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Money Demand in the Eurozone: Do Monetary Aggregates Matter?

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The definition of money demand and the study of its stability are still relevant issues, as the effects of monetary policies are also analyzed on the basis of the movements in the demand for money. Therefore, understanding the functioning of money demand is extremely important for monetary policy decisions. In this paper we study money demand in the euro-area, investigating if its estimated stability is influenced by the monetary aggregate employed. This aspect is particularly relevant in the context of the European Monetary Union (EMU), as the European Central Bank (ECB) conducts monetary policy on the basis of the broad money aggregate M3 and one of the most relevant problems for monetary policy decisions in this area is the instability of money demand. By employing panel data techniques, we are able to show that the stability of the relation between money demand and its determinants changes depending on the monetary aggregate (M1, M2 or M3) employed as a proxy for money demand. Moreover, money demand is substantially more stable when M2 is considered. Then, by switching from M3 to M2 as the reference monetary aggregate can increase the estimated money demand stability and improve the performance of the ECB's monetary policy. This result is also confirmed by splitting the sample in two separate groups of countries. Nevertheless, in less stable economies the impact of inflation on money demand is significantly higher, while in more stable economies the role of income is more relevant.

Keywords: *Money Demand, Monetary Policy, Euro-area, Panel Cointegration, Panel DOLS.*

Introduction

The determinants of money demand in the euro-area and its stability have been the scientific problem tackled by many authors. The interest in the eurozone money demand is due to the crucial role assigned to monetary aggregates by the ECB. It is worth noting that among the most important central banks, the ECB is the one assigning the most prominent role to money when conducting monetary policy.

The main monetary aggregate for the ECB is the broad money measure M3. The explanation for the choice of this monetary aggregate is the following:

"*The analysis of the broad monetary aggregate M3 should be seen from the medium to long-term perspective. It serves to remind the central bank of the fundamental principle that, while responding to economic developments, it must never lose sight of the fact that, over sufficiently extended horizons, the rate of money growth must be consistent with the price stability objective."* (ECB, 2013).

The ECB sets a reference value of 4,5 per cent for the annual growth of M3. Based on the assumption that velocity of money demand is fixed over time, the 4,5 reference value is considered consistent with the ECB's objective of price stability over the medium term.

(Goldfeld & Sichel, 1990) assert that a stable money demand has always been perceived as a precondition for the use of monetary aggregates in the conduct of monetary policy. However, in the presence of an unstable money demand function, (Lucas, 1976) stresses that it is not possible to postulate a constant conditional model for money demand. On the contrary, according to (Pradhan & Subramanian, 2003) a stable demand for money implies a stable money multiplier and then, it is possible to forecast the effects of monetary policy. Moreover, the stability of the demand for money is also seen as the pre-requisite of the non-neutrality of monetary policy (see Hamori & Tokihisa, 2001). Therefore, the effectiveness of a central bank's monetary policy significantly depends on a stable money demand function, since it ensures that the money supply will have unsurprising impacts on the macroeconomic indicators like inflation and national income.

Following the start of the euro in 1999, many empirical analyses have evidenced the instability of the M3-based money demand in the euro-area (see Beyer *et al.*, 2007; Fischer *et al.*, 2007). This evidence is also confirmed by the fact that euro-area consumer price inflation has been close to 2 % and it has been not volatile, while the growth of M3 has been above its reference value. This has been considered in the literature as a sign of the

instability of money demand in the euro-area. Nevertheless, it can be argued that the estimated degree of instability of money demand in the euro-area has been affected by the monetary aggregate used in most of the studies (M3). It seems worth investigating if the use of a wide monetary aggregate can play a significant role in the determination of the stability of money demand.

Therefore, the object of our study is money demand in the eurozone. The aim of the article is to assess the degree of stability of money demand in the eurozone and to understand if this degree depends on the monetary aggregate adopted to measure money.

