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Cointegration Analysis of the Money Demand in the Euro Area

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Abstract: The analysis of the evolution of the M3 money aggregate is an important element in the definition and implementation of monetary policy for the ECB. A well-defined and stable long run demand function is an essential requisite for M3 to be a valid monetary tool. Therefore, this paper analyzes based in cointegration techniques the existence of a long run money demand, estimating it and testing its stability for the Euro Area and for ten of its member countries. Specifically, bearing in mind the high degree of monetary instability that the current economic crisis has created in the Euro Area, we also test whether this has had a noticeable impact in the cointegration among real money demand and its determinants. The analysis gives evidence of the existence of a long run relationship when the aggregated Euro Area and six of the ten countries are considered. However, these relationships are highly instable since the outbreak of the financial crisis, leading in some cases to even rejecting cointegration. All this suggests that the ECB's strategy of focusing in the M3 monetary aggregates could not be a convenient approach under the current circumstances.

Key Words: Cointegration, Money Demand, Euro Area

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1 Introduction

1.1 Questions of Interest

In the last decades of the 20th century a debate arose on which strategies Central Banks should follow for conducting successful monetary policy. Tradionally, developed economies had followed an intermediate targeting strategy based on monetary aggregates, which were considered the main determinants of inflation in the long run. Under this strategy, which was known as monetary targeting, the central bank used its instruments to control monetary aggregates, in order to stabilize the inflation rate around a target value. However, after a not very favorable application of monetary targeting during the 1980s, and as new money substitutes were developed by financial institutions, this approach to the monetary policy was progressively replaced. In the first years of the 1990s New Zealand, Canada, Israel, the United Kingdom, Australia, Finland, Spain, and Sweden, by this order, adopted explicit inflation targeting as their strategy for conducting monetary policy (Croce & Khan, September 2000). The supporters of this shift doubt that there exists a well-defined relation between the intermediate target, the monetary aggregate, and the inflation rate. They also argue that in the case that this clear link existed, it is not easy to control the intermediate variable. Therefore, they advocate for inflation targeting framework, which begins with the explicit central bank declaration of a low target for future inflation. Then, if the central bank, which must be independent from the government to avoid time inconsistency, judges that the future inflation will deviate from the target it will take the necessary measures to prevent it.

Contrary to this trend, the German Bundesbank has maintained monetary targeting as its main strategy since its adoption at the end of 1974. The main intermediate monetary variable has been broad money, which has plaid a crucial role in the definition of this bank's policy to ensure the price stability objective. On one hand targets for this variable are established annually and on the other it is a clear indicator to coordinate the process of adjusting wages and prices in Germany. During negotiations before the creation of the Euro Area on 1999, the Bundesbank defended the monetary targeting as the strategy for the new central bank against other countries that supported a strategy based on inflation targets. After an intense debate a compromise was reached in which both policies were adopted forming what is known as the ECB two-pillar strategy (Issing, 2008).

In this strategy, the first pillar is the announcement of a reference target for the yearly growth of the M3 money supply over medium to longer term horizons. Each December the ECB publishes this reference target, which has been maintained at 4.5% level. This value is the result of forecasts of 2% inflation, 2–2.5% economic growth and an annual fall in the velocity of M3 circulation of around 0.5–1%. The second pillar is to monitor the inflation to evaluate the possible risks to price stability. Specifically, the ECB states that price stability would, in numerical terms, mean an inflation of less than 2% for the euro area over the medium term (ECB, 2000). Although later, in 2003 the ECB revised the strategy to downgrade the priority of the M3 growth as a policy objective by changing it to the second pillar, it was not eliminated. This supposed a clear sign that the ECB believes that the growth in broad money is a leading indicator of the inflation trend in the long run. The ECB maintains, contrary to other main central banks, its belief that it is important to focus on the evolution of the M3 in order not only to avoid inflation, but also to prevent any asset bubbles due to excess liquidity (Hamori & Hamori, 2008).

However, the effectiveness and success of these monetary targets established by the ECB depend on a stable money demand function, because it ensures that the money supply would have predictable impacts on other economic variables such as inflation or interest rates (Goldfeld & Sichel, 1990). If the money demand defined in broad terms for the Euro Area is stable, there is a clear and predictable link between the ECB's M3 money supply targets and inflation, and therefore controlling the growth of the M3 the ECB would be able to achieve its inflationary objectives. However, if the money demand is unstable a constant growth in the money supply does not guarantee stable inflation and consequently the monetary targeting strategy has no meaning. The topic of the money demand's stability has become very attractive, and with the development of the cointegration idea in the last two decades, much literature has been produced on this topic using this new approach. The vast majority of this literature supports the existence of cointegration between the variables, and consequently, the stability of the long run money demand. The support of a stable money demand is overwhelming in the works that use data up to 2001 (Dreger & Wolters, 2010). Examples of this are (Calza, Jung, & Stracca, 2000) (Funke, 2001), (Coenen & Vega, 2001) (Biggs, 2003) (Bruggeman, Donati, & Warne, 2003). However, when the sample is extended to more recent years there begin to appear more works which reject the existence of cointegration. For example (Greiber & Lemke, 2005), (Alves, Marques, & Sousa, 2007) or (Nautz & Rondorf, 2010). This, linked to the fact that since 2001 the M3 reference growth has continuously exceeded its target value of 4.5 by more than 2.5 points without accelerating the inflation, could suggest that the long run relation has become unstable in the last decade, and that accordingly money growth is not a reliable instrument to catch future deviations from the inflation target (Dreger & Wolters, 2010).

In this sense, the main purpose of this work is to analyze the existence of a stable long run relation among the determinants of the money demand in the Euro Area, independently of the period considered. For this we will check, using the most recent data, the existence of cointegration between the elements of a pre-specified money demand. In this way we would like to test the existence of a stable long run demand, in order to examine if the ECB strategy is still valid. We will conduct the analysis for data of the whole Euro Area and for data of ten economies that compose it. The reason to take into consideration ten countries, apart from the whole Eurozone, is the considerable heterogeneity among the countries that compose it. Although it is a unique monetary area, the different economies that compose it have remarkable differences, and the evolution of the inflation, the real income and interest rates is rather dissimilar among them. Therefore, to test the validity of a common policy for a whole monetary union it is important to take into consideration if the policy is valid for all the parts that compose it. Furthermore, bearing in mind the high degree of monetary imbalances that the current economic crisis has created in the euro area (ECB, 2009), we would also like to check if this instability has had a noticeable impact in the long run relation among the determinants of the money demand.

To pursue this aim the rest of the work has been organized as follows. The remaining part of section 1 reviews the basic theoretical approach to the concepts in which this work is founded, money demand and cointegration,. Section 2 explains the methodological procedure that will be followed to analyze the existence of cointegration. In section 3, the data series used in the analysis are described and in section 4 the results of this analysis are shown. Finally, in Section 5 the main conclusions are presented and they are complemented by some last remarks in Section 6.

1.2 Theoretical Background

1.21 Money Demand

Following the literature review made by Serletis (2007), the earliest theoretical approach to the money demand that we find in the literature is the classical version of the Quantity Theory of Money. This proposal only takes into account the transactions motive to hold money, what means that individuals only need money for day-to-day transactions in the near future. It is based in the income version of equation of exchange $M^S V = PY$ proposed by Irving Fisher (1911), where M^S is the money stock, V is its velocity (the average of times a unit of money changes hands during a period of time), *P* is the price level and *Y* is the real income. Assuming that real income and money stock are exogenous, that velocity tends in the long run to an equilibrium value and that the price level is the unique endogenous variable, we can rearrange the equation of exchange to obtain the long run money demand function according to this theory:

$$\frac{M^d}{P} = kY$$

where $k = 1/V$ and it tends to be constant. Its interpretation says that the long run demand for real money is a constant proportion to real income.The neoclassical economists of the Cambridge University introduced the possibility that $k$could fluctuate in the short run with the variations in the expected and real return of the different assets that individuals hold, bringing in the idea that interest rates can affect the money demand in the short run. They did not introduce this notion explicitly in the equation, but they opened the possibility for including new reasons for holding money to the demand equation.

In this sense, Keynes, in the frame of its liquidity preference theory, proposed the existence of three reasons to hold money. Additionally to the transactions motive, he suggested the existence of a precautionary motive and a speculative motive. The former one is constructed around the idea that individuals hold money to be able to cope with future unexpected situations and thus its demand depends on the level of uncertainty about the future. On the other hand, the later one responds to the fact that money is an asset and thus it competes with other assets. Specifically, for this second motive Keynes distinguished between money, which has no expected return, and bonds, which have an expected return equal to the sum of the current yield and the expected rate of capital gain. Hence, if the interest rates in this economy are below the normal value, individuals will expect them to rise, bond prices to fall, and capital losses to be realized. Therefore, they will prefer to hold money, increasing its demand. In the same way, if the interest rates in this economy are above the normal value, individuals will expect them to fall, bond prices to rise, and capital gains to be realized. Then they will prefer to hold bonds, decreasing the money demand. Acordingly, the demand for money depends negatively on the interest rate, and the demand function under the liquidity preference theory takes the form:

$$\frac{M^d}{P} = F(R, Y)$$

where $F_1 < 0$ and $F_2 > 0$. Considering that $V = {}^{Y}\!/_{M/P} = {}^{Y}\!/_{F(R,Y)}$, in this theory the velocity is not constant, but positively related to the interest rates. Consequently, the demand for money is not stable.

