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Stability of the Euro-Demand Function

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ABSTRACT

While the empirical literature on money demand is vast by any standards, it is relatively silent when it comes to the Euro, a major currency in the world. This hampers efforts, for example, to determine whether or not the European Central Bank can target monetary aggregates for inflation control. The difficulty has come from the lack of information about euro-wide monetary behavior, relying instead on speculative techniques for aggregating country-level data from previous periods of the European exchange rate mechanism. Now that we have six years of monthly data points, we investigate the stability of various Euro-zone monetary aggregates using the Bound Testing Procedure of Cointegration proposed by Pesaran et al. (2001) and study their policy implications.

JEL Classification: E41.

It is now widely accepted that monetary policy's primary goal is price stability. Monetary authorities face the difficult choice of a suitable strategy for monetary policy that effectively determines the amount and source of pressure placed on a country's price level. Over time, direct targeting of inflation has replaced use of monetary aggregates. While the literature on money demand has grown in leaps and bounds, it is relatively silent when it comes to the euro, one of the most unique and important currency of the world.

Were the European Central Bank (ECB) using inflation targeting solely as its monetary policy strategy, the absence of interest in the demand for the euro would be reasonable. However, the ECB employs a two-pillar strategy for the euro, one of which is the level of M3 versus some reference level and the other of which is everything else. Since its beginning, economic researchers have viewed the ECB as looking chiefly (only?) at everything else, while the bank itself has continued to insist there are two pillars. Otmar Issing [2006] stated that while the ECB could not simply adopt the monetary strategy of the Bundesbank that it would replace, it would have to have some strategy. The pillars in his view play complementary roles in the conduct of monetary policy.

> It was clear from the beginning that risks to price stability identified under the two pillars referred to different time horizons. The relation between "money" and prices is a long run phenomenon and short-term movements in monetary data do not necessarily give an indication on the need for policy actions. On the other hand, limiting the horizon of monetary policy to the information coming from the economic analysis would run the risk of conducting a short term oriented and "activist" monetary policy loosing side of trend developments. Money is therefore a kind of "natural" anchor for the longer term orientation of monetary policy. (p. 6)

Issing's statement required an appreciation of there being a long-run relationship between money and prices that transcended the uncertainty and noise that were expected in the joining of the European Monetary Union. With hindsight and data, we can now look to see if Mr. Issing was correct to rely on the existence of a long-run relationship. We do so by estimating a money demand function for the euro and place it within a strategy for monetary policy. While inflation targeting alone – the second pillar without the first – could still exist with a stable money demand function, money demand could be seen as a source of information of how far from an equilibrium price level the euro area is. We attempt to show this in this paper (a) whether there exists a long run relation (cointegration) between the three euro-zone different monetary aggregates, viz. M1, M2, and M3 and the underlying scale and interest rate variables; and (b) if any of these relations are indeed stable.

The rest of the paper is organized as follows: a review of related literature is provided in section II, followed by the model in section III, methodology and empirical results in section IV, summary and concluding remarks in section V.

II. Review of Related Literature

Monetary policy rules have been used in New Keynesian analysis to link the gap between actual and expected inflation from an IS curve to the output gap from a Phillips curve. Taylor rules frequently bridge the gap between the two. The LM curve has largely been abandoned from analysis due to its medium-term instability. Yet Coenen and Vega [2001] estimate three cointegrating vectors from an analysis of five variables – real GDP, real M3, short and long run interest rates, and the inflation rate. One of these

is a money demand function that relates real M3 to income, inflation and the spread between short- and long-term interest rates. The results are obtained on data through 1998 and show stability of euro area money demand.

That M2 has a stable, long run relationship with the relevant macro variables is accepted by most studies for the US. Using error correction modeling, Mehra (1991) examines the stability of both M1 and M2 and finds that M1 has no long term, stable relation whereas M2 does. Mehra (1993) further confirms this pattern. Hafer and Jensen (1991) incorporate two specifications for money demand, two monetary aggregates (M1 and M2) and two sample periods, viz. Pre-war (1915-38) and Post-war (1953-88) and come up with the same conclusion. Miller (1991) uses the Engle-Granger Cointegration approach and further confirms the stability of M2. Hoffman and Rasche (1991), however, find strong evidence of long run relationship between M1, 90-day Treasury bill rate, and real personal income. They claim that specification error may have resulted in unstable M1 in other studies.[1]