The latter is the main novelty of the article as, to the best of our knowledge, this is the first study that evaluates the degree of stability of money demand depending on the monetary aggregate adopted. To fulfill the aim we analyze and compare the stability of money demand in the eurozone employing three different monetary aggregates: M1, M2 and M3. After performing unit root and cointegration analyses, we estimate three money demands for a panel of 11 EMU countries by adopting the Panel Dynamic Ordinary Least Squares (PDOLS) technique. Then, we evaluate the degree of stability of the estimated parameters by running window PDOLS regressions. We also repeat this exercise for two groups formed according to the economic stability of the countries in our dataset. These groups are named as PIIGS (Portugal, Italy, Ireland, Greece and Spain) and non-PIIGS (Germany, France, Belgium, Netherlands, Austria and Finland).

Our results are in line with the existing literature concerning the elasticities of the determinants of money demand. Moreover, we are able to show that when M2 is adopted, the estimated money demand in the eurozone is more stable when compared to M1 and M3 estimations. An indirect confirmation for the goodness of our result is the fact that in March 2006 the Federal Reserve, following a great instability of M3 and divergences between M2 and M3, stopped publishing data on the latter.

We also show that this result is not depending on the degree of economic stability, as the estimations of money demand in the separate groups confirm a higher stability of the parameters when M2 is adopted. Nevertheless, some differences can be highlighted. In particular the impact of inflation on money demand is significantly higher in less stable economies (PIIGS). On the other hand, the role of income in the determination of the demand for money is stronger in more stable economies (non-PIIGS).

Literature Review

According to economic theory, a basic representation of the long-run money demand should model it as depending on its opportunity cost and on income.

In the existing literature it is assumed that money demand should react positively to an increase in income. Moreover, an increase in the opportunity cost of money holdings should have a negative impact on money demand, as it measures the earnings from alternative assets. In general, empirical analyses rely on this specification, but in some cases other variables are included to explain the determinants of money demand. These variables can be inflation, exchange rates and different forms of wealth.

There is a vast literature on money demand adopting time series techniques (see for instance Capasso & Napolitano, 2012), and only in recent years some studies have started applying panel data methodologies to this topic. It is worth noting that adding a cross-sectional dimension to the data can solve some of the problems evidenced in studies adopting time-series techniques. (Mulligan & Sala-i-Martin, 1992), show that cross-section data may solve the problems concerning the sensitivity to the sample period and to the relevant interest rate, the non-stationarity and serial correlation of the error terms, the low statistical power of tests when the series are short, and the distortion of the income measure in the short-run. Therefore, we can assume that in a panel data analysis these problems are mitigated without any loss of information on the time dimension.

Despite a common evidence of positive estimated income elasticity, its values vary across different panel studies. Estimated income elasticity usually ranges between 1 and 2, but there are some exceptions in the literature. DOLS estimations by (Setzer & Wolff, 2013) provide income elasticity between 1 and 2 for the euro-area members' M3. By using the Autoregressive Distributed Lag (ARDL) model, (Nautz & Rondorf, 2011) find income elasticities between 1 and 2 for ten euro-area countries' M3. Similar conclusions are drawn by (Dreger *et al.*, 2007) employing Pedroni, Breitung and DOLS techniques for a panel of ten new member countries in EMU on M2. (Arnold & Roelands, 2010; Hamori & Hamori, 2008) highlight income elasticity above 2 for M3 and M1 in the EU adopting, respectively, cointegration and DOLS estimations. (Harb, 2004; Elbadawi & Schmidt-Hebbel, 2007; Hamori, 2008; Kumar *et al.*, 2010) estimate income elasticities below 1 for M1 in different groups of countries. DOLS estimations provide income elasticities between 1 and 2 in (Mark & Sul, 2003) for 19 OECD countries on M1, and by (Rao *et al.*, 2009) for eleven Asian countries adopting System Generalized Methods of Moments (SGMM).

Estimated interest rate semi-elasticity is negative in the great majority of the existing literature. Exceptions are in (Arnold & Roelands, 2010; Nautz & Rondorf, 2011; Harb, 2004). (Garcia-Hiernaux & Cerno, 2006) estimate a money demand function for a panel of 27 developed and developing countries using GMM and they find -0,004 and -0,005 interest rate semi-elasticities, while (Carrera, 2008) estimates a -0,008 semi-elasticity with the Pedroni technique for a panel of 15 Latin American countries. On the opposite, higher semi-elasticities are shown in (Dreger *et al.*, 2007; Setzer & Wolff, 2013). Both studies have the same estimated value of -0,09.