Later on, Friedman (1956) built its modern quantitative theory without specifying any particular motive to hold money. He just took it for granted that people hold money because they perceive it as a durable good that generates a flow of goods and services. He also considered that it competes with other assets for a place in portfolios, decreasing its marginal utility as the quantity of money held increases. Accordingly, he proposed the following money demand equation for each individual:

$$\frac{M^d}{P} = F\left(Y_p\,,\; R_b - R_m\,,\; R_e - R_m\,,\; \pi^e - R_m\,, \dots\right)$$

where Y_p is the real permanent income (the hypothetical constant level of expected long term income), R_b is the expected return on bonds, R_e is the expected return on equities, R_m is the expected return on money, π^e is the expected inflation rate and the dots imply the existence of other relevant variables which play no fundamental role in the theory. It is important to notice that for Friedman it is a change in permanent income, rather than a change in temporary income, what determines individual's money demand patterns. This means that temporary changes in income have little effect on consumer spending behavior, whereas permanent changes can have large effects on the money demand. Additionally, when interest rates go up, the expected return on all the assets, included the broad money, goes up in the same extent, maintaining constant the incentives to invest in each asset. According to this, the money demand is insensitive to changes in interest rates and therefore the only variable that determines the real money demand is the real permanent income:

$$\frac{M^d}{P} = F\left(Y_p\right)$$

The velocity in this case depends only in real permanent income, which has a very stable relationship with the real income. This implies that the velocity and the demand function are very stable and predictable.

Baumol (1952) and Tobin (1956) developed independently a microfundamentated model based in the tradeoff between the liquidity that holding money grants and its cost represented by the lost interests for not holding other assets. Applying the portfolio theory to this tradeoff they developed a model that describes the optimal number of transactions for the individuals in the economy. They consider an individual who plans to expend Y gradually during a certain period of time and who can decide whether he holds its wealth in the form of bonds, having a return of R, or in terms of money, having no return. The individual suffers also b transaction costs each time bonds are exchanged for money and he obtains a K fix amount of money in each one of these transactions. Thus, Y/K is the total number of exchanges he is going to make, $b(Y/K)$ the total transaction costs he bears, $K/2$ the average real money he is holding, and $R(K/2)$ the interests to which he renounces for holding a certain amount of money. Accordingly, the total cost suffered is:

$$TC = b\frac{Y}{K} + R\frac{K}{2}$$

Minimizing this total cost with respect to K they obtained that the adequate average quantity of real money that the individual should hold ($= M/P$) is:

$$\frac{K}{2} = \frac{M}{P} = \frac{1}{2}\sqrt{\frac{2bY}{R}}$$

Hence, the demand for real money according to the Baumol-Tobin model is a direct proportion of the transactions a person intends to do and an inverse proportion of the interest rate. The transaction costs play a key role in this theory as they are the cause for the existence of a real money demand. When these transaction costs disappear there is no real demand for money. Expressing the money demand function in a logarithmic form:

$$\ln\frac{M}{P} = \alpha + \frac{1}{2}\ln Y - \frac{1}{2}\ln R$$

where $\alpha = \ln(1/2)\sqrt{2b}$. The elasticity of real money demand with respect to real spending is equal to 0.5, which implies that an increase in this variable will cause a less than proportional increase in the demand of real money. This receives the name of economies of scale in the holding of money and it stands for the fact that as the level of real spending increases the proportion of assets held in the form of money decreases. This model, apart from including the notion of economies of scale, is relevant because it introduces the idea that the money demand for transactions motive is also likely to be dependent on the interest rate.

Tobin (1958) also developed its own liquidity preference theory, which is based in the idea that individuals hold money as another asset in their portfolios. They decide how much to retain in the form of money depending on the returns and risks of each asset. Tobin's theory only deals with the speculative motive for holding money and its reasoning is based in the portfolio theory. According to it, given any level of risk aversion, individuals maximizing their utility will shift from safe assets, money, to more risky ones when the interest rates increase, which implies an increase in the level of expected returns. This shows a clear negative relationship between the nominal interest rate and the demand for money. Thus, based on these ideas Tobin reformulates the Keynesian liquidity preference theory. However, contrary to Keynesian theory he does it based on uncertain expectations and in the principle of portfolio diversification. Additionally, the model proposes that the optimal amount of money held will increase when the expected riskiness of the substitute assets increases. Therefore, this model is also relevant because it proposes the inclusion of the concept of expected risk in the money demand function.

In more recent years more theories have been developed, but their impact has been more discreet. It has been tried to explain the transactions motives by means of more sophisticated microfundamentated theories as cash-in-advance models and the shopping-time model. The first family of models is founded in the introduction of the cash-in-advance constraint proposed by Clover (1967), which tries to introduce the idea that transactions can only take place if the needed money is held in advance. These models explain the reasons for rational individuals to hold money, an asset that does not provide any direct utility and gives a lower return than other assets. The second model was proposed by McCallum and Goodfriend (1990) and is founded in the idea that money produces considerable savings of what is called shopping time. This theory also supports the idea that the money demand for transactions motive is dependent on the interest rate.

All these theories presented here show how the notion of money demand has evolved since it was first formulated. As we can see, there is not a universal way of understanding and representing it. This is reflected in the empirical literature, where there coexist very different specifications and interpretations of the money demand. However, each one of the described models introduces ideas that are worth having into account when formulating the money demand in our empirical work.

1.22 Cointegration

Granger and Newbold (1974) realized that when the ordinary least squares procedure is used with non-stationary data we can easily obtain misleading conclusions. They claimed that results obtained in these cases were completely spurious and therefore they called to the resulting models spurious regressions. Specifically, they designed a Monte Carlo analysis where they randomly generated two groups of times series with a unit root. Then, they regressed time series from one group on time series from the other, and since both groups were completely independent from each other, they expected to obtain evidences of non-significance and of a low explanatory capacity. However, the results were completely unexpected. When they tested the significance of the explanatory variable, in 75% of the cases they were unable to reject the hypothesis of non-significance. Furthermore, they found that the coefficients of determination in these models were very high.

Based on these results they realized that if we consider two non-stationary time series, even if they are completely unrelated, as time goes on we would expect that either they will both go up or down together, or one will go up while the other goes down. In this situation it sounds very reasonable to find a significant positive or negative relation when a regression between both of them is proposed. However, as there is no real cause relation between the variables this regression will be spurious and, apart from a complete lack of economic meaning, it will produce non valid inference. Recalling in the error term we can realize that it is a mere linear combination of the rest of the variables involved in the regression. Therefore, when variables are non-stationary and there does not exist a true relation between them, errors will be also non-stationary. This means that errors will not oscillate around a zero mean with constant deviation. Hence, the t and F statistics will not be distributed as a Student's t and a Snedecor's F respectively, and they will not be valid. However, it is also possible a linear combination of two non-stationary series to be stationary. This only happens when there is a true long run relation between the variables and in this case it is said that both series are cointegrated.

The idea of cointegration was first formulated by Granger (1981) to give an answer to the problem of spurious regressions. Later, it has been further developed by many scholars, among them Engle and Granger (1987), Stock and Watson (1988), Phillips (1986) and (1987) and Johansen (1988) (1991). Cointegration is a specific property of time series variables and, as we have previously stated, it is based in the idea that only when there is a true long run relation among non-stationary series a linear combination of them is stationary. As Asteriou and Hall (2011) explain, the intuition behind cointegration is that if we have two related variables they will move together with very similar stochastic trends, and therefore we will be able to find a linear combination that eliminates the non-stability. Zivot and Wang (2003) express mathematically the idea of cointegration in the following way: Let $X_t = (x_{1t},\ldots,x_{nt})'$ denote a $(p \times 1)$ vector with p I(1) time series. X_t is cointegrated if there exists an $(p \times 1)$ vector $\beta = (\beta_1,\ldots,\beta_n)'$ such that

$$\beta' X_t = \beta_1 x_{1t} + \cdots + \beta_n x_{nt} \sim I(0)$$

If some elements of β are equal to zero, then we can say that only the subset of the time series in X_t with non-zero coefficients is cointegrated. The most common case in economics is to have non-stationary time series that become stationary when differenced, this is I(1) time series. However, the definition of cointegration can be generalized to other cases where we have integration degrees higher than one. In these cases we say that some non-stationary times series variables are cointegrated when there is at least one linear combination of these variables that has a lower order of integration (Asteriou & Hall, 2011).

The stationary linear combination is usually referred to as a long run equilibrium relationship and the intuition behind it is that non-stationary time series with a long run equilibrium relationship cannot move too far apart from the equilibrium because economic forces in the short run will induce them to go back to the equilibrium (Zivot & Wang, 2003). In this sense, the representation theorem, proposed by Engle and Granger (1987), states that when a cointegration relationship is identified there must exist an error correcting model that explains the short run dynamics of the variables as they converge to the long run equilibrium. Specifically, the error correction model shows how the variables change in response to stochastic shocks, which are portrayed by the error terms and the divergence from the long run equilibrium in the former period. This divergence from the long run equilibrium in the former period is known as the error correction term and is introduced in the different specifications of the error correction model as the lagged error term of the long run relation. There exist different error correction model specifications but all of them imply for each variable a relation among the current and lagged differences of the considered and the rest of the variables, and at least one lagged value of the estimated error term (Zivot & Wang, 2003).

To sum up, the notion of cointegration plays a key role in our work. If we are able to find cointegration between the variables that we think that compose the money demand, we would be able to guarantee that there is a long run relation between them. This relation would be determined by the stationary linear combination, which is given by the cointegrating vector (β). Therefore, this stationary linear combination would constitute the long run money demand and its coefficients would be the elements of the cointegrating vector. In the meantime, the short run dynamics would be shown by the error correction model.

2 Methodology

In this section we are going to introduce the practical way in which we are going to deal with the two basic concepts on which this work is founded. First of all we will determine how we are going to define the money demand equation and later we will explain which procedure we will follow to test the existence of cointegration and calculate the long run relations.

