Monetary Asset Substitution in the Euro Area

Zagaglia, Paolo

Modelling Division, Sveriges Riksbank

14 October 2009

Monetary Asset Substitution in the Euro Area

Paolo Zagaglia*

This version: October 14, 2009

Abstract

I estimate time-varying elasticities of substitution between monetary assets for the Euro area using the semi-nonparametric method of Gallant (1981). The estimated elasticities suggest are consistent with the assumption of imperfect substitution between asset. Furthermore, the elasticities provide little evidence for the presence of structural breaks in money demand in the period 2001-2003 suggested by ECB (2003).

Keywords: money demand, public debt, nonparametric methods.

JEL Classification: C14, C63, E41.

*Modelling Division, Sveriges Riksbank. E-mail: paolo.zagaglia@gmail.com. Web: http://pz.pcriot.com. This paper was written while I was visiting the Research Unit of the Bank of Finland, whose kind hospitality is gratefully acknowledged.I have benefitted from suggestions and comments from Juha Kilponen, Jouko Vilmunen, Massimo Rostagno and Ulf Söderström.

"*In a world involving no transaction friction and no uncertainty, there would be no reason for a spread between the yield on any two assets, and hence there would be no difference in the yield on money and on securities. (...) In such a world securities themselves would circulate as money and be acceptable in transactions; demand bank deposits would bear interest, just as they did in this country in the period of the twenties.*"

Samuelson (1947), p. 123

1 Introduction

The monetary policy strategy of the European Central Bank (ECB) contemplates a monetary pillar. Various measures of money growth are monitored or 'money gap' are monitored to extract information on inflation for the medium and long term (see ECB, 2008). Although quite a lot of empirical evidence is available on the interpretation of the structural determinants of money growth in the Euro area (e.g., see ECB, 2009), there are no established empirical facts on the how the relative holdings of monetary assets evolve over time. This is somewhat surprising because knowledge of the degree of substitution between monetary assets could inform the policy options of the ECB, especially during the ongoing episode of financial market turmoil. As Walsh (2004) notes, the available literature on monetary policy at low nominal interest rates suggests that

> *(t)he possibility that altering the relative supply of short-term and long-term securities will have real effects is based on the idea that different assets are imperfect substitutes. (...) (T)he empirical evidence for imperfect asset substitutability is limited. What evidence does exist suggests a relatively high degree of substitutability."*

In this note, I use the semi-nonparametric method of Gallant (1981) to estimate time-varying elasticities of substitution between monetary assets for the Euro area over the period January 1995-June 2007. The results show that the elasticities are remarkably stable in a region of values that is consistent with imperfect substitution. Between 2001 and 2004 massive portfolio shifts took place in the Euro area from equity to money balances. ECB (2003, 2004) suggests that this was caused by heightened risk aversion in the wake of financial market instability. Differently from these types of analyses, the estimated elasticities provide no evidence of structural breaks in money demand for the Euro area.

The paper is organized as follows. Section 2 outlines the empirical model and the concept of elasticity of substitution used in the paper. Section 3 discusses both the construction of the dataset and the estimation results.

2 The demand system approach

The standard approach for the estimation of substitution elasticities relies on the specification of a conditional demand system of assets from the two-stage utility maximization problem of a representative consumer. The first-stage problem consists in the choice of the expenditure level for each asset. The second problem, instead, is based on utility maximization for a given aggregate expenditure level. The solution of the second step yields a conditional Marshallian demand function and a conditional indirect utility which is then used to calculate the elasticities of substitution (see Barnett, Fisher and Serletis, 1992).[1]

[1] The indirect utility function measures consumer's utility at a given price and wealth level.