The literature focusing on the eurozone has also investigated the degree of stability of money demand in this area. Despite an early support for money demand stability, the general evidence has highlighted a substantial instability of money demand in the EMU (see for instance Beyer *et al.*, 2007; Fischer *et al.*, 2007; Gerlach & Svensson, 2003). As a consequence of this result, the recent literature has tried to understand the causes of the instability. It is worth noting that the majority of studies has tried to re-establish stability by including additional explicative variables in the money demand. All these studies have assumed that the main cause of money demand instability in the eurozone was the lack of

relevant explanatory variables. (Greiber & Lemke, 2005) investigate the role of macroeconomic uncertainty by adding economic sentiment indicators and financial markets characteristics in a money demand equation. (Carstensen, 2003) includes stock prices and stock market volatility to a standard money demand specification. (Boone and van den Noord, 2008; Nautz & Rondorf, 2011) try to measure the wealth effect on money demand by including in their equation different measures of wealth, like stock prices and house prices. (Dreger & Wolters, 2010) remove the short-run homogeneity restriction between money and prices.

Thus, the literature has mainly focused on the explanatory variables in order to understand the causes of money demand instability in the EMU, and the monetary aggregate commonly adopted to estimate the eurozone money demand has been M3. Nevertheless, it can be argued that the monetary aggregate used as a proxy for money demand can be another source of potential instability, and to the best of our knowledge this part of the analysis is missing in the literature on the euro-area. In this respect we think that, by comparing the stability of money demand in the euro-area with different monetary aggregates, this paper can be a relevant contribution to the understanding of the money demand and its instability in the EMU.

Data and Research Methodology

Our panel consists of eleven EMU countries with monthly observations spanning the period 1999:1–2012:3. The countries in the panel are Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain. Furthermore, we also split the counties in two groups (PIIGS and non-PIIGS).

In our panel analysis the long-run money demand (M^d) is a linear function of income (Y), short-term interest rate (R) and inflation (π):

$$\ln M_{i,t}^{d} = \alpha_i + \beta_{1,i} \ln Y_{i,t} + \beta_{2,i} R_{i,t} + \beta_{3,i} \pi_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where α_i is the estimated constant. $\beta_{1,i}$, $\beta_{2,i}$ and $\beta_{3,i}$ are the estimated parameters explaining the effects of income, interest rate and inflation rate on money demand, respectively. $\varepsilon_{i,t}$ is the error term. Industrial production and the three-month treasury bill interest rate are used as proxies for Y and R, while CPI growth rate is used as a proxy for π. Moreover, based on equation (1), we estimate three long-run equations in which money demand is approximated by three different monetary aggregates (*M1*, *M2* and *M3*). In order to estimate the long-run money demand, we employ the Dynamic Ordinary Least Square (DOLS) estimator proposed by (Mark & Sul, 2003). A panel DOLS estimator extends the DOLS method introduced by (Saikkonen, 1991; Stock & Watson, 1993) to panel data, by augmenting the estimated relation with lead and lag differences of the explanatory variables to control for endogeneity and serial correlation of the regressors.

According to (Hlouskova & Wagner, 2010), the DOLS estimator outperforms all other single equation estimators and system estimators analyzed, even for large samples. Moreover, (Harris & Sollis, 2003) suggest that non-parametric approaches, such as Fully Modified Ordinary Least Squares (FMLOS), are less robust if the data have significant outliers and they also show some problems when the residuals have large negative moving average components. It is worth noting that both situations are quite common in macro time series data. The DOLS estimator is also able to correct standard OLS for the bias due to endogeneity and serial correlation. Lead and lagged differences of the dependent variable are included to account for serial correlation (see Stock & Watson, 1993). The regression is also augmented by lead and lagged differences of the explanatory variables in order to control for endogenous feedbacks (Saikkonen, 1991).