2.1 Specification of Money Demand

As we have shown in the preceding section there exist plenty of theoretical approaches to the notion of money demand. In the same way, in empirical literature there also exist a wide variety of specifications of the money demand function. However, according to Ericsson (1998) all these different empirical specifications imply a long run relationship of the form:

$$\frac{M}{P} = f(Y, OC)$$

where M denotes nominal money demand, P the level of prices, Y a scale variable to describe the economy's level of transactions and OC a variable representing the opportunity cost of holding money. Therefore, the money demand equation is generally formed by the combination of a scale variable that describes the economy's level of transactions and a variable representing the opportunity cost. Following the Keynesian approach, the scale variable represents the transactions motive and the precaution motive for holding money, while the opportunity cost variable represents the speculative motive. However, while there is a consensus in the selection of the scale variable, there are great discrepancies in practical specification of the opportunity costs. For this purpose various interest rates, interest rate differentials or the inflation rate are generally used as a proxy (Belke & Czudaj, 2010).

Having into account all the possibilities and the most recent studies, we have decided to follow the example of Calza *et al.* (2001) and make use of an interest differential, as we think that it is the option that best represents the idea of opportunity costs of holding money. We have decided to use specifically, a differential between the return on assets included in M3 over the return on assets not included in M3. An individual who owns M3 assets, money in a broad sense, would get a return on them but would renounce to the return on other assets. Therefore, he will be having a profit, and prone to maintain more assets in the form of broad money, if the return on assets included in M3 is greater than the return on assets not included in M3. On the contrary he will be experiencing losses, and prone to maintain fewer assets in the form of broad money, if the return on assets included in M3 is greater than the return on assets not included in M3. Additionally, we have decided not to include the inflation in our specification of the money demand, because in agreement with Calza *et al.* (2001), and opposed to Ericsson (1998), Bruggeman *et al.* (2003) and Dreger and Wolters (2010), we doubt that inflation adds any additional explanatory capacity to money demand once the nominal return on assets not included in M3 has been included.

Based in the above discussion, the general long-run function of the demand for real money balances can be specified as follows:

$$\frac{M_t}{P_t} = \beta_0 + \beta_1 Y_t + \beta_2 (RS_t - RL_t) + u_t$$

Taking logarithms, except for nominal interest rates, as it is done in the vast majority of the literature (i.e. (Coenen & Vega, 2001), (Funke, 2001), (Hamori & Hamori, 2008) (Dreger & Wolters, 2010)):

$$m_t - p_t = \beta_0 + \beta_1 y_t + \beta_2 (RS_t - RL_t) + u_t$$

where m denotes the logarithm of monetary aggregates, p the logarithm of the level of prices, y the logarithm of a measure of real income, RS and RL the long run and short run interest rates respectively, and u the error term. As proposed by Coenen and Vega (2001) and Brand and Casola (2004), taking into account the liquid nature of assets included in M3, we will use a short run interest rate as a proxy for their return, while for the yield of assets not included in M3, we will use a long run interest.

The coefficient β_1 measures the long run elasticity with respect to the scale variable. We expect its sign to be positive, reflecting that an increase in the real income induces an increase in the demand for real money balances. Some of the theories on money demand (see Section 1) as the Baumol-Tobin model and some formulations of the quantity theory predict exact values for this coefficient, 0.5 and 1 respectively (Baumol, 1952) (Friedman, 1956). Nevertheless, according to the literature on this topic empirical elasticities higher than the unity tend to be found when using broad money, *i.e.* (Funke, 2001), (Hamori & Hamori, 2008), (Dreger & Wolters, 2010). According to Coenen and Vega (2001), this happens as a result of the neglect of the wealth effect. Meanwhile, the coefficient β_2 is the long run semi-elasticity with respect to the differential of the long run interest rate over the short run interest rate. We also expect this coefficient to be positive, since an increase in this variable would boost the demand for real money balances.

Table 1 Recent Euro Area money demand studies with interest rate differentials

Study	Estimation Period	Income	Spread between interest rates	Other Variable	Adjust. Coeff.
Calza *et al.* (2000)	1990:1-1999:9	1.21	0.97	-	0.31
Calza *et al.* (2001)	1980:I-1999:IV	1.34	0.86	-	0.12
Coenen & Vega (2001)	1980:I-1998:IV	1.13	0.87	-	0.13
Greiber & Lemke (2005)	1980:I-2004:IV	1.26	1.20	-	0.15

Table 2 Recent Euro Area money demand studies with long run and short run interest rates

Study	Estimation Period	Income	Shorter run rate	Longer run rate	Other Variabl.	Adjust. Coeff.
Dedola *et al.* (2001)	1983:III-1999:I	1.26	-0.08	-3.36	-	0.12
Biggs (2003)	1980:I-2002:IV	1.47	-0.10	-0.50	-0.06	0.69
Biggs (2003)	1980:I-2002:IV	1.00	0.30	-0.70	-0.06	0.69
Bruggeman *et al.* (2003)	1980:I-2001:IV	1.38	1.31	-0.81	-	0.12
Boone *et al.* (2004)	1971:I-2003:IV	1.27	-0.69	-0.44	-	0.04

These predictions agree with the results obtained in the in the empirical literature on the estimation of the money demand for the Eurozone using broad money. In the table 1 and 2, which are a modification of the table obtained from De Bondt (2009), we can see which are the coefficients obtained in works with a long run money demand specification similar to ours for the Euro Area. In the former one, we introduce the papers that make use of a spread between a short run and a long run interest rates, or that impose the requisite that the coefficients of the two variables introduced separately should be the same. We can confirm that, as we expected, in all the cases of this table β_1 and β_2 are positive, being β_1 greater and β_2 lower than the unit, except in one case. In the second table we present the results of works that introduce both the long run and the sort run interest rates but separately and without imposing any condition. In this table $\beta_1$is positive and greater than one, except in Biggs (2003), where it has been imposed the long run income elasticity to be equal to one. Since there is no equivalent for β_2 we cannot extract a direct conclusion for it. However, if we realize that $\beta_2(RS_t - RL_t) = \beta_2 RS_t - \beta_2 RL_t$, we can expect the coefficient of the short run rate to be positive, the one of the long run rate to be negative and both of them to be similar. In the case of the long run rate there is no doubt that it enters negatively in the long run money demand of the most recent empirical literature. On the contrary, there are big discrepancies in the results for the short run coefficient, which takes very heterogeneous values with different signs. Additionally, while in some cases the values of both coefficients are similar, in others they are completely different. To sum up, we can say that it is difficult to extract a clear prediction for β_2 from the papers of the table 2.

2.2 Statistical Procedure

As we have explained in the previous section to analyze whether there is a stable long run money demand function like the one we propose, we are going to check the existence of a stable long run relation among the variables that compose it. This means testing for the existence of cointegration among them, then obtaining the cointegrating vectors and finally checking if the stability of the coeffcients.

2.21 ADF Test

Before testing for cointegration, time series properties of the variables need to be examined. They should be integrated of the same order to be cointegrated, which means that after differencing the same number of times, all the variables should be stationary. In order to test for stationarity, apart from the visual inspection of the graph and the correlogram, it is common to implement unit root tests. These tests check using an autoregressive model for the existence of a unit root, which would mean the non stationarity of the time series. Among all the different tests, a very well-known one that is valid in large samples is the Augmented Dickey–Fuller test (ADF). The ADF is an augmented version of the Dickey–Fuller test, which was proposed by Dickey and Fuller (1979). Therefore, the testing procedure for the ADF is the same but applied to an AR(p) model instead of a AR(1). Following the description of the test made by Serletis (2007), we begin with the AR(p) model without constant:

$$X_t = \phi_1 X_{t-1} + \phi_2 X_{t-2} + \cdots + \phi_p X_{t-p} + \varepsilon_t$$

This can be written as:

$$X_t = \sum_{j=1}^{p} \phi_j X_{t-j} + \varepsilon_t$$

where X_t is the series being tested, p the lag order of the autoregressive process, ϕ_j each coefficient of the autoregressive model and ε_t is an error term. Subtracting X_{t-1} in both sides:

$$\Delta X_t = \phi X_{t-1} + \sum_{j=1}^{p-1} a_j \, \Delta X_{t-j} + \varepsilon_t$$

where $\phi = \left(1 - \sum_{j=1}^{p} \phi_j\right)$ and $a_j = -\sum_{i=j+1}^{p} \phi_i$

Depending on the nature of the series we can have three alternatives of this model:

1. Test for a unit root:

$$\Delta X_t = \phi X_{t-1} + \sum_{j=1}^{p-1} a_j \, \Delta X_{t-j} + \varepsilon_t$$

2. Test for a unit root with a constant:

$$\Delta X_t = \alpha + \phi X_{t-1} + \sum_{j=1}^{p-1} a_j \, \Delta X_{t-j} + \varepsilon_t$$

3. Test for a unit root with a constant and deterministic time trend:

$$\Delta X_t = \alpha + \beta t + \phi X_{t-1} + \sum_{j=1}^{p-1} a_j \, \Delta X_{t-j} + \varepsilon_t$$

where α is a constant and β is the coefficient of a time trend. In all the three cases the null hypothesis of existence of a unit root, $\phi = 1$, is tested against a general alternative of no unit roots, $\phi \neq 1$. An important result obtained by Fuller (1976) is that the asymptotic distribution of the t-statistic on ϕ is independent of the number of lagged first differences included in the ADF test regression. Therefore the critical values for the t-statistics under the null hypothesis tabulated by Dickey and Fuller (1976) for the basic DF test are valid also for the augmented version. In this way, once the model is estimated and the t-statistic for ϕ is calculated, we compare this statistic with the correspondent critical value. If the t-statistic is less than the critical value, then the null hypothesis cannot be rejected and the series are non-stationary. However, if the t-ratio is larger than the critical value, the null hypothesis can be rejected and the series are stationary. It is worth mentioning, that even if the assumption that X_t follows an autoregressive process could seem very restrictive, Said and Dickey (1984) demonstrated that an unknown ARIMA process can be adequately approximated by an autoregressive process, implying that the ADF test is valid for any model.