The demand system for assets is obtained from the household's indirect utility function $g(x, \theta)$, where x is a vector of normalized asset prices or user costs, and θ is a parameter vector. Roy's identity can be used to compute the expenditure share of each asset. Instead of specifying a functional form for indirect utility, Gallant (1981) introduces the semi-nonparametric Fourier approximation

$$g^*(x, \theta) = u_0 + b'x + \frac{1}{2}x'Cx + \sum_{\alpha=1}^{A} \left[u_{0,\alpha} + \sum_{j=1}^{J} \left(u_{j,\alpha} \cos(jk'_\alpha x) - v_{j,\alpha} \sin(jk'_\alpha x) \right) \right], \quad (1)$$

where $C = -\sum_{\alpha=1}^{A} u_{0,\alpha} k_\alpha k'_\alpha$, the parameter vector is $\theta := \{b, u_{0,\alpha}, u_{j,\alpha}, v_{j,\alpha}\}$ for $\alpha = 1, \ldots A$ and $j = 1, \ldots J$, and k_α denotes the partial differentiation of the utility function. After applying Roy's identity to equation 1, a Fourier system of shares

$$s_i(x, \theta) = \frac{x_i b_i - \sum_{\alpha=1}^{A} \left[u_{0,\alpha} x' k_\alpha + 2 \sum_{j=1}^{J} \left(u_{j,\alpha} \cos(jk'_\alpha x) - v_{j,\alpha} \sin(jk'_\alpha x) \right) \right] k'_{i,\alpha} x_i}{b'x - \sum_{\alpha=1}^{A} \left[u_{0,\alpha} x' k_\alpha + 2 \sum_{j=1}^{J} \left(u_{j,\alpha} \cos(jk'_\alpha x) - v_{j,\alpha} \sin(jk'_\alpha x) \right) \right] k'_\alpha x} \quad (2)$$

is obtained. This allows to set up a system of expenditure shares for each asset. In the empirical application, I estimate a system of four share equations

$$s_t = f(x_t, \theta) + e_t \quad (3)$$

with additive errors $e_t = \rho e_{t-1} + \epsilon_t$, and ϵ_t is a white noise with constant covariance matrix. Since the shares sum up to unity, the covariance matrix of the error term is singular. Hence maximum likelihood estimates can be obtained by dropping any equation.

There is a large literature on measures for the degree of substitution in asset demand systems for the U.S. economy. Davis and Gauger (1996) show that, when more than two assets are included in the household's budget constraint, the Hicksian elasticity of substitution should not be used. In this paper, I use the Morishima elasticity $ME_{i,j}$ between assets i and j is equal to $s_i\left(\sigma_{j,i} - \sigma_{i,i}\right)$, where $\sigma_{j,i}$ is the Allen-Uzawa elasticity. Computing the elasticities of substitution requires differentiating the Fourier flexible form.[2] This means that the elasticities are a function of both the parameters and the expenditure shares. Hence, the flexible Fourier form produces point estimates for the elasticities over the available sample.

3 Results

The dataset consists of four assets for the Euro area at a monthly frequency, measured as end-of-period stocks: M1, consisting of currency, demand deposits, and interest-bearing checkable deposits in M1 (denoted as 1); the non-term assets in M2, consisting of savings deposits, money market accounts and money market mutual funds (denoted as 2); the outstanding amounts of central government's short and long-term debt securities (denoted as 3 and 4 respectively). The sample spans from January 1995 to June 2007.

All the asset quantities are deflated by the price level. The normalized user costs are defined as $x_i = (R - r_i)/(1 + R)$, where R is the interest rate on the benchmark asset, and r_i is the asset's own rate (see Barnett, 1978). The benchmark rate is the yield on a 3-month government bond. I

[2] Gallant (1981) reports the formulas for compensated elasticities.

assume that the own price of M1 is the average rate on demand deposits for the Euro area. The user cost of M2 is the return on money market funds. Finally, I use the yields on 1 and 10-year bonds as proxies for the prices of short and long-term bonds. The data on quantities are available from the ECB's Statistical Data Warehouse. The user costs on non-bond assets have been downloaded from Datastream.