Following the estimation of the elasticities of money demand to income, interest rate and inflation we are able to hypothesize a money demand function. Nevertheless, the validity of this equation and its suitability for the understanding of the reactions of money demand depend on the degree of stability of the estimated coefficients. Therefore, we also investigate the stability of our money demand and we try to understand whether the coefficients of the function are changing over time or are stable. This analysis is performed with a sequence of regressions for a moving window of specified length (hereafter we refer to these as window regressions). After all these regressions are run, it is possible to plot the series of coefficients in order to understand how stable is the relation between the money demand and each determinant (for a similar approach applied to money demand, see Foresti & Napolitano, 2013). Moreover, in order to have clear-cut results, it is also possible to calculate the standard deviations of the estimated series of parameters.

Empirical Results

The first step of our empirical analysis requires the investigation of the properties of the panel data in order to understand whether there is a long-run relation among the variables. The results of the three panel unit root tests employed are reported in table 1. From these tests it can be concluded that there is a clear evidence for non-stationarity of all variables. At the same time, table 1 also shows that all the variables employed are stationary in their first difference. Hence, the results in table 1 establish a premise for a possible cointegration among the variables in our panel.

Table 1

Panel Unit Root Tests

Series	Tests		
	IPS	**ADF**	**PP**
$\ln M1_{i,t}$	0,04	32,24*	25,81
$\ln M2_{i,t}$	2,22	9,98	11,6
$\ln M3_{i,t}$	1,31	10,94	9,85
$\ln Y_{i,t}$	-2,89***	9,35	8,96
$R_{i,t}$	-1,56*	25,6	38,97
$\pi_{i,t}$	-0,05	20,06	50,45***
$\Delta \ln M1_{i,t}$	-19,72***	394,3***	976,5***
$\Delta \ln M2_{i,t}$	-15,51***	288***	1003,5***
$\Delta \ln M3_{i,t}$	-14,58***	261,8***	1015,6***
$\Delta \ln Y_{i,t}$	-24,43***	521,05***	602,5***
$\Delta R_{i,t}$	-10,82***	172,7***	495,9***
$\Delta \pi_{i,t}$	-11,45***	182,15***	769,3***

Tests are: Im, Pesaran & Shin, 2003 (IPS); ADF Fisher χ^2 (ADF); PP Fisher χ^2 (due to Maddala & Wu; 1999).
****, **, and * reject the null at 1 %, 5 % and 10 % respectively.*

Therefore, in order to test for a possible long-run relation among the variables we apply the (Pedroni, 1999) panel cointegration test and the results from a total of seven different panel test statistics are reported in Table 2.

Table 2

Panel Cointegration Tests

Tests	$lnM1_{i,t}$	$lnM2_{i,t}$	$lnM3_{i,t}$
Panel v-Statistic	-2,98***	3,83***	3,88***
Panel rho-Statisitc	-3,18***	-31,93***	-31,41***
Panel PP-Statistic	-3,84***	-25,49***	-24,84***
Panel ADF-Statisitc	-0,18	-16,47***	-15,86***
Group rho-Statistic	-5,41***	-20,41***	-19,29***
Group PP-Statistic	-4,24	-16,43***	-15,68***
Group ADF-Statistic	-1,39	-10,88***	-10,46***
***, **, and * reject the null at 1%, 5% and 10% respectively.			

We report the results for [M1, Y, R, π], [M2, Y, R, π] and [M3, Y, R, π] respectively in the three columns. We find that all the seven tests highlight panel cointegration between M2 and M3 with their proposed determinants at the 1 % level. Four tests out of seven also show evidence that M1 and its determinants are cointegrated at 1 % significance level. Having established that a long-run relationship exists among [M1, Y, R, π], [M2, Y, R, π] and [M3, Y, R, π] in our panel, we can study the long-run elasticities of the impact of income, inflation and domestic interest rates on money demand. Hence, we estimate equation (1) three times, using different measures for money demand. The results of the panel estimations are reported in table 3.