But the addition of a long-run money demand function does not preclude the use of monetary targets. To the contrary, price signals that reflect movements in aggregate supply of goods and services may prove a very useful additional signal to monetary policy makers. And if one argues that most major price level movements in the last quarter century have resulted from supply shocks, reliance solely on monetary targeting could prove inferior. For example Meyer [2001] argues that the replacement of the LM curve with a Taylor rule comes from the fact that central banks generally "implement monetary policy by setting a target for some key interest rate." He considers this a "more

[1] M2 also emerges to be the most stable monetary aggregate for much of the industrial world. See, for example, Karfakis and Parikh (1993) for Australia, Adam (1991) and Johansen (1992) for the UK, Muscatelli and Papi (1990) for Italy.

modern view" of monetary policymaking, and renders money supply as "a less interesting, minor endogenous variable".

> This approach is not, however, inconsistent with a stable empirical relation between money growth and other economic variables, specifically between money growth and inflation. In fact, if the money demand equation (underlying the LM curve) is stable, there will be a stable relationship between money and inflation in the long run.

Based on this observation, Meyer finds it possible for ECB to hold its two-pillar approach as providing useful information about the outcome of prices, at least in the long run.

> The ECB is very explicit about the fact that, in light of the short-term volatility of velocity, short-run deviations of money growth from the reference value might provide little useful information that would help policymakers adjust the stance of monetary policy. But in light of the more stable longer-term relationship, continued deviations would raise significant questions and should, at the least, require a careful reassessment of whether the prevailing monetary policy is consistent with the inflation objective.

Stability of money demand leads the Bundesbank in Germany to its use of monetary targets. When the ECB was created, the hope of other signatories to the Maastricht Treaty was that the Bundesbank's credibility would be transferred to the new central bank. It would be difficult to do so, however, without maintaining the mechanism and strategy of its monetary policy. Jürgen Stark, a member of the ECB executive board, said in a speech this past January,

> The ECB could thankfully rely on a strong record of success by our best performing predecessor central banks. This suggested to place emphasis on continuity in order to preserve credibility. At the same time, the ECB as a new institution faced a deeper set of uncertainties in managing a new currency area. It could not be taken for granted that previously established economic relationships and regularities would continue to hold after the transition to monetary union, since – as implied by the well-known "Lucas critique" – a change in policy regime as significant as the introduction of a new currency was likely to affect the behaviour of the private sector. This placed a premium on choosing a strategy framework that would prove robust to changing circumstances and would continue to stand the test of time in the face of new challenges.

Stark argued that, therefore, the ECB would need a complementarity of monetary and inflation targeting, even though most of the academic literature had moved to the latter as its preferred means of describing monetary policy. The two pillars are deployed in a temporal fashion:

> The monetary analysis serves as a means of cross-checking, from a medium to a long-term perspective, the short to medium-term indications coming from the economic analysis. In October 1998 the ECB assigned a prominent role to money in recognition of the close association between monetary growth and inflation in the medium to long run. Information from money and credit may help to identify risks to price stability at time horizons beyond those usually covered by conventional macroeconomic projections.
>
> The prominent role assigned to money in the ECB's strategy has been signalled by the announcement of a reference value for monetary growth. The reference value provides a rough benchmark around which a much broader set of analyses of money and credit is conducted. Grouping the monetary analysis under a distinct pillar helps to ensure that information on monetary developments is given appropriate weight in the decision-making process and is not crowded out by shorter-term considerations. From the outset, the Governing Council has stressed the medium-term horizon of the monetary perspective and emphasized that there is no mechanical link between short-term monetary developments and monetary policy decisions. (Stark [2007].)

Issing [2006] says the same thing:

> From the outset, the ECB has argued that a prominent role for money in its strategy did not imply a mechanical relationship between monthly out-turns for annual M3 growth and policy decisions. As I have already mentioned, the policy-relevant signal in money is in the low frequency or persistent component of monetary developments. The challenge is to identify in real time this underlying trend in monetary growth, which – at any specific moment – may differ in size and/or direction from developments in the annual M3 growth rate.

It therefore stands to reason that the reference value for monetary growth set by the ECB measures the equilibrium value for real money demand in the long run. We turn next to an estimate of this equilibrium value, employing a strategy that takes finding this long-run relationship in a parsimonious specification as its goal.