2.22 Johansen Test

Once it is checked that the order of integration is the same for all the time series, we can proceed to test the existence of cointegration between the variables. Many methods for testing cointegration have been developed since this concept was introduced. Gonzalo (1994) gives a complete list of them and compares their behavior by means of a Monte Carlo study.

However, in the empirical literature on money demand the most used methods are the Engle-Granger and the Johansen procedures. The Engle Granger approach is based in in the arbitrary selection of the long run relation between variables, regressing one against the others and obtaining the OLS residuals. Then, the application of a unit root test, generally the ADF test, will indicate if the residuals are stationary. If they are, we can conclude that the variables are cointegrated, since there is a linear combination of these variables that is stationary (Engle & Granger, 1987). This approach to testing cointegration is dominant in earlier empirical applications of cointegration to the money demand.

However, the most recent studies tend to favor the Johansen approach. As argued by Serletis (2007) this testing procedure is superior to the Engle-Granger's one because it fully captures the underlying time series properties of the data, provides estimates of all the cointegrating relations among a given set of variables, offers a set of test statistics for the number of cointegrating vectors, and allows direct hypothesis testing on the elements of the cointegrating vectors. Because of these reasons, we have decided to apply this approach in this work. The Johansen maximum likelihood procedure is developed in four steps. First of all, an autoregressive vector VAR of p dimensions is specified and estimated. Then, two test statistics are built around the rank of Π and its maximum eigenvalue to determine the number of cointegrating vectors that there exist. Once the number of vectors is known, they are obtained and normalized. Finally given these vectors the resulting cointegrated VECM is estimated by maximum likelihood.

Following the description that Serletis (2007) gives of this procedure proposed by Johansen and Juselius (1990), we specify a p-dimensional VAR model of order k:

$$\boldsymbol{X}_t = \sum_{i=1}^{k} \boldsymbol{A}_i \boldsymbol{X}_{t-i} + \boldsymbol{u}_t$$

where $\boldsymbol{X}_t$is a $p \, x \, 1$ vector containing the variables under test (in our specific case, $p = 3$ and $\boldsymbol{X_t} = [(m_t - p_t), (y_t), (RS_t - RL_t)\,]')$, A_t is a $p \, x \, p$ matrix of parameters and $\boldsymbol{u}_t$ is a $p \, x \, 1$ vector of independently and identically distributed innovations with mean zero.

Subtracting $\boldsymbol{X}_{t-1}$in both sides:

$$\Delta \boldsymbol{X}_t = (\boldsymbol{A}_1 - \boldsymbol{I})\boldsymbol{X}_{t-1} + \sum_{i=2}^{k} \boldsymbol{A}_i \boldsymbol{X}_{t-i} + \boldsymbol{u}_t$$

Now, adding and subtracting $(\boldsymbol{A}_1 - \boldsymbol{I})\boldsymbol{X}_{t-2}$ to the right side:

$$\Delta \boldsymbol{X}_t = (\boldsymbol{A}_1 - \boldsymbol{I})\Delta \boldsymbol{X}_{t-1} + (\boldsymbol{A}_2 + \boldsymbol{A}_1 - \boldsymbol{I})\boldsymbol{X}_{t-2} + \sum_{i=2}^{k} \boldsymbol{A}_i \boldsymbol{X}_{t-i} + \boldsymbol{u}_t$$

Doing the same with $(\boldsymbol{A}_2 + \boldsymbol{A}_1 - \boldsymbol{I})\boldsymbol{X}_{t-3}$:

$$\Delta \boldsymbol{X}_t = (\boldsymbol{A}_1 - \boldsymbol{I})\Delta \boldsymbol{X}_{t-1} + (\boldsymbol{A}_2 + \boldsymbol{A}_1 - \boldsymbol{I})\Delta \boldsymbol{X}_{t-2} + (\boldsymbol{A}_3 + \ \boldsymbol{A}_2 + \boldsymbol{A}_1 - \boldsymbol{I})\boldsymbol{X}_{t-3} \sum_{i=3}^{k} \boldsymbol{A}_i \boldsymbol{X}_{t-i} + \boldsymbol{u}_t$$

Proceeding in this fashion until we reach the k^{th} lag we obtain the following equation that constitutes the error correction representation of the original VAR model:

$$\Delta \boldsymbol{X}_t = \sum_{i=1}^{k-1} \boldsymbol{\Gamma}_i \Delta \boldsymbol{X}_{t-i} + \boldsymbol{\Pi} \boldsymbol{X}_{t-k} + \boldsymbol{u}_t$$

where $\boldsymbol{\Gamma}_i = -\left(\boldsymbol{I} - \sum_{j=1}^{i} \boldsymbol{A}_j\right)$ and $\boldsymbol{\Pi} = -\left(\boldsymbol{I} - \sum_{i=1}^{k} \boldsymbol{A}_i\right)$, both being $p\,x\,p$ matrices and $\boldsymbol{\Pi}$ containing information about the long run relationship between the variables in $\boldsymbol{X}_t$.

Johansen (1988) proposed a maximum likelihood estimation method for this model. Applying this method, which is fully described in his article, we obtain an estimate of $\boldsymbol{\Pi}$. The rank of the $\boldsymbol{\Pi}$ matrix, r, shows the number of of distinct cointegrating vectors that exist between the elements of $\boldsymbol{X}_t$. The rank of a square matrix, as $\boldsymbol{\Pi}$, represents the number of linearly independent rows and columns in the matrix and is given by the number of eigenvalues significantly different from zero. If each element of $\boldsymbol{\Pi}$ equals 0, the rank of $\boldsymbol{\Pi}$ is zero, and its eigenvalues are $\lambda_1 = \lambda_2 = \cdots = \lambda_p = 0$. In this case there are *p* unit roots, which means that all the elements of $\boldsymbol{X}_t$ have unit roots. This includes all the possible linear combinations of these elements, which implies that there is no cointegration. On the contrary, if all the rows of $\boldsymbol{\Pi}$ are linearly independent, $\boldsymbol{\Pi}$ has full rank, so that $rank(\boldsymbol{\Pi}) = p$, and all its eigenvalues are significantly different from 0. In this case there are no unit roots, which means that all elements of $\boldsymbol{X}_t$ are stationary. This includes the $p-1$ possible linear combinations of these elements, which implies that there can exist $p-1$ cointegrating vectors. In the middle, when $0 < rank(\boldsymbol{\Pi}) = r < p$, there are r cointegrating relations among the elements of $\boldsymbol{X}_t$.

Therefore, to know the number of different cointegrating vectors we just need to check the number of eigenvalues that are different from zero. However, we can only obtain estimates of $\boldsymbol{\Pi}$ and its eigenvalues, and thus we cannot directly observe this characteristic roots. Nevertheless, Johansen (1991) proposed two methods to extract the number of distinct cointegrating vectors from the estimated eigenvalues, the trace test and maximum eigenvalue test.

The trace statistic tests the null hypothesis that there are r or less cointegrating vectors against a general alternative by calculating the test statistic:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} \ln\left(1 - \hat{\lambda}_i\right)$$

where $\hat{\lambda}_i$ denotes the estimated values of the eigenvalues obtained from the estimated $\boldsymbol{\Pi}$ and T the number of observations. When the variables are not cointegrated, the $rank(\boldsymbol{\Pi}) = 0$, the eigenvalues $\lambda_1 = \lambda_2 = \cdots = \lambda_p = 0$, and the term $\ln\left(1 - \hat{\lambda}_i\right)$ will be zero for every eigenvalue. In this situation the value of the $\lambda_{trace}(r)$ is also zero and the null hypothesis is rejected. On the contrary, as the estimated value for the eigenvalues departs from zero, the term $\ln\left(1 - \hat{\lambda}_i\right)$ becomes more and more negative, and the $\lambda_{trace}(r)$ statistic becomes larger and larger, reducing the possibility of rejecting the null hypothesis.

The maximum eigenvalue statistic tests the null hypothesis that there are exactly r cointegrating vectors against the alternative that there are $r + 1$ cointegrating vectors by calculating the test statistic:

$$\lambda_{max}(r, r+1) = -T \ln\left(1 - \hat{\lambda}_{r+1}\right)$$

Again, if the estimated value for the eigenvalues $\hat{\lambda}_{r+1}$ lies in the neighborhood of zero, the statistic $\lambda_{max}(r, r+1)$ takes a small value, and the null hypothesis will not be rejected.

Once the number of cointegrating relation is determined by means of these two tests, the cointegrating vectors can be extracted from the matrix $\boldsymbol{\Pi}$. The cointegration vectors are obtained as an application of the Granger representation theorem, which asserts that if the coefficient matrix π has a reduced order $r < n$, then there exist $n \times r$ matrices α and β of order r, such that $\boldsymbol{\Pi} = \boldsymbol{\alpha\beta}'$ and $\boldsymbol{\beta}'\boldsymbol{X_t}$ is stationary (Engle & Granger, 1987). Johansen (1988) demonstrated that the maximum likelihood estimation of each column of β is a cointegrating vector. He also argued that these cointegrating vectors after normalization can be interpreted as the long run parameters.

