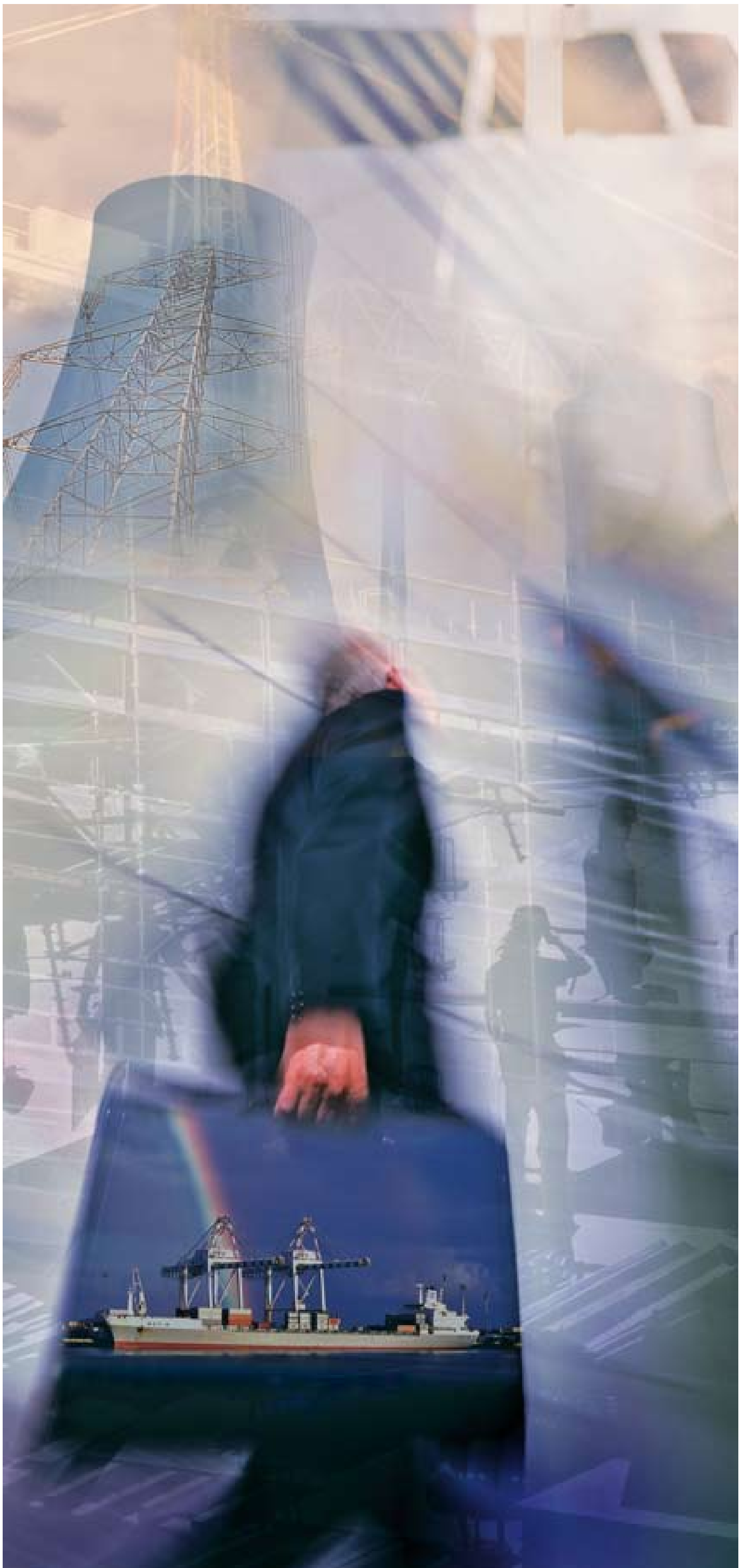

Queensland

The Economic Society of Australia Inc.

Proceedings of the 37th Australian Conference of Economists

Papers delivered at ACE 08

30th September to 4th October 2008

Gold Coast Queensland Australia

ISBN 978-0-9591806-4-0

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The Economic Society of Australia warmly welcomes you to the Gold Coast, Queensland, Australia for the 37th Australian Conference of Economists.