III. The Model

Researchers debate the choice of variables for money demand regressions. There is hardly any unanimity regarding the choice of the appropriate monetary aggregate, interest rate, and scale variable measures. We estimate the money demand equation employed by Coenen and Vega (2001):

$$ln\ (M/P)_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \qquad (1)$$

where M_t is the monetary aggregate M1, M2, or M3, $Y_{,t}$ is a scale variable, proxied by the index of industrial production, IBR_t is the inter bank rate (short-term interest rate) and GBY_t is the government bond yield (long-term interest rate) for the euro zone, P_t is the producer price index, and *INFLN* stands for the inflation rate measured by $\Delta\log(P_t)$.

While we expect *b* to be positive and *f* negative and significant in all cases, the signs of *c* and *d* can depend on the underlying monetary aggregate. For example, in the M1 equation they should both be negative since higher interest rates imply higher opportunity cost (price) of holding liquid money. However, this may not be true of the broader monetary aggregates because they do include some interest bearing assets, relatively less liquid assets.

IV. The Methodology and Empirical Results

Equation 1 above outlines the long-run relation (cointegration) among the variables of interest. We employ the Autoregressive Distributed Lag (ARDL) approach to cointegration, proposed by Pesaran, *et. al* (2001), and extensively used in recent works in similar context. Unlike its predecessors, viz. Engle-Granger cointegration Method (1987), and Johansen-cointegration technique (1990), the ARDL is free from unit-root testing and can be applied regardless of whether variables are I(0) or I(1).[2]

The error-correction version of the ARDL model pertaining to variables in equation 1 follows:

$$\begin{aligned} \Delta LnM_t &= a_i + \sum_{i=1}^{n} b_i \Delta LnY_{t-i} + \sum_{i=1}^{n} c_i \Delta IBR_{t-i} \\ &+ \sum_{i=1}^{n} d_i \Delta GBY_{t-i} + \sum_{i=1}^{n} f_i \Delta INFLN_{t-i} + \delta_1 LnM_{t-1} \qquad \ldots (2) \\ &+ \delta_2 LnY_{t-1} + \delta_3 IBR_{t-1} + \delta_4 GBY_{t-1} + \delta_5 INFLN_{t-1} + \varepsilon_t \end{aligned}$$

We estimate (2) in two-steps:

1. *Variable Addition Test* to test the significance of the lagged dependent variables in the error-correction model. This accomplished by a simple F-test where the null hypothesis of "*non-existence of cointegration*" (i.e., H_0: $\delta_1=\delta_2=\delta_3=\delta_4=\delta_5=0$) is tested against its alternative. Since the underlying F-statistic has a non-standard asymptotic distribution, Pesaran et al. (2001) provide a band comprising of two critical values, depending on the number of regressors and model type. If the value of the F-statistic exceeds the upper bound of this band, then the null may be rejected (i.e., the variables are cointegrated). If the value is less the lower bound, then the null can not be rejected. If the value falls within the band, the results are inconclusive and

[2]. Bahmani-Oskooee and Brooks (1999) has a good account of the details on using the ARDL approach.

unit root testing would be required. However, in such inconclusive cases, following Kremers et al. (1992), we look at the sign and significance of the error correction terms to infer cointegration.[3]

2. S*election of Optimal Lag Structure* in the error correction model, based on the Schwartz Bayesian Criterion (*SBC*). Given the relatively small sample size, SBC seems to be the natural choice as it yields relatively smaller lag-structures.

Several variants of Model 1, along with their error correction models, are estimated:

$$ln\ M1_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \quad (1.1)$$

$$ln\ M2_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \quad (1.2)$$

$$ln\ M3_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \quad (1.3)$$

where *M1/P*, *M2/P*, or *M3/P* are the three real monetary aggregates.

Since the progression from M1 to M2 to M3 involves addition of relatively less and less liquid assets, it is interesting to see how these added components respond to the underlying regressors (the scale variable, interest rate, and inflation). For example, assets accounting for the M2-M1 segment are less liquid than those included in M2-M1, and therefore, respond differently to interest rate changes. To study any such pattern we estimate three more equations:

$$ln\ M31_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \quad (1.4)$$

$$ln\ M21_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \quad (1.5)$$

$$ln\ M32_t = a + b\ ln\ Y_{,t} + c\ IBR_t + d\ GBY_t + f\ INFLN_t + \varepsilon_t \quad \ldots \quad (1.6)$$

[3] Since the F-test results depend on the number of lags imposed on each first differenced variable, we only report the value of the F-statistic for lag-structure chosen by SBC in step 2.

where *M31=(M3-M1)/P*, *M32=(M3-M2)/P*, and *M21=(M2-M1)/P* are the differences between the three monetary aggregates in real terms.