Finally, the last step in the Johansen process would be the estimation of the error correction model in order to analyze the short run dynamics of the variables as they converge to the long run equilibrium. However, bearing in mind that $\boldsymbol{\Pi} = \boldsymbol{\alpha\beta}'$, we can substitute it in error correction representation of the original VAR model:

$$\Delta \boldsymbol{X}_t = \sum_{i=1}^{k-1} \boldsymbol{\Gamma}_i \Delta \boldsymbol{X}_{t-i} + \boldsymbol{\alpha\beta}'\boldsymbol{X}_{t-k} + \boldsymbol{u}_t$$

Now, taking into account that the error correction term is just the error lagged k periods, since $\boldsymbol{\beta}'\boldsymbol{X}_{t-k} = \boldsymbol{\varepsilon}_{t-k}$, the expression $\boldsymbol{\beta}'\boldsymbol{X_{t-k}}$ is equivalent to the error correction term and we can see that the equation above already contains an error correction term. In fact, this equation constitutes what is called the Vector Error Correction Model (VECM) (Asteriou & Hall, 2011). As it was needed to test the number of existing cointegrating relations, we already have the error correction model estimated following the maximum likelihood approach. So hence, the Johansen cointegration test is completed and thoroughly evaluating its results we can have a clear picture about the existence of cointegration and about the nature of the hypothetical long run relation.

3 Data

In this work we use quarterly data for the monetary aggregate M3, the nominal GDP, the Consumer Price Index (CPI) and two kinds of interest rates, 3 month money market rate and 10 year government bond yield. We use the nominal GDP corrected with the CPI as a proxy for the real income (Y_t), the CPI as the proxy for the level of prices (P_t), the 3 month money demand market rate as a proxy for the short run interest rate (RS_t) and the 10 year government bond yield as a proxy for the long run interest rate (RL_t). All of this data has been collected for the whole Euro Area and for each of the 10 analyzed countries. In the case of the time series for the Euro Area the unique source has been Eurostat and they cover the period between 1995 and 2013, while in the case of each country the main source has been their central banks complemented with data from Eurostat, FRED and OECD.

Table 3 Information about the data used for each country

Country	Accession Date to the Euro Area	Data Period
Euro Area	01/01/1999	1995:I-2013:IV
Austria	01/01/1999	1988:I-2013:IV
Belgium	02/01/1999	1980:I-2013:IV
Finland	03/01/1999	1980:I-2013:IV
France	04/01/1999	1980:I-2013:IV
Germany	05/01/1999	1991:I-2013:IV
Greece	06/01/2001	1992:IV-2013:IV
Italy	07/01/1999	1980:I-2013:IV
Netherlands	08/01/1999	1982:IV-2013:IV
Portugal	09/01/1999	1997:III-2013:IV
Spain	10/01/1999	1980:I-2013:IV

The periods covered by the series of the countries are shown in the table 3 and it depends on the availability and reliability of the data. In most of the cases it covers the period 1980-2014, however for of Austria, Germany, Greece, Netherlands and Portugal it is more restricted. In the case of Germany although there is data available for years before 1990, this data only takes into account the Federal Republic. For the whole Euro Area there are plenty of studies that use data starting before 1995. Since the Euro Area was established in 1999 and Eurostat only provides official data starting in 1995, older observations must be obtained with a wide variety of estimations and aggregation techniques. There are big discrepancies in the results obtained with each estimation or aggregation technique (Bruggeman, Donati, & Warne, 2003), and therefore we have decided not enlarging the available series to avoid any interference in the results. Finally, we have tried to obtain seasonally adjusted series for M3 and GDP whenever it was possible. In the cases in which seasonally adjusted data was not available we have adjusted the series seasonally using the TRAMO software for data deseasonalization.

4 Empirical Results

The main purpose of this work is to analyze the existence of a stable long run money demand function for the euro area and for ten of its constituent countries. Additionally, we would like to see whether the stable long run relation encapsulated in the money demand has been affected by the current financial instability. To achieve these goals we have decided to analyze the existence of cointegration among the variables that form the money demand by means of the Johansen approach, and then to analyze the stability of the obtained coefficients. To show all the results in the most clear and logic way, we have decided to arrange this section in the following way. First of all, we present the results of the unit root testing for the series. Then, the results of the Johansen test are presented for the case of the whole Euro Area and the ten countries. After this, we show the obtained long run relations, which represent the different money demands, and analyze thereafter their short run dynamics. Finally, the stability of the obtained long run money demands is tested.

4.1 Unit Root Test

Figures 1 and 2 show for all the cases under analysis the time series variables included in the money demand. From the mere visual inspection of the figures we get the impression that it is very likely that we find cointegration between the variables because both $(m_t - p_t)$ and (y_t) series follow a very similar path, except perhaps for Greece. This initial suspicion is reinforce if we realize that in some cases the discrepancies in this two series can be linked to broad shifts in the $(RS_t - RL_t)$ series.

Focusing on the stationarity, both figures give us a first impression that all the variables, except perhaps the interest rate differential, may be non-stationary for the whole Euro Area and for all the countries analyzed. Both the broad money $(m_t - p_t)$ and the real GDP (y_t) series show a clear upward tendency for all the countries, which is a clear sign of non-stationarity in average. On the contrary, the difference between the long run and short run interest rates $(RS_t - RL_t)$ shows a more heterogeneous behavior among the analyzed cases. There are countries in which the series seem to oscillate with a fairly constant variance along a fairly constant average, giving evidence of stationarity. However, for others it shows clear level changes in the average or a non-constant dispersion, leading us to believe that in these cases the series are non-stationary. To test whether this first impressions are true we will make use of the Augmented Dickey-Fuller (ADF) unit root tests. As explained before (see Section 2), this test allows us to examine the possible existence of a unit root in the series, which would mean that the series are non-stationary. Bearing in mind the assumptions we have made for the series, we have decided to conduct for $(m_t - p_t)$ and (y_t) the ADF test including a constant and a deterministic trend and for $(RS_t - RL_t)$ to include only a possible constant. The Table 4 shows the p-values of the ADF test statistic of each variable and its first difference for the whole Euro Area and for each one of the ten countries that we analyze.

Figure 1 Evolution of the variables for the Euro area

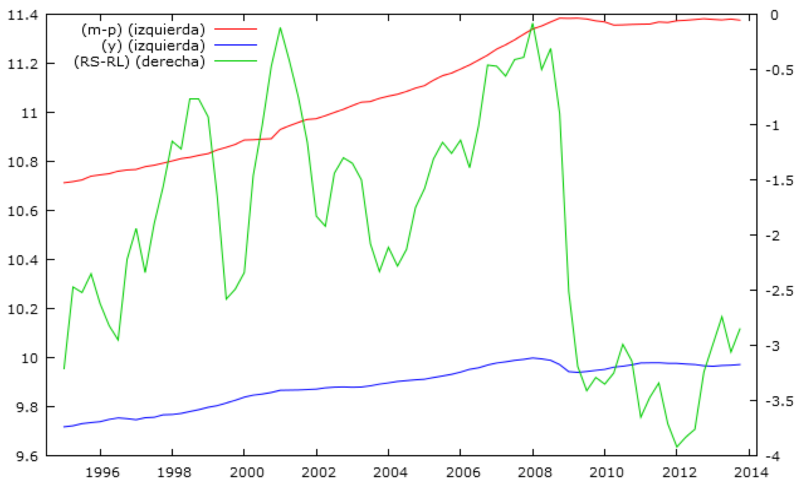

Figure 2 Evolution of the variables in the ten Euro Area countries under study

Considering the results for the whole Euro Area, we find that the p-value for the three variables without any difference is always higher than 0.05. This implies that we cannot reject the null hypothesis of existence of one unit root with a five percent significance level. When first differences are considered, the p-values for $\Delta(y_t)$ and $\Delta(RS_t - RL_t)$ lie below 0.05 and therefore, we reject with a five percent of significance the null hypothesis of existence of one additional unit root. Consequently, we can conclude that (y_t) and $(RS_t - RL_t)$ are integrated of order one. However, in the case of $\Delta(m_t - p_t)$ we obtain a p-value considerably higher than 0.05, suggesting that the variable is integrated of order two. This result seems to contradict the conclusions obtained in the majority of the works done on the behavior of the money demand function, where they observe that the variable $(m_t - p_t)$ is integrated of order one. Nevertheless, in general, as most unit-root tests are known to have low power when the sample size is relatively small, some subjective judgment can be made to interpret the results. This requires a visual inspection of the data set and the autocorrelation function for each of the time series. The autocorrelation function of $(m_t - p_t)$ without any difference dies out slowly, implying that this series is non-stationary. On the contrary, the autocorrelation function of the first difference is random and dies out speedily, indicating that taking one difference the variable is stationary. Hence, correlograms confirm that this is a non-stationary variable in its levels but stationary in its first difference form. Therefore, $(m_t - p_t)$ must be also integrated of order one, which is in consonance with the results of most of the previous analysis on the behavior of real M3 money.