Figure 1 reports the estimated series of Morishima elasticity. Table 1 includes some selected statistics for both the point estimates and the standard deviations. The mean elasticities are significant at standard confidence levels. A number of stylized facts are worth stressing. The elasticities vary to some extent. However, they are rather stable as they change within narrow ranges. The substitution elasticity between holdings of medium-term bonds and M1 ($M_{3,1}$) jumps in 2002. The estimates of substitution between long-term bonds and M1 ($M_{4,1}$), instead, follows an upward trend from 1999 throughout 2001. This suggests that the money demand surge of 2001-2003 may not have induced a structural break in the relationship between government bond holdings and liquid assets.

The result of interest is that all the estimated elasticities of substitution are marginally higher than one, and are broadly in line to those of Jones et al. (2008) for the U.S. This holds also for the relation between long-term and short-term bonds. Furthermore, the degree of substitution between bonds, as well as between bonds and the liquid assets is not as high in absolute value. The overall picture indicates that the assumption of imperfect substitution between bonds and money is supported by the data.

References

Barnett, William A. (1978), "The User Cost of Money," *Economics Letters*, 1 (2), 145–149.

Barnett, William A., Douglas Fisher, and Apostolos Serletis (1992), "Consumer Theory and the Demand for Money," *Journal of Economic Literature*, 30, 2086–2129.

Davis, George C., and Jean Gauger (1996), "Measuring Substitution in Monetary-Asset Demand Systems," *Journal of Business and Economic Statistics*, 14(2), 203-208.

European Central Bank (2003), "Estimating the Size of Portfolio Shifts from Equity to Money," *Monthly Bulletin* 5, 11-14.

European Central Bank (2004), "Recent Trends in Portfolio Allocation Between Monetary and Longer-Term Financial Assets," *Monthly Bulletin* 7, 13-14.

European Central Bank (2005), "Approaches to Identifying and Estimating Portfolio Shifts Into and Out of M3," *Monthly Bulletin* 1, 13-17.

European Central Bank (2008), "Underlying monetary dynamics: concept and quantitative illustration," *Monthly Bulletin* 5, 15-17.

European Central Bank (2009), "Tracking extraordinary portfolio shifts into money during the period of financial turmoil," *Monthly Bulletin*, 1, 17-19.