Table 3

Money Demand Panel DOLS Estimation

Dependent Variable	α_i	$lnY_{i,t}$	$R_{i,t}$	$\pi_{i,t}$
$lnM1_{i,t}$	3,68*** (0,25)	1,14*** (0,05)	-0,071*** (0,004)	-0,04*** (0,005)
$lnM2_{i,t}$	6,93*** (0,20)	0,49*** (0,04)	-0,05*** (0,003)	−0,02*** (0,004)
$lnM3_{i,t}$	6,71*** (0,19)	0,58*** (0,04)	-0,05*** (0,003)	−0,02*** (0,004)
****, **, and * reject the null at 1 %, 5 % and 10 % respectively. Standard errors in brackets.*				

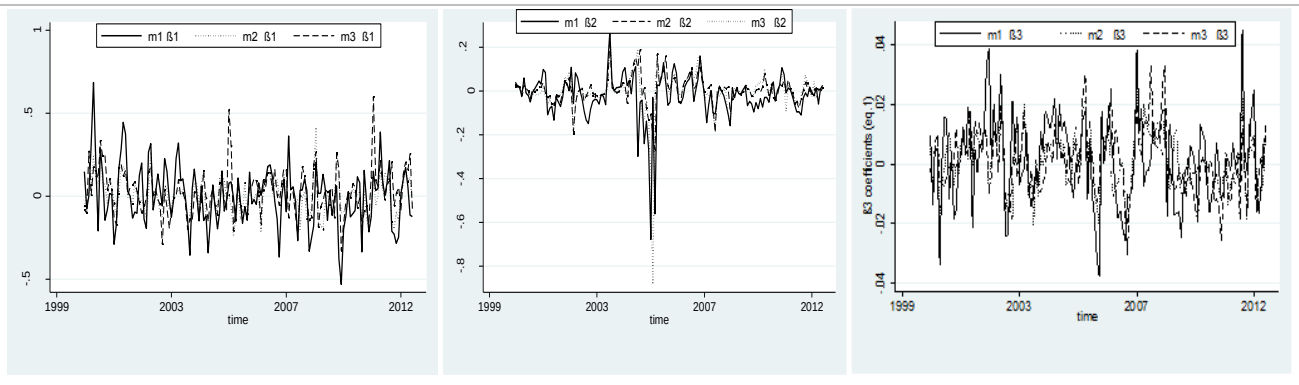
All the signs of the coefficients are in line with the existing literature, independently of the proxy used for money demand. An increase in the short-run interest rate reduces the demand for money due to the increase in its opportunity cost, while an increase in income augments money demand because of the increasing transactions. An increase in inflation reduces the demand for money. In terms of the estimated elasticities, our results show that adopting M2 or M3 as proxies for money demand yields similar results. In both regressions the estimated semi-elasticity of money demand to the interest rate is -0,05, while the one to inflation is -0,02. The main difference between the two estimations concerns the elasticity of money demand to income that is 0,58 for M3 and 0,49 for M2. Despite the similarities between the estimated parameters, when M2 and M3 are used as dependent variable it can be shown that they differ substantially in terms of stability. Figure 1 groups the series of the estimated parameters from the window regressions of the three equations.

From these figures we can conclude that when money demand is represented by M2 the relations with its determinants are more stable. In order to have clear-cut results we also compute the standard deviations of the series presented in figure 1 (A), (B) and (C), and we report these results in table 4. Once again, the results highlight that the estimated relations that use M2 are more stable than the estimations obtained with M1 and M3. Then, we can conclude that the evidence from the entire panel of EMU countries is that the monetary aggregate used to estimate money demand does matter and affects the results. Furthermore, more stable relations are obtained when M2 is employed, as the lowest standard deviations of the estimated parameters are obtained from the specification in which money demand is represented by M2.

Table 4

Stability: Standard Deviations of the Estimated Coefficients Series

Dependent Variable	$lnY_{i,t}$	$R_{i,t}$	$\pi_{i,t}$
$lnM1_{i,t}$	0,179	0,104	0,014
$lnM2_{i,t}$	0,11	0,063	0,009
$lnM3_{i,t}$	0,140	0,101	0,011



(A) Income (B) Interest Rate (C) Inflation Rate

Figure 1. Coefficients Series from Window Regressions of Entire Panel.

In this case, the estimated standard deviations are 0,009 for inflation, 0,06 for the interest rate and 0,11 for income, resulting substantially lower than the standard deviations obtained using M1 or M3 as proxies.

It can be inferred that some heterogeneities may characterize our panel, as the countries in our dataset have experienced different economic situations and are based on different economic traditions. Some of the countries in the sample are characterized by less stable economies and have undergone a period of evident economic problems starting from 2007.

