevant CBDs to the published monetary aggregates.

As mentioned in Chapter 2, by summing CBDs 1, 2, 3 and 4, the extended monetary aggregate based on currency of denomination (MC) is obtained. Summing CBDs 1, 2, 5 and 6, the extended monetary aggregate based on the residence of holder (MR) is reached. The third extended monetary aggregate based on the bank's location (ML) is obtained by summing CBDs 1, 3, 5 and 7.

To illustrate the calculation of extended monetary aggregates, consider Germany's position as of 1992:1. Germany's national definition of broad monetary aggregate M3 is 1746.50 billion DM in the first quarter of 1992. Table A2.2 gives the outstanding amounts for all relevant CBDs in billions of DM. Since CBD 1 is included in all monetary aggregates, its quantity is not given here. CBD 8 is also not given for reasons stated above.

Table A2.2: Outstanding Amounts of CBDs in Germany in 1992:1

holders currency	residents w/ domestic banks	residents w/ banks abroad	nonresidents w/ domestic banks	nonresidents w/ banks abroad
national	-	187.95	57.29	135.59
foreign	10.84	38.48	40.32	-

Source : BIS 'International Banking and Financial Market Developments' Quarterly Bulletins.

Extended monetary aggregates are calculated as follows:

$MC = M3 + CBD2 + CBD3 + CBD4 - CBD5 = 2116.49$ billion DM.

$MR = M3 + CBD2 + CBD6 = 1972.93$ billion DM.

$ML = M3 + CBD3 + CBD7 = 1844.11$ billion DM.

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