Table 4 Results of the ADF test

	$(m_t - p_t)$	(y_t)	$(RS_t - RL_t)$	$\Delta(m_t - p_t)$	$\Delta(y_t)$	$\Delta(RS_t - RL_t)$
Euro Area	0.5497	0.3511	0.2342	0.2815	0.0037	0.0000
Austria	0.8885	0.3477	0.0574	0.0592	0.0028	0.0000
Belgium	0.2130	0.0599	0.0051	0.0018	0.0091	0.0000
Finland	0.5306	0.3961	0.0259	0.1465	0.0013	0.0000
France	0.9257	0.9360	0.1980	0.2966	0.0000	0.0000
Germany	0.7362	0.6600	0.0497	0.0000	0.0136	0.0000
Greece	0.0863	0.5784	0.4279	0.3544	0.0087	0.0000
Italy	0.7234	0.3961	0.8166	0.0101	0.0013	0.0000
Netherlands	0.3680	0.4232	0.0252	0.6056	0.0474	0.0000
Portugal	0.4156	0.6000	0.7254	0.0462	0.0401	0.0026
Spain	0.4508	0.8554	0.9361	0.4433	0.0485	0.0000

Considering the results for the ten euro are countries, the p-value for the three variables is always higher than 0.05, except for $(RS_t - RL_t)$ in the case of Belgium, Finland, Germany and Netherlands. This indicates that, with the exception of $(RS_t - RL_t)$ for these four countries, all the variables are non-stationary. When first differences are considered, the p-values for $\Delta(y_t)$ and $\Delta(RS_t - RL_t)$ lie below 0.05 in all the considered cases, suggesting that (y_t) and $(RS_t - RL_t)$ are I(1). However, for $\Delta(m_t - p_t)$ we find two groups of countries, the ones that show a p-value higher than 0.05, as it happened for the whole euro area, suggesting that $(m_t - p_t)$ is I(2) and the ones that show a p-value lower than 0.05, suggesting that $(m_t - p_t)$ is I(1). This raises again the doubts on the nature of $(m_t - p_t)$, but when we repeat the analysis of the correlograms done for the whole euro area, we confirm that this variable is in fact an I(1) process.

As we mentioned before for the variable $(RS_t - RL_t)$ there are four countries in which the p-value of this ADF test lies below 0.05. This would imply that for these countries, contrary to what happens for the other six and the whole euro area combined, the variable $(RS_t - RL_t)$ is stationary. This result is completely sound if we consider that the four exceptional countries, Belgium, Finland, Germany and Netherlands, are all northern European countries with a very stable interest rate history in the second half of the 20th century, while the other six, as more southern European countries, have experienced alternating periods of continued high and low interest rates. This difference induces the $(RS_t - RL_t)$ series to oscillate regularly along a mean for the four northern European countries, which is a clear pattern of an I(0) process, and to move creating changing trends with differences in the dispersion for the rest of the countries, which is a clear pattern of a non I(0) process. This can be seen in the figures 1 and 2. Nevertheless, having a look at the $(RS_t - RL_t)$ evolution for these northern European countries we see that even if they look more stationary than the others there are still non-stationary since for all of them the variance is not constant along the series.

4.2 Cointegration Test

Before conducting the cointegration test we have to make an assumption about the deterministic trend specification of the time series and determine the order of lags of the VAR model on which the test is build. For the former assumption, we follow Coenen and Vega (2001), as recommended by Belke and Czudaj (2010), and we assume linear trends in the time series variables and an unrestricted constant in the cointegrating equations. For the later decision, based in the fact that we are using quarterly data we decide to choose a four lag specification. This decision is also supported by the results of the VAR order selection test applied to the whole Euro Area and the ten countries. These tests indicate which order lag specification is batter based in the Akaike criterion, Schwartz Bayesian criterion and the Hannan-Quinn criterion. Although the obtained results are very heterogeneous, the most common results are the values around four.

The table 5 shows the results of the application of the Johansen test (see Section 2). The Johansen procedure proposes two statistics for testing the order of cointegration, the likelihood ratio test and the trace test. There is no big difference in the results obtained using each one of the two statistics, and therefore we have decided to provide only the results for the trace test to make it simpler. In this sense, in the table 5 we do only provide the test statistic and its associated p-value. For the whole Euro Area the results support the existence of cointegration. We reject the null hypothesis of no cointegration vector among the variables at the 5 percent significance level, and then, we do not reject the existence of one or less cointegration vectors with the same significance level. Therefore, we can conclude that for the whole European Union a long run relation exists among $(m_t - p_t)$, (y_t) and $(RS_t - RL_t)$. For six out of the ten euro area countries the results also support the existence of cointegration. These countries are Austria, Finland, Germany, Italy, Netherlands and Spain. In all the cases we reject the null hypothesis of no cointegration vector among the variables at the 5 percent significance level, and then, we do not reject the existence of less than one cointegration vector with the same significance level. This suggests us that there exists also a stable long run relation among $(m_t - p_t)$, (y_t) and $(RS_t - RL_t)$ for these countries, as it happened for the whole Eurozone. On the other hand, we have countries like Belgium, France, Portugal and Greece in which we cannot reject the null hypothesis of no cointegration vector among the variables at the 5 percent significance level. Therefore, for these four countries we have clear evidence that there is no long run relation among $(m_t - p_t)$, (y_t) and $(RS_t - RL_t)$.

Table 5 Results of the Johansen trace test

	Trace Test H_o: r		
	r = 0	r ≤ 1	r ≤ 2
Euro Area	26.5880 [0.0239]	6.4800 [0.3811]	0.076269 [0.8447]
Austria	29.9170 [0.0485]	5.6497 [0.7379]	0.97108 [0.3244]
Finland	31.7420 [0.0289]	15.7480 [0.0442]	3.1785 [0.0746]
Germany	34.4800 [0.0126]	16.0800 [0.0391]	1.8248 [0.1767]
Italy	33.5900 [0.0166]	14.4030 [0.0714]	0.9820 [0.3217]
Netherlands	56.9890 [0.0000]	15.4710 [0.0489]	2.0914 [0.1481]
Spain	50.4180 [0.0000]	15.3650 [0.0508]	2.5272 [0.1119]
Belgium	27.1050 [0.1013]	11.1300 [0.2068]	1.6028 [0.2055]
France	26.2360 [0.1251]	12.1960 [0.1490]	0.071832 [0.7887]
Greece	29.0900 [0.0607]	7.5300 [0.5239]	2.3596 [0.1245]
Portugal	22.1120 [0.3016]	9.0055 [0.3716]	2.8803 [0.0897]

As a last comment, we observe that for some countries there is evidence of more than one cointegration relations. Specifically, we obtain evidence of two cointegrating vectors. This implies that in addition to the one expected there is an additional vector that could show a long run relation between two of the three variables considered. These other minor relations do not affect the existence of a long run money demand and thus they do not change any of the above conclusions.

4.3 Long Run Relation

The table 6 shows the cointegration vectors obtained for each country normalized on money balances to give economic significance to them. The number in brackets represents the t-test statistic for each coefficient. We omit the results for Belgium, France, Greece and Portugal because the evidence rejects the existence of cointegration relationships in these four cases. When there are more than one cointegrating vectors we select the one that fits with the described money demand equation.

Table 6 Cointegrating vectors obtained from the Johansen approach

Cointegrating Vector (Beta normalized)			
	$(m_t - p_t)$	(y_t)	$(RS_t - RL_t)$
Eurozone	1 (0.0000)	-1.9813 (0.2497)	-0.1245 (0.0350)
Austria	1 (0.0000)	-2.9931 (1.2975)	-0.2052 (0.0435)
Finland	1 (0.0000)	-1.4652 (0.4943)	-0.0754 (0.0249)
Germany	1 (0.0000)	-2.3251 (1.0533)	-0.0367 (0.0576)
Italy	1 (0.0000)	-0.4842 (0.2778)	-0.0655 (0.0136)
Netherlands	1 (0.0000)	-1.9296 (0.0549)	-0.0050 (0.0051)
Spain	1 (0.0000)	-1.0584 (0.2688)	-0.1029 (0.0144)

Since these normalized cointegration vectors show the long run relation for the three variables, we obtain the following long run money demand for the whole Euro Area:

Euro Area: $$m_t - p_t = 1.9813y_t + 0.1245(RS_t - RL_t)$$

The obtained coefficients for the long run money demand equation in the whole Euro Area are in line with the economic theory and with the general lines of the theoretical literature on money demand (see Section 1). The long run income elasticity is positive and above the unit as expected, meaning that when there is an increase in the income the money demand grows in the long run, ceteris paribus. Even if this result is also in line with the majority of the recent empirical literature on the money demand for the Euro Area (see Section 2), it refutes the idea of economies of scale in the holding of money proposed by the Tobin-Baumol model. This idea implies that when the level of real spending increases, the proportion of assets held in the form of money decreases, and thus under this proposition the long run income elasticity should be lower than one. The Friedman's quantitative theory of money that predicts that the income elasticity should be around the unit is also refuted by these results.

The long run semi-elasticity for the interest rate differential, which is low but positive, also behaves in the expected way. When there is an increase of the interest differential the money demand grows in the long run. This is completely logic if we notice that an increase in the interest differential implies that keeping savings in assets included in M3 gets more profitable, and this consequently increases the demand of these assets, ceteris paribus.

For the ten Euro Area economies we obtain the following long run money demands. A * denotes significance at 10 percent significance level and a ** at 5 percent:

Austria: $m_t - p_t = 2.9931^{**}y_t + 0.2052^{**}(RS_t - RL_t)$

Finland: $m_t - p_t = 1.4652^{**}y_t + 0.0754^{**}(RS_t - RL_t)$

Germany: $m_t - p_t = 2.3251^{**}y_t + 0.0367(RS_t - RL_t)$

Italy: $m_t - p_t = 0.4842^{*}y_t + 0.0655^{**}(RS_t - RL_t)$

Netherlands: $m_t - p_t = 1.9296^{**}y_t + 0.0050(RS_t - RL_t)$

Spain: $m_t - p_t = 1.0584^{**}y_t + 0.1029^{**}(RS_t - RL_t)$

We can see that the obtained coefficients are similar for all the countries, and as it happened with the aggregated Euro Area, they have the expected signs. Both the long run income elasticity and the long run semi-elasticity of the interest rate differential are positive as expected. However, in the case of the long run income there is a high heterogeneity with countries as Austria and Germany that have values much higher than the unit, and countries as Spain and Italy that have long run income elasticities equal to or lower than the unit. The Spanish case could support the Friedman's theory of unit income elasticity, while the Italian case could back the Tobin-Baumol's idea of economies of scale in the holding of money. For Italy the income is statistically significant at 10% significance level, but not at a 5%. It is worth noticing also the cases of Germany and the Netherlands because for them the interest rate differential is statistically non-significant at any reasonable level of signification. This supposes that for these countries the interest differential has no explanatory capacity and therefore is irrelevant in the people's decision to hold money. It could also be explained by the fact that interest rates differential for these countries gave evidence of being stationary.