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The Paper following forms part of - *Proceedings of the 37th Australian Conference of Economists*
ISBN 978-0-9591806-4-0

M3 money demand and excess liquidity in the euro area

Christian Dreger and Jürgen Wolters[1]

Abstract: Monetary growth in the euro area has exceeded its target since 2001. Likewise, recent empirical studies did not find evidence in favour of a stable long run money demand function. The equation appears to be increasingly unstable if more recent data are used. If the link between money balances and the macroeconomy is fragile, the rationale of monetary aggregates in the ECB strategy has to be doubted. In contrast to the bulk of the literature, we are able to identify a stable long run money demand relationship for M3 with reasonable long run behaviour. This finding is robust for different (ML and S2S) estimation methods. To obtain the result, the short run homogeneity restriction between money and prices is relaxed. In addition, a rise in the income elasticity after 2001 is taken into account. The break might be linked to the introduction of euro coins and banknotes. The corresponding error correction model survives a battery of specification tests.

Keywords: Cointegration analysis, error correction, excess liquidity, money demand, monetary policy

JEL Classification: C22, C52, E41

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1 Introduction

The primary goal of the European Central Bank (ECB) is to maintain price stability. To achieve this objective the ECB has developed the so called two pillar strategy, where monetary aggregates play a crucial role. In particular, one pillar is based on the economic analysis of price risks in the short term, while the other one is built on the analysis of risks to price stability in the medium and long run. Given the complexity of the monetary transmission process central bankers "often also take into account some simple rules of thumb to guide or cross-check their action. One such rule is based on the fact that inflation is always a monetary phenomenon in the medium to long term. This rule recommends that central bankers be generally aware of monetary developments in order to assess inflation trends" (ECB, 2004, p47). In fact, the reference value for monetary growth is taken as a benchmark for assessing monetary developments. It is based on price stability which is seen to be consistent with consumer price inflation of below 2 percent. Potential output growth is estimated at around 2-2.5 percent, and a negative trend in velocity lead to an increase of money growth in a range between 0.5 and 1 percent. Given these assumptions, the target for money growth has been set at 4.5 percent per annum.

Since the end of 2001, monetary conditions became abnormally loose. Actual monetary growth has continuously exceeded its target. For example, M3 increased by 9.9 percent in 2006, after 7.3 percent in 2005. Due to uncertainties in the stock market development and a relatively flat term structure of interest rates agents shifted their portfolio towards safe and liquid assets. During this process, inflation did not accelerate at all, thereby questioning whether a fixed reference path is a reliable tool to interpret the monetary evolution. If the link between money and prices turns out to be increasingly unstable, money growth is not well-designed to analyze future inflation prospects and support policy decisions.

For monitoring the inflation process, a stable money demand function is extremely important, at least as a long run reference (see ECB, 2004, p64). If this condition is met, money demand can be linked to the real economy. But recent evidence has cast serious doubts concerning the robustness of the relationship. If data up to 2001 are used, standard money demand functions for the euro area can be firmly established, see Fagan and Henry (1998), Hayo (1999), Funke (2001), Coenen and Vega (2001), Bruggemann, Donati and Warne (2003), Brand and Cassola (2004) and Holtemöller (2004a, b). Extending the sample to a more recent period usually destroys these findings, as a stable long run relation between the variables cannot be detected anymore, see Gerlach and Svensson (2003), Greiber and Lemke (2005) and Carstensen (2006). This has led some authors to analyse relationships between the core components of the original variables, either generated by the Hodrick Prescott filter or moving averages, see Gerlach (2004) and Neumann and Greiber (2004). In other studies, measures of uncertainty are allowed to enter the long run equation. Using this modification, Greiber and Lemke (2005) and Carstensen (2006) find support for a money demand function. Nevertheless, as proxies for uncertainty should be stationary, this approach is not really convincing. Greiber and Setzer (2007) extend the standard specification by real house prices and housing wealth and obtained a stable long run relation with data up to 2006. Brüggemann and Lütkepohl (2006) have reported a stable money demand equation for the euro area based on data up to 2002. In contrast to the other papers, they used German instead of euro area series until the end of 1998.