Is M3 the Most Stable Monetary Aggregate?

Table 1 shows the results from the F-test: Since the calculated value of the F-Statistic exceeds the 90% critical value of 3.57, we may reject the null hypothesis (of non-cointegration) in all cases except for equation 1.1 and 1.3. However, we notice that the coefficient of the error-correction term in Table 2, is negative in most cases, including model 1.3, indicating cointegraton amongst the underlying variables in most cases. In fact, it is clear from Table 3 that, equation 1.3, showing the results for M3, appears to be the most robust of all.[4] The variables have all expected signs and are significant. The demand for real M3 balances is income-elastic, and is highly sensitive to inflation. Interest elasticity remains relatively low, as hypothesized earlier. Moreover, as shown in figure 2, the CUSUM and CUSUMSQ stability tests confirm the stability of the estimated coefficients. Table 6 summarizes the stability test results for all equations.

Has the ECB been Targeting M3?

Figure 2 shows a plot of the error correction term from the M3 equation and the euro-area discount rate (marginal lending facility rate) for the sample period. A quick glance at this figure confirms that, indeed, the ECB has been closely following the real M3. For example, discount rate was raised above 4% during 2000M2 - 2002M11 when the ECM turned negative (meaning M3 had overshot its long-run equilibrium), and lowered to 3% starting with 2003M6 when the ECM started turning positive.

[4] An inspection of the corresponding error correction term in figure 1 visually confirms the stationarity of the same.

Which Segment is Most Stable?

Of the three segments estimated as in equations 1.4–1.7, the last one viz. the part corresponding to M3-M2 appears to be the most stable. While all variables including the error correction term behave as expected in all three cases, inflation takes a role reversal: it has a positive impact on the demand for real M3-M2. Unlike the other segments, this segment also tends to be income elastic which is to be expected. The Stability results from table 6 further confirm the robustness of equation 1.6.

IV. Summary and Concluding Remarks

The paper has investigated a long-run relationship among demand for real money, inter bank rate, govt bond yield, and index of industrial production in the euro-area. Among all the monetary aggregates, M3 is found to be the most stable. Our findings also confirm the stability of the M3-M2 component to be the most stable of all, viz. M2-M1, M3-M1, and M3-M2. A relatively recent, bound testing approach to cointegration was employed for the empirical analysis. Also the sample included actual data over the 1999M1-2006M3 period. The results are in line with previous findings confirming the stability of the euro-area broad money, M3.

References

Adams, C. S. (19910, "Financial innovation and the demand for M3 in the UK 1975-86," *Oxford Bulletin of Economics and Statistics*, **53**, 401-23

Coenen, G. and Vega, J, -L. (2001), "The demand for M3 in the Euro Area," *Journal of Applied Econometrics*, **16**, No. 6 (Nov.-Dec.), 727-748

Hafer, R.W. and Jensen, D. W. (1991), "The Demand for money in the United States: evidence from conintegration tests," *Journal of Money, Credit, and Banking*, **23**, 155-68.

Hoffman, D. L. and Rasche, R. H. (1991), "Long-run income and interest elasticities of money demand in the United States," *Review of Economics and Statistics,* **73**, 665-74

Issing, Otmar (2006), "Theory and practice of monetary policy." Speech at The Watchers Conference, Franfurt, 5 May 2006. Viewed online on March 15 at http://www.ecb.int/press/key/date/2006/html/sp060505_2.en.html

Johansen, S. (1992), "testing weak exogeniety and the order of cointegration in UK money demand data," *Journal of Policy Modeling*, **14**, 313-34

Karfakis, C. I. and Parikh, A. (1993), "A cointegration approach to monetary targeting in Australia," *Australian Economic Papers*, **32**, 53-70

Kremers, J. J., N. R. Ericsson, and J. J. Dolado (1992), "The power of cointegration tests" *Oxford Bulletin of Economics and Statistics*, 54 (3): Pp. 325-348

Mehra, Yash P (1991), "An error-correction model of U.S. M2 demand," *Economic Review*, May/June, 3-12

Mehra, Yash P (1993), "The Stability of the M2 Demand Function: Evidence from an Error-Correction Model," *Journal of Money, Credit and Banking*, **25**, No. 3, Part 1, Aug., pp. 455-460

Meyer, Laurence (2001) "Does Money Matter?" Homer Jones Memorial Lecture, Washington University, St. Louis, Missouri, March 28, 2001. Viewed online at http://www.federalreserve.gov/boardDocs/Speeches/2001/20010328/default.htm on 15 March, 2007.