This group is commonly referred as PIIGS countries, due to the acronym made of the initial letters of the countries that experienced the most severe problems during the recent two crises (Portugal, Italy, Ireland, Greece and Spain). On the other side, countries like Germany, Belgium, Netherlands and France have experienced a more stable economic history after the introduction of the euro.

These differences may have influenced the stability of money demand in such countries. Therefore, we investigate whether the demand for money has different characteristics in the two groups by re-estimating our money demand function for the PIIGS and non-PIIGS countries.

Table 5

Money Demand Group Panel DOLS Estimation

Dependent Variable	**Non-PIIGS**			
	α_i	$lnY_{i,t}$	$R_{i,t}$	$\pi_{i,t}$
$lnM1_{i,t}$	4,01*** (0,22)	1,03*** (0,05)	-0,073*** (0,004)	-0,009 (0,006)
$lnM2_{i,t}$	5,79*** (0,21)	0,78*** (0,05)	-0,05*** (0,004)	−0,001 (0,006)
$lnM3_{i,t}$	5,49*** (0,21)	0,92*** (0,04)	-0,05*** (0,004)	−0,007 (0,006)
	PIIGS			
	α_i	$lnY_{i,t}$	$R_{i,t}$	$\pi_{i,t}$
$lnM1_{i,t}$	4,48*** (1,61)	0,68* (0,05)	-0,04 (0,35)	-0,1*** (0,02)
$lnM2_{i,t}$	7,73*** (0,37)	0,08 (0,06)	-0,05*** (0,005)	−0,02 (0,004)
$lnM3_{i,t}$	7,48*** (0,36)	0,15*** (0,57)	-0,03*** (0,004)	−0,18*** (0,004)

****, **, and * reject the null at 1 %, 5 % and 10 % respectively. Standard errors in brackets.*

Table 5 reports the results obtained from the estimations of the two groups of countries. The estimation of money demand in the group non-PIIGS highlights how the euro-area members with more stable economies show results in line with the entire panel estimation in terms of reaction to the interest rate. Nevertheless, the impact of the rate of inflation is less important in explaining their demand for money. It can be inferred that the lower rates of inflation have undermined its importance in the explanation of money demand in this group of countries.

On the other side, the impact of income on M2 and M3 is substantially higher than in the whole panel.

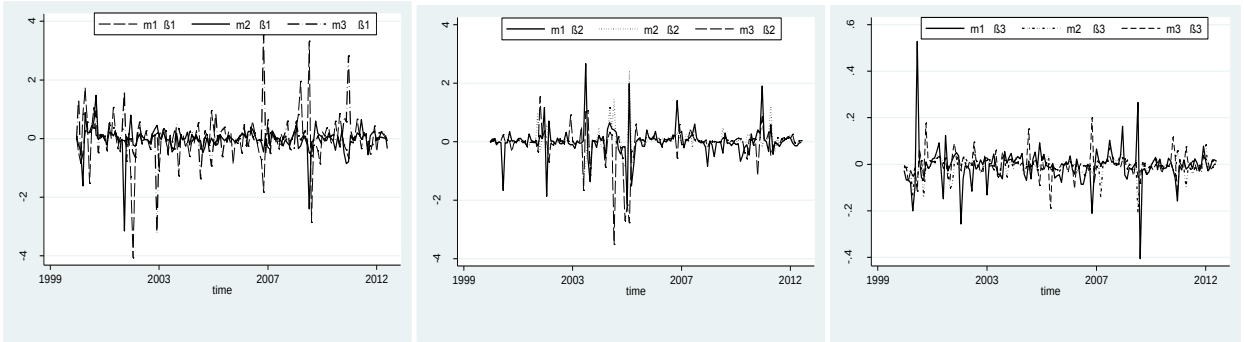
The group of countries with less stable economies show somehow different results. The elasticity of money to variations in output is consistently low, even if for M2 the parameter is not statistically significant. On the other side, in these countries the reaction to inflation variations is stronger for both M1 and M3.

Table 6 reports the results concerning the stability of the parameters for the two groups of countries, while figures 2 and 3 plot the series of the estimated coefficients from the window regressions. Our results confirm the evidence that estimated money demand is more stable when M2 is used as a proxy for money demand for both groups. Despite this result, it seems worth noting that in the PIIGS group a general lower stability is evidenced, and it can be interpreted as a result of the more turbulent economic history of the countries in this group.