Despite the results from the previous literature, this paper presents strong evidence in favour of a stable long run money demand relationship specified in terms of a standard set of explanatory variables. The existence of such a long run relation allows to quantify excess liquidity which is a threat to price stability. In principle, excess liquidity can be measured in different ways, see Masuch, Pill and Willeke (2001) for a discussion. One option is the so called money gap expressed as the deviation of actual money from its equilibrium value, the latter calculated on the basis of the ECB's reference for M3. However, one has to choose arbitrarily a base period. The money overhang defined as the difference between the observed monetary aggregate and the estimated long run money demand relation is a better indicator, as it takes the actual situation of the economy into account (ECB, 2001).

The rest of the paper is organized as follows. Section 2 reviews the specification of the long-run money demand function. In section 3, the series used in the empirical analysis are discussed. Specification and estimation of money demand functions in error correction form has been the customary approach to capture the nonstationary behaviour of the time series involved. Evidence regarding the cointegration properties is provided in section 4. In section 5, an error correction model for money demand is presented. Section 6 concludes.

2 Specification of money demand

In this paper, a widely used specification of money demand is chosen as the point of departure. According to Ericsson (1998), the specification of the demand for a broad monetary aggregate leads to a long run relationship of the form

(1) $$m_t - p_t = \delta_0 + \delta_1 y_t + \delta_2 R_t + \delta_3 r_t + \delta_4 \pi_t$$

where m is nominal money taken in logs, p is the log of the price level, and y log income, representing the transaction volume in the economy. Opportunity costs of holding money are proxied by long (R) and short (r) term interest rates and the annualized inflation rate, i.e. $\pi=4\Delta p$ in case of quarterly data. The index t denotes time.

Price homogeneity is assumed to be valid as a long-run condition. In fact, the money stock and the price level might be integrated of order 2, I(2). If these variables are cointegrated, real money balances could be I(1). Then, the long run homogeneity restriction is appropriate to map the money demand analysis into an I(1) system, see Holtemöller (2004b). According to textbook presentations, the scale variable is expected to exert a positive effect on nominal and real money balances. Typical models in the literature differ in the opportunity cost measure, see Golinelli and Pastorello (2002) for a survey. If the costs refer to earnings of alternative financial assets, possibly relative to the own yield of money balances, their coefficients should enter with a negative sign. Inflation is usually interpreted as a part of the opportunity costs, as it represents the costs of holding money in spite of holding real assets, see Ericsson (1998). But its inclusion can be justified by different arguments. In the presence of adjustment costs and nominal inertia, Wolters and Lütkepohl (1997) have shown that inflation should enter the long run relation for real balances, even if it is not relevant in the equation for nominal balances. See also Wolters, Teräsvirta and Lütkepohl (1998) on this point. Thus, the variable allows to discriminate whether adjustment is in nominal or real terms (Hwang, 1985). Alternatively, the inflation rate provides a convenient way to generalize the short run homogeneity restriction imposed between money and prices. While the restriction is justified from a theoretical point of view, there might be a lack of support in the particular observation period.

The parameters δ_1>0, δ_2<0, δ_3 and δ_4 denote the income elasticity, and the semielasticities with respect to the return of other financial assets and inflation, respectively. The parameter δ_3 is positive when r is mainly a proxy for the own rate of interest of money balances, but negative otherwise. Due to the ambuigity in the interpretation of the inflation variable, the sign of its impact cannot be specified on theoretical reasoning.

3 Data and preliminary analysis

Since the introduction of the euro on January 1, 1999 the ECB is responsible for the implementation and conduction of monetary policy in the euro area. As the time series under the new institutional framework are too short to draw robust conclusions, they have to be extented by artificial data. Usually, euro area series prior to 1999 are obtained by aggregating national time series, see for example Artis and Beyer (2004). Different aggregation methods are available and can lead to different results. By comparing aggregation based on methods using variable or fixed period exchange rates, Bosker (2006) has emphasized that the differences are substantial prior to 1983, in particular for interest and inflation rates. However, they are almost negligible for money demand variables from 1983 onwards. The European Monetary System started working in 1983, and the financial markets of the member countries have become much more integrated since then. Therefore, the observation period in this study is 1983.1-2006.4, where quarterly seasonally adjusted series are used.