4.4 Short Run Dynamics

After obtaining the long run cointegration relationship we proceed to examine the short run dynamics of the money demand function by estimating the vector error correction model (VECM). This constitutes the last step in the Johansen approach. The table 7 shows the estimated error correction models for the complete Eurozone. A * denotes significance at 10 percent significance level, a ** at 5 percent, and *** at one percent.

Removing insignificant regressors we obtain the most parsimonious specification of the model for the short run dynamics in the Euro Area:

$$\begin{aligned} \mathit{\Delta}(m-p)_t = {} & -0.4975 + 0.3243\mathit{\Delta}y_{t-1} + 0.0041\Delta(RS_t - RL_t)_{t-1} \\ & + 0.0040\mathit{\Delta}(RS_t - RL_t)_{t-3} - 0.0278EC_{t-1} \end{aligned}$$

The coefficient of the error correction term can be interpreted as an estimate of the speed of adjustment back to the long-run equilibrium relationship. Therefore under cointegration the error correction term must be negative and significantly different from zero, indicating that when the real money demand departures from its equilibrium value there is an adjustment back to the long run relationship in the following periods that progressively eliminates the discrepancy. As we can see in table 7 the estimated coefficient is in fact negative and statistically significant, and consequently the cointegration vector obtained in the previous section constitutes a long run equilibrium. Nevertheless, the value of the estimated coefficient for the error term is relatively low, which would show a slow speed of convergence to the equilibrium level. This has been a very recurrent result in the literature when broad money is used (Bose & Rahman, 1996) and Cuthbertson and Taylor (1990) explained that it is normal to observe this phenomenon when the precautionary motive for holding money is significantly influenced by the expectations about of future income and the rates of return.

Table 7 VECM estimation results for the Euro Area

	Euro Area				
	Coeff.		St. Dev.	t-stat.	p-value
$Const.$	-0.4975	***	0.1374	-3.6220	0.0006
$\Delta(m-p)_{t-1}$	0.0030		0.1190	0.0255	0.9797
$\Delta(m-p)_{t-2}$	0.0971		0.1235	0.7860	0.4349
$\Delta(m-p)_{t-3}$	0.0115		0.1237	0.0933	0.9260
$\Delta(y)_{t-1}$	0.3243	**	0.1515	2.1406	0.0363
$\Delta(y)_{t-2}$	-0.0814		0.1870	-0.4352	0.6650
$\Delta(y)_{t-3}$	0.1392		0.1603	0.8683	0.3887
$\Delta(RS-RL)_{t-1}$	0.0041	**	0.0020	2.0122	0.0487
$\Delta(RS-RL)_{t-2}$	-0.0039	*	0.0022	-1.7640	0.0827
$\Delta(RS-RL)_{t-3}$	0.0040	**	0.0019	2.1410	0.0363
EC_{t-1}	-0.0278	***	0.0076	-3.6310	0.0006

RSS	0.001961	Durbin-Watson	1.950947
R-squared	0.629143	R-squared adjusted	0.568347

The table 8 shows the estimated error correction models for each one of the ten Euro Area countries analyzed. A * denotes significance at 10 percent significance level, a ** at 5 percent, and *** at a one percent. Analyzing the results for the error correction term presented in the table 8, we can see that for all the countries for which cointegration evidence is found this term is negative and statistically significant. This implies that in these countries when the real money demand departures from its equilibrium value there is an adjustment back to the long run relationship in the following periods eliminating progressively the discrepancy. This dynamic shows that the obtained cointegrating vectors constitute long run equilibriums and it confirms the evidences of cointegration. The values of the error correction coefficient are very low, but this, as we have explained before, is completely normal when broad money data is used. This result confirms our suspicion that the adjustment to the long run equilibrium is very slow when we deal with broad money demand. Additionally, the results presented in the table 8 also confirm that there is no cointegration for Belgium, France, Greece and Portugal, since the statistical significance of the error correction term is rejected for these four cases.

Table 8 VECM estimation results for the ten analyzed countries

	Austria		Belgium		Finland		France		Germany	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
$Const.$	-0.2633	0.0009***	-0.0436	0.4293	-0.0251	0.0127**	0.0344	0.1906	-0.2934	0.0526*
$\Delta(m-p)_{t-1}$	-0.0779	0.4772	-0.0718	0.4710	-0.1051	0.2401	0.2022	0.0318**	0.2180	0.0467**
$\Delta(m-p)_{t-2}$	-0.1095	0.3198	0.2620	0.0086***	-0.0462	0.6048	0.1030	0.2759	0.0628	0.5807
$\Delta(m-p)_{t-3}$	-0.0955	0.3828	-0.1338	0.1762	-0.0529	0.5521	0.0421	0.6536	-0.1140	0.3028
$\Delta(y)_{t-1}$	0.0418	0.8675	-0.0054	0.9820	-0.0446	0.7168	0.1168	0.3555	0.2987	0.0156**
$\Delta(y)_{t-2}$	-0.0819	0.7562	0.0084	0.9733	0.2296	0.0786*	-0.0019	0.9882	0.1635	0.1973
$\Delta(y)_{t-3}$	0.5200	0.0481**	0.1135	0.6241	0.0010	0.9932	0.1782	0.1606	0.0177	0.8863
$\Delta(RS-RL)_{t-1}$	0.0043	0.0491**	0.0038	0.0336**	-0.0003	0.8113	0.0005	0.5867	0.0031	0.0697*
$\Delta(RS-RL)_{t-2}$	-0.0007	0.7457	-0.0008	0.6523	0.0023	0.0432**	0.0006	0.4099	-0.0031	0.1053
$\Delta(RS-RL)_{t-3}$	0.0004	0.8574	0.0001	0.9308	0.0008	0.4584	0.0010	0.2304	0.0043	0.0101**
EC_{t-1}	-0.0168	0.0008***	-0.0452	0.3956	-0.0236	0.0033***	0.0039	0.2130	-0.0247	0.0507*
	Greece		Italy		Netherlands		Portugal		Spain	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
$Const.$	0.0196	0.0025***	0.0249	0.1179	-0.1824	0.0000***	-0.1978	0.1516	0.0041	0.0512*
$\Delta(m-p)_{t-1}$	0.4471	0.0003***	0.2954	0.0013***	-0.0552	0.5240	0.0040	0.9754	0.2551	0.0070***
$\Delta(m-p)_{t-2}$	0.3334	0.0093***	0.1108	0.2381	0.0761	0.3816	0.1417	0.2761	0.0971	0.3118
$\Delta(m-p)_{t-3}$	0.3473	0.0083***	0.1529	0.0972*	0.0932	0.2833	0.2428	0.0746*	0.1918	0.0410**
$\Delta(y)_{t-1}$	0.0838	0.6279	-0.0073	0.9085	0.2050	0.0036***	0.4162	0.1754	0.0226	0.6753
$\Delta(y)_{t-2}$	0.0015	0.9926	0.1152	0.0852*	0.1806	0.0326**	0.3113	0.3007	0.1213	0.0307**
$\Delta(y)_{t-3}$	0.3667	0.0277**	0.0664	0.3004	-0.0708	0.2676	0.4097	0.1828	0.1089	0.0492**
$\Delta(RS-RL)_{t-1}$	0.0005	0.0913*	0.0004	0.6198	0.0026	0.1483	0.0008	0.6735	0.0007	0.1954
$\Delta(RS-RL)_{t-2}$	0.0001	0.7690	0.0010	0.2267	-0.0012	0.5782	-0.0022	0.3042	-0.0004	0.5231
$\Delta(RS-RL)_{t-3}$	-0.0003	0.3584	0.0002	0.7910	0.0050	0.0089***	0.0052	0.0088***	0.0003	0.5432
EC_{t-1}	-0.0015	0.4030	-0.0155	0.0455**	-0.0830	0.0000***	-0.0337	0.1513	0.0119	0.0399**

4.5 Stability of the Results

As we have argued, the effectiveness and success of the intermediate monetary targets established by the ECB depend on a stable money demand function (see Section 1). Therefore, we need to check whether the estimated coefficients for the long run money demand are stable over time. For this, as Belke and Czudaj (2010) propose, we apply the Johansen procedure to obtain the coefficients of the cointegrating vectors sequentially letting the sample end after each year from 2003 on. With this we observe the evolution of the coefficient estimates and we verify whether they remain constant or whether they show relevant shifts. In this test, the four cases for which we do not find evidence of cointegration have been omitted. We have decided to set the starting year, 2003, the further as possible in order to be able to fully identify the effects that the pre-crisis overheating and the resultant global financial crisis in 2007 could have had in the stability of the money demand. We would have liked to set the beginning point before 2003 to catch other effects, as the dotcom bubble, but the samples of the Euro Area and Germany are very limited in the number of observations to do it.

Tables 9 and 10 show the obtained cointegrating vectors for this testing procedure. We have decided to divide the analyzed cases in two groups based in the nature of the results. For the cases included in the table 9, Germany, Netherlands and Spain, there is evidence that the estimated coefficients of both regressors are stable over time. Therefore, for these cases we can confirm the existence of a stable long run relation, and consequently a stable money demand. On the other hand, in the table 10 we have included the cases in which stability in the estimated coefficients is seen except for the years between 2005 and 2009. Here we found the whole Euro Area, Austria, Finland and Italy. This behavior shows that the rapid monetary growth in the pre-crisis years and the subsequent financial instability have had a disturbing effect in the preexisting stability in the money demand. However, from 2010 on the stability reappears until the end of the series, showing that the unsteadiness is just a circumstantial effect of the imbalances in the money market.