Table 6

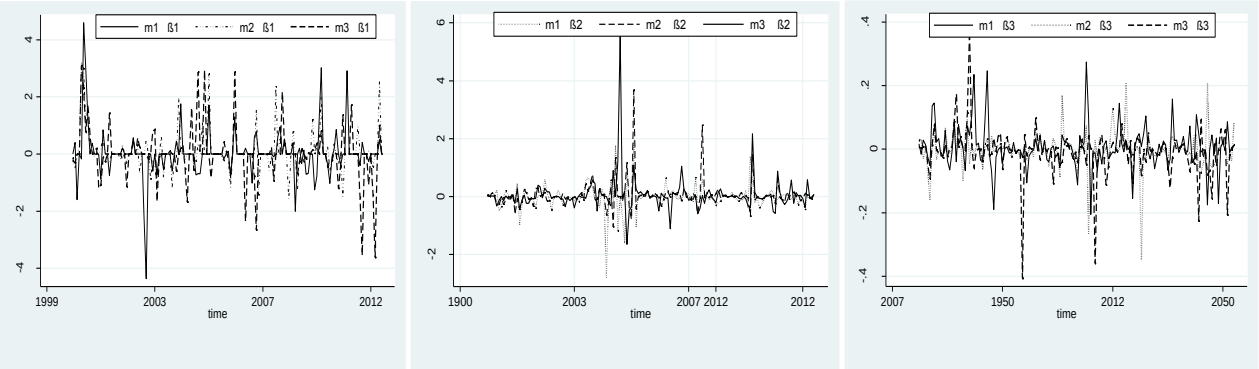
Stability: Group Standard Deviations of the Estimated Coefficients Series

Dependent Variable	**Non-PIIGS**		
	$lnY_{i,t}$	$R_{i,t}$	$\pi_{i,t}$
$lnM1_{i,t}$	0,698	0,537	0,082
$lnM2_{i,t}$	0,448	0,376	0,039
$lnM3_{i,t}$	0,598	0,583	0,046
	PIIGS		
	$lnY_{i,t}$	$R_{i,t}$	$\pi_{i,t}$
$lnM1_{i,t}$	0,852	0,471	0,067
$lnM2_{i,t}$	0,723	0,461	0,060
$lnM3_{i,t}$	0,925	0,597	0,073



(A) Income (B) Interest Rate (C) Inflation Rate

Figure 2. Coefficients Series from Window Regressions of non-PIIGS Countries.



(A) Income (B) Interest Rate (C) Inflation Rate

Figure 3. Coefficients Series from Window Regressions of non-PIIGS Countries.

Conclusion

A fundamental principle of monetary theory is that central banks can control the monetary aggregates and forecast their growth paths. To this aim, monetary policymakers have to verify the stability of money demand and test if there exists a long-run relationship between money demand and its determinants.

In this work, we have examined the stability of money demand function in the eurozone. Large part of the existing empirical studies on the EMU agrees on the instability of money demand. Based on the fact that the ECB has a reference value of M3 for its monetary policy, all these studies rely only on this monetary aggregate as a proxy for money demand.

Therefore, we have studied whether the degree of stability of money demand can be affected by the monetary aggregate chosen as a proxy for money demand.

The findings of this study recommend that the monetary aggregate chosen does matter, and the money demand based on the aggregate M2 is more stable. We can then conclude that M2 should be considered as a better target for monetary policy in the EMU. This conclusion is very important for the engineering of monetary policy and for the architecture of financial markets in the EMU.

The increase in money demand stability can ease the postulation of a constant conditional model for money demand. Moreover, a more stable demand for money implies a more stable money multiplier and then, better forecasts of the effects of monetary policy for the ECB as well as for the financial markets.

The higher stability of money demand, when M2 is adopted as a proxy for money demand, is also confirmed after splitting our dataset in two groups of countries. Nevertheless, countries with a more turbulent economic history show less stable money demand and a higher influence of inflation on money demand while, in countries with more stable economies, the variable to which money demand has the strongest reaction is income.

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