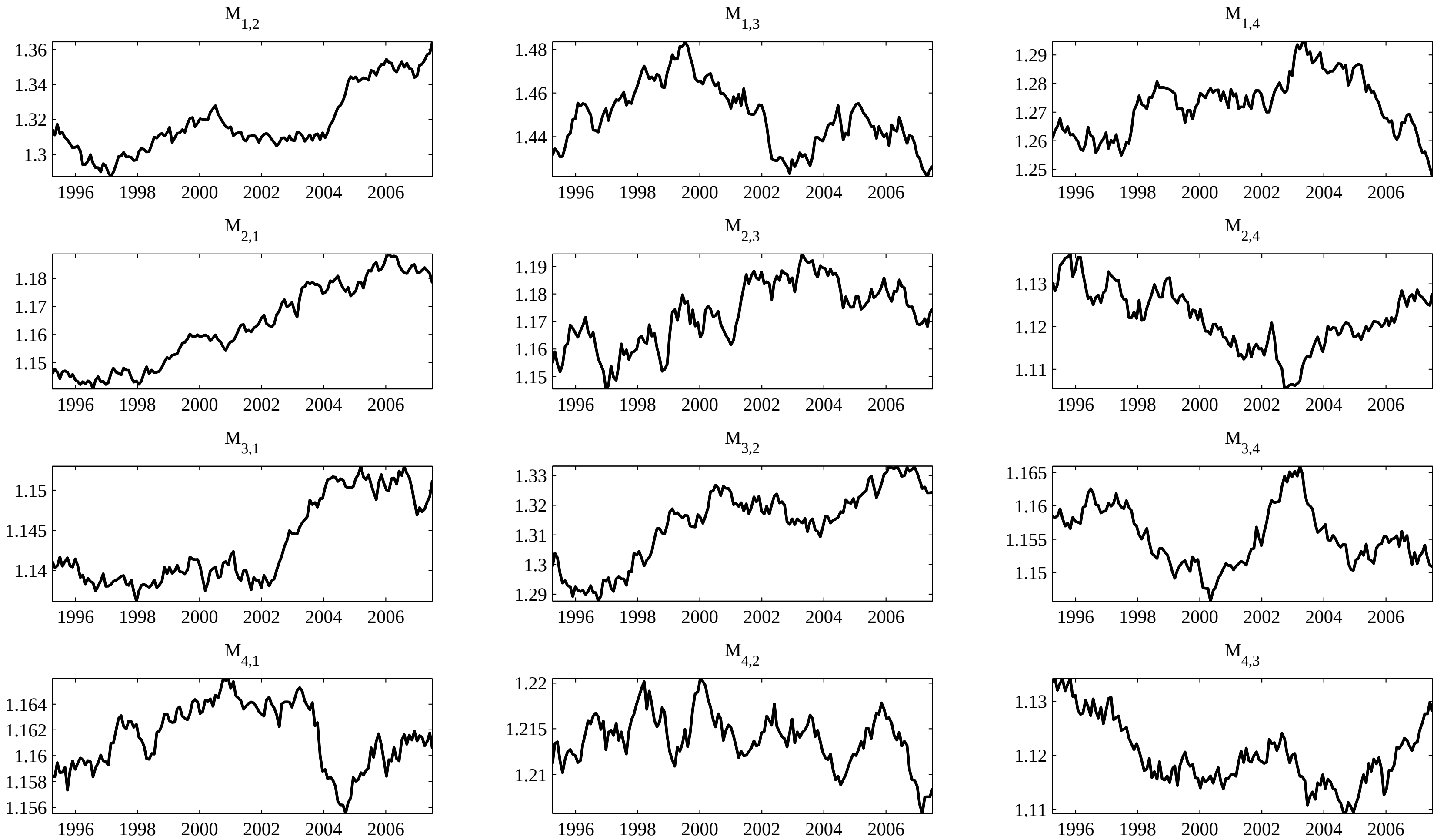
Gallant, Ronals A. (1981), "On the Bias in Flexible Functional Forms and an Essentially Unbiased Form," *Journal of Econometrics* 15, 211–245.

Jones, Barry E., Adrian R. Fleissig, Thomas Elger, and Donald H. Dutkowsky (2008), "Monetary Policy and Monetary Asset Substitution," *Economics Letters* 99, 18–22.

Samuelson, Paul A., (1947), *Foundations of Economic Analysis*, Harvard University Press, Cambridge.

Walsh, Carl E. (2004), "Comments on: Conducting Monetary Policy at Very Low Short-Term Interest Rates, by Ben S. Bernanke and Vincent Reinhart," ASSA Meetings, San Diego, January 3.

Figure 1: Estimated Morishima elasticities



Legend: This figures plots the Morishima elasticities $M_{i,j}$ of asset i with respect to asset j. The assets are M1 (denoted as 1), non-term assets in M2 (indicated as 2), monthly changes in outstanding amounts of short-term government bonds (reported as 3) and long-term bonds (denoted as 4).

Table 1: Statistics of estimated Morishima elasticities

Elasticity	Mean	St.dev.	Minimum	Maximum
$ME_{1,2}$	1.3183	0.3187	1.2874	1.3645
$ME_{1,3}$	1.4495	0.3146	1.4219	1.4834
$ME_{1,4}$	1.2726	0.1102	1.2475	1.2946
$ME_{2,1}$	1.1632	0.2149	1.1407	1.1887
$ME_{2,3}$	1.1730	0.2117	1.1455	1.1946
$ME_{2,4}$	1.1220	0.5071	1.1054	1.1370
$ME_{3,1}$	1.1434	0.5053	1.1362	1.1530
$ME_{3,2}$	1.3139	0.7126	1.2876	1.3332
$ME_{3,4}$	1.1843	0.0945	1.1744	1.1951
$ME_{4,1}$	1.1615	0.1025	1.1744	1.1660
$ME_{4,2}$	1.2140	0.3920	1.2057	1.2205
$ME_{4,3}$	1.1201	0.4160	1.1092	1.1342