Miller, Stephan M. (1991) "Monetary Dynamics: An Application of Cointegration and Error-Correction Modeling" *Journal of Money, Credit, and Banking,* **23, No.** 2*,* May, 123-154

Muscatelli, V. A. and Papi, L. (1990), "Cointegration, financial innovation, and modeling demand for money in Italy," *The Manchester School*, **58**, 242-59

Pesaran, H. M.; Shin, Y., Smith, R.J., (2001), "Bounds Testing Approach to the Analysis of Level Relationships," *Journal of Applied Econometrics,* **16**, 289-326.

Stark, Jürgen (2007), "Objectives and challenges of monetary policy: a view from the ECB." Speech at conference on inflation targeting, Magyar Nemzeti Bank, Budapest, 19 January 2007. Viewed online on March 15 at http://www.ecb.int/press/key/date/2007/html/sp070119.en.html.

Table 1: The F-test Results

From Error Correction Model corresponding to Equation:	*Value of F-Statistic*
1.1	3.40
1.2	21.21*
1.3	2.96
1.4	2.42
1.5	4.00*
1.6	4.02*

An asterisk (*) denotes significance at the 10% level. The 90% critical value corresponding to a model with 4 regressors and an intercept is 3.57.

Table 2: Coefficient Estimate of the Error-Correction Term Based on *SBC*

From Error Correction Model corresponding to Equation:	*Coefficient of* EC_{t-1}
1.1	-0.12 (1.60)
1.2	0.74* (5.49)
1.3	-0.11* (3.06)
1.4	-0.13* (1.96)
1.5	-0.11* (2.00)
1.6	-0.27* (4.41)

Note: Figures in parentheses represent absolute values of t-statistic. An asterisk (*) denotes significance at 5% level

Table 3: Estimated Long Run Coefficients Based on Schwartz Bayesian Criterion

Regressor	*Dependent Variable*		
	Log(M1/P)	*Log(M2/P)*	*Log(M3/P)*
Intercept	-3.50 (0.59)	-3.64* (7.20)	-3.44 (1.54)
LY	-1.64 (1.33)	1.65* (15.86)	1.71* (3.59)
IBR	-0.08* (3.07)	-0.06* (14.66)	-0.04* (3.56)
GBY	-0.11 (1.90)	0.01 (0.85)	-0.05* (2.53)
INFL	-9.43 (1.24)	0.60 (0.25)	-18.87* (3.43)

Note: Figures in parentheses represent absolute values of t-statistic. An asterisk (*) denotes significance at 5% level

Table 4: Estimated Long Run Coefficients Based on Schwartz Bayesian Criterion:
Broad Components of the Euro-Zone Monetary Aggregates

Regressor	*Dependent Variable*		
	Log(M2-M1/P)	*Log(M3-M1/P)*	*Log(M3-M2/P)*
Intercept	0.14 (0.03)	-5.60 (0.92)	-7.74* (1.98)
LY	0.67 (0.70)	1.95 (1.51)	2.17* (2.62)
IBR	-0.04* (2.29)	-0.06* (2.89)	-0.10* (6.10)
GBY	0.02 (0.66)	0.05 (0.17)	0.03 (0.88)
INFL	-11.79 (1.84)	-8.00 (1.65)	1.51 (0.60)

Note: Figures in parentheses represent absolute values of t-statistic. An asterisk (*) denotes significance at 5% level

Table 5: Stability Tests results Based on CUSUM and CUSUMSQ

From Error Correction Model corresponding to Equation:	*CUSUM*	*CUSUMSQ*
1.1	Stable	Unstable
1.2	Stable	Unstable
1.3	**Stable**	**Stable**
1.4	Stable	Unstable
1.5	Stable	Unstable
1.6	**Stable**	**Stable**