Table 9 Results of the Johansen procedure with different sample upper limits

	Germany		Netherlands		Spain	
	β_1	β_2	β_1	β_2	β_1	β_2
2003:IV	2.89	0.04	1.80	0.08	1.12	0.07
2004:IV	2.15	0.06	1.96	0.06	1.16	0.07
2005:IV	2.47	0.06	2.23	0.10	1.10	0.07
2006:IV	2.39	0.04	1.98	0.04	1.12	0.07
2007:IV	2.42	0.03	1.97	0.04	1.07	0.07
2008:IV	2.51	0.02	1.99	0.04	0.91	0.08
2009:IV	2.57	0.03	2.25	0.08	1.00	0.08
2010:IV	2.61	0.03	2.39	0.10	1.07	0.09
2011:IV	2.79	0.02	2.69	0.14	1.02	0.09
2012:IV	2.60	0.03	2.36	0.09	1.02	0.09
2013:IV	2.33	0.04	1.93	0.01	1.06	0.10

Table 10 Results of the Johansen procedure with different sample upper limits

	Euro Area		Austria		Finland		Italy	
	β_1	β_2	β_1	β_2	β_1	β_2	β_1	β_2
2003:IV	1.69	0.01	7.45	0.83	1.03	0.22	0.50	0.07
2004:IV	1.69	0.00	8.97	0.98	0.99	0.25	0.54	0.07
2005:IV	2.01	-0.02	-0.05	-0.07	6.62	-0.59	0.59	0.07
2006:IV	491.56	23.19	-1.12	-0.19	4.56	-0.38	0.76	0.07
2007:IV	-1.07	-0.16	-0.01	-0.06	3.18	-0.19	1.02	0.07
2008:IV	-2.89	-0.31	-0.14	-0.07	2.48	-0.10	1.08	0.07
2009:IV	3.62	0.14	12.67	1.01	1.76	0.03	0.95	0.07
2010:IV	2.04	0.23	3.12	0.22	1.57	0.06	0.60	0.07
2011:IV	2.04	0.15	3.15	0.25	1.45	0.07	0.48	0.07
2012:IV	2.04	0.12	3.14	0.23	1.47	0.08	0.51	0.06
2013:IV	1.98	0.12	2.99	0.21	1.47	0.08	0.48	0.07

This result is a clear evidence that the instability in the monetary markets has had a remarkable impact in the general stability of the money demand. This leads us to think that perhaps the non cointegration results that we observe for Belgium, France, Greece and Portugal are motivated by this situation. To test this idea, we have decided to apply the Johansen procedure to check the existence of cointegration sequentially letting the sample end after each year from 2003 on. In this way, we will be able to see whether there was a long run relation among the money demand variables before the monetary instability began, and if this is true, the moment in which this relation was broken. The table 11 shows the results of the application of this testing procedure. It contains for each country and for each upper limit the number of cointegrating vectors that trace statistic suggests there are.

Table 11 Number of cointegrating vectors for each country and upper limit

	Belgium	France	Greece	Portugal
2003:IV	1	2	0	1
2004:IV	1	1	0	1
2005:IV	1	1	0	1
2006:IV	1	1	0	1
2007:IV	1	2	0	1
2008:IV	1	1	0	1
2009:IV	0	0	0	1
2010:IV	0	0	0	0
2011:IV	0	0	0	0
2012:IV	0	0	0	0
2013:IV	0	0	0	0

In the case of Belgium and France we observe that there existed cointegration between the variables, but it was broken in 2009. The same pattern is seen in Portugal, where there was also a cointegration relation that was broken in 2010. For these three countries the existence of cointegration is supported in the pre-crisis period, but is not supported when the instability of the financial markets began to affect the monetary markets. This is a clear evidence that there existed a long run relation among $(m_t - p_t)$, (y_t) and $(RS_t - RL_t)$, which has been broken by the current economic instability. The case of Greece is very exceptional as it does not show any evidence of cointegration for any sample length.

Having all these results into account, we can extract the conclusion that the money market instability has affected people's decisions about holding money. However, this has had very different consequences depending on the country. For countries like Germany, Netherlands or Spain, the money demand and its coefficients have remained very stable, and therefore the evidence for cointegration is strong. In Austria, Finland, Italy, and the whole Euro Area, even if the long run relation has not been broken and we find evidence of cointegration, the monetary instability in the pre-crisis boom and in the first years of the financial crisis has made the money demand very instable. In this case the weight of the imbalances in last observations seems to be low, and therefore, when the whole period is considered the existence of cointegration between the variables is not broken. Finally, in Belgium, France and Portugal, the monetary instability that arose with European debt crisis after 2009 has made the money demand so instable, that the weight of these last observations has completely broken the long run relation as encapsulated in the money demand. As a bottom line, we can conclude that the money demand for the whole Euro Area and for most of its countries has not remained stable during the last years, with the exception of Germany, the Netherlands and Spain.

5 Conclusions

The main objective of this paper has been to examine the existence of a stable long run demand for money in the Euro Area and ten of its integrating economies, in order to verify whether the BCE's two pillar monetary policy was reliable. For this aim, our paper has examined the existence of cointegration among the variables that form the money demand by means of the Johansen approach. The obtained results show that there is a long run relationship between the real demand of broad money and its determinants for the aggregated Euro Area and most of its member countries. However, for most of the cases, this long run relationship happens to be instable in the last years due to the imbalances generated in the monetary markets by the pre-crisis financial overheating and the subsequent financial, economic and debt crises. The impact of these imbalances in the stability of the money demand has been very heterogeneous among the countries. For some of them, as Germany, Netherlands and Spain, the impact has been irrelevant, while for some others as Belgium, France, Greece and Portugal, the long run equilibrium relationship has been broken after 2009. These four cases, but specially the last two, are countries where the crisis has had a profound impact and has created important economic imbalances. Greece and Portugal have been bailed out and their debt interests have rocketed creating important distortions in their respective money markets. In this sense, although the effect of the crisis in Belgium and France has been more moderate, they have also experienced important distortions in their money markets.

In the whole Euro Area, as it happens in some countries as Austria, Finland and Italy, the monetary imbalances have made the money demand instable but they have not broken the relation contained in it. In this sense, in these countries the imbalances in the money markets began before the crisis, around the year 2005, when a very strong increase in the M3 assets held by the public not justified by any increase in any of the explanatory variable took place. This increase in the M3 can be seen in figures 1 and 2 and it shows the bubbling pattern of the speculation in the financial markets. With the arrival of the crisis this scenario reversed, people went back to their old money holding patterns and evidence of stability in the money demand appeared again by 2010.

In the light of these results, we can conclude that money demand in the Euro Area has not been stable in the last years. Hence, the BCE's strategy of setting annual monetary targets could not be very effective for achieving the objective of low controlled inflation in the current context of monetary imbalances. Since the link between money supply and inflation cannot be quoted to be stable, it cannot be assured that controlling the growth of the M3 monetary aggregate we can stabilize the inflation. Nevertheless, bearing in mind that for the periods before 2005 and after 2010 we find evidence of cointegration and stability in the money demand, monetary targeting could still be a useful tool for the ECB if it takes into account the possible problems that could arose in exceptional situations. In this sense, even if monetary targeting does not seem to be the best strategy for achieving inflation stability objectives, it can be a reliable indicator and an auxiliary method for avoiding imbalances that could lead to inflationary situations. In this sense, if the M3 growth figures had been observed more carefully in the booming years between 2005 and 2008, a very sharp increase in this variable could have been seen, indicating the enormous imbalances that were gestating in the monetary markets. Therefore, as long as the ECB uses monetary targeting as a complement in the two pillar strategy, this approach to the monetary policy could be completely reliable.

6 Final Comments

The same analysis shown in this paper has been conducted with monthly data for all the variables. However, since monthly GDP data series are not available for the Euro Area and for most of the considered countries, a disaggregation procedure has been used to obtain it. Specifically, we have disaggregated the quarterly data for nominal GDP to monthly data by means of the Industrial Production Index. The results obtained in this study have been totally inconclusive. They are very different for each one of the countries analyzed, but in general the hypothesis of cointegration has been rejected. We suspect that the overall rejection of the existence of a long run relation has been caused by the disaggregation procedures employed to obtain the monthly GDP data and not by the actual behavior of the variables. Since the use of monthly data for money demand analysis is not usual, we cannot compare these results with any other work to establish to which extent these results are reliable. In this sense, for a future possible extension of this paper we suggest the idea of conducting the same analysis only with the monthly data available, this is, without using any disaggregation technique. In this way, we would not have any potential disturbance, and we could contrast the results with the ones obtained with quarterly data.

In the theoretical and empirical literature about the demand of money there exist plenty of works that instead of the M3 monetary aggregate use the M2 or even the M1. In this sense, it could be suggested that perhaps it is better for the ECB to define its monetary targets in a more restricted definitions of money for which a stable demand could exist. Therefore, it could be interesting in future works to test this idea, verifying if the results of this paper are also obtained using other monetary aggregates. Additionally, some authors suggest from a theoretical point of view the existence of more explanatory variables for the long run money demand. In this sense, Friedman (1988) proposes the hypothesis that assets that constitute an alternative to money for portfolio decisions should affect the money demand. He put the focus primarily over the stock market, suggesting that stock price developments should affect money demand. According to this, it could be interesting in a further extension of this work to include other variables as the stock prices, in order to be able to test if this is a relevant explanatory variable.

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