Figure 1: Plot of the Error Correction Term Based on the M3/P Equation

*ECM = LRM3 -1.7120*LY + .043745*IBR + .053345*GBY + 18.8670*INFLN + 3.4421*

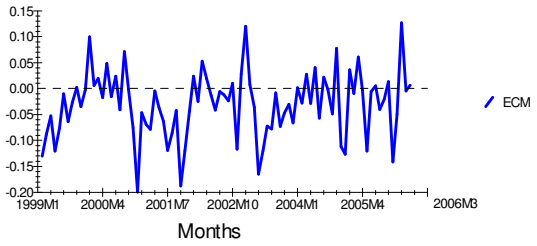
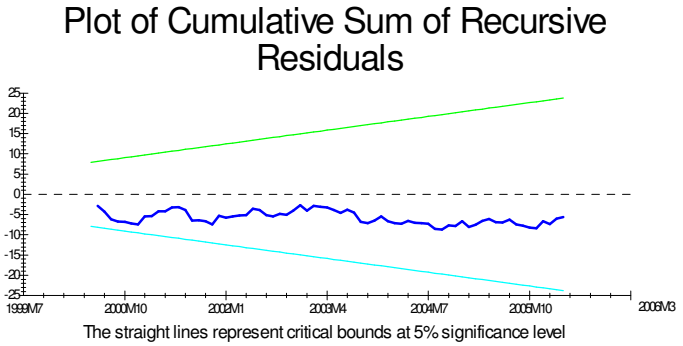


Figure 2: Stability Test Results for M3/P based on CUSUM and CUSUM SQUARE Criteria



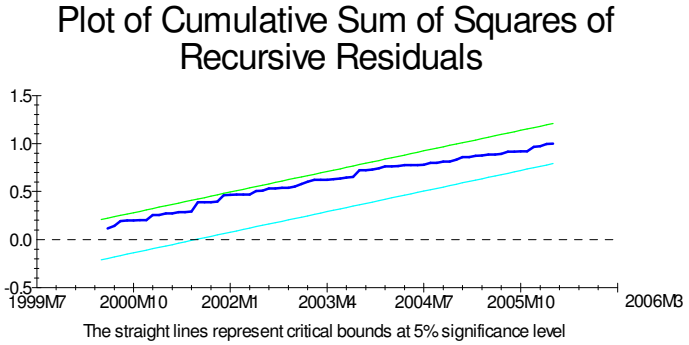
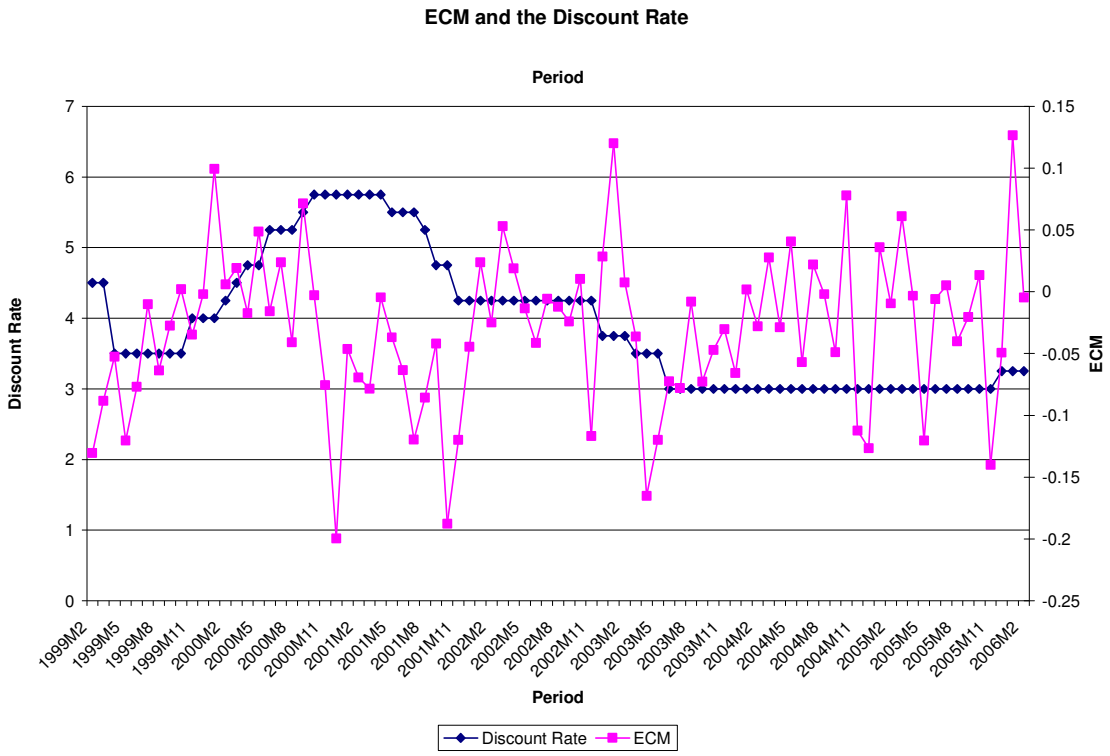



Figure 3: Has the ECB been Targeting M3?