Nominal money balances are taken from the ECB monthly bulletin database and refer to M3 and end of period values. The short and long term interest rates r and R are also obtained from this source and defined by the end of period 3month Euribor and 10 years government bond rate, respectively. Nominal and real GDP as a proxy for income are taken from Eurostat, the latter defined as chain-linked volumes with 2000 as the reference year. The GDP deflator (2000=100) is constructed to be the ratio of nominal to real GDP multiplied by 100. Due to evidence presented by Holtemöller (2004a), the Brand and Cassola (2004) GDP data should be used in earlier periods, as these data yield stable and economically interpretable results. Note that this choice does not affect any conclusions in this paper, as instability of money demand is only a problem in recent years. In order to obtain real money balances, the nominal money stock is deflated with the GDP deflator. Figure 1 shows the evolution of series in levels (A) and first differences (B) in the 1983.1-2006.4 period.

-Figure 1 about here-

Several comments are in order. First, all variables are integrated of order 1, I(1), implying that they are nonstationary in the levels representation, but stationary in first differences. The results of the integration tests are omitted here in order to save space, but can be obtained from the authors upon request. This well known result holds for different observation periods, compare the results in the aforementioned empirical studies. Second, outliers occur in real money balances, see the graph for the first differences. The first one (1990.2) is due to the German unification, while the other one (2001.1) refers to stock market turbulences, see Kontolemis (2002). In particular, the large decrease in stock markets have raised the demand for liquid assets. In the subsequent analysis, these outliers are acknowledged by two impulse dummies, which are equal to 1 in the respective period and 0 otherwise (d902 and d011).

-Figure 2 about here-

Looking at the scatterplot between real money and real GDP reveals a clear change in the income elasticity starting in 2002.1 that coincides with the introduction of euro coins and banknotes to the public (figure 2). A break in the income elasticity has also been reported by Lütkepohl, Teräsvirta and Wolters (1999) in case of the German M1 aggregate. According to the strategy outlined in that paper, the break is captured by an additional income variable y^* as the product of y and a step dummy s021 equal to 1 from 2002.1 until the end of the sample and 0 in the period before.

4 Cointegration analysis

In systems including real money balances, real income, nominal interest rates and inflation, at least one cointegration relationship should represent a long run money demand equation in the style of (1). To explore the cointegration properties of different sets of variables, the Johansen (1995) trace test is used as the workhorse, see table 1 for the results. To correct for finite samples, the trace statistic is multiplied by the scale factor $(T\text{-}pk)/T$, where T denotes the number of the observations, k the number of the variables and p the lag order of the underlying VAR model in levels (Reimers, 1992). The lag length of the VARs is determined by the Schwarz criterion and is equal to 1 throughout the analysis. All models are estimated with an unrestricted constant and the two impulse dummies.[2]

There is a strong indication for exactly one cointegrating vector in the (m-p, y, π) and (m-p, y, y^*, π) system, respectively. This evidence can be consistent with a money demand relationship in the long run, probably without the interest rates. Due to the increase of the income elasticity since 2002, the cointegration parameters in (m-p, y, π) are unstable[3]. Therefore, the further analysis refers to the (m-p, y, y^*, π) system, which does not suffer from parameter instability. As a drawback, replacing π with interest rates does not lead to a significant long run equation. However, the economic content of the long run relation implied by the (m-p, y, y^*, π) system can be improved. In fact, the term structure R-r can be embedded, because it is a stationary variable. An augmented Dickey Fuller unit root test rejects the null hypothesis of nonstationarity with a p-value of 0.03.

-Table 1 about here-

The cointegration parameters are revealed using Johansen's reduced rank maximum likelihood (ML) estimator. However, the ML estimator should be applied cautiously because it can produce extremely distorted and unreliable estimates in small samples.

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[2] All computations have been carried out with EViews 6 and JMulti 4.

[3] Using recursive estimation methods, Dreger and Wolters (2006) have demonstrated that instability does not distort the results, if data up to 2004.4 are employed. If the observation period is shifted beyond this point, the parameters become increasingly unstable in this specification.

Furthermore, the usual diagnostic tests are not helpful in detecting the distorting estimates. To overcome the problem, Brüggemann and Lütkepohl (2005) have proposed a two step generalized least squares estimator, which is more robust in this regard. Their so called S2S estimator is used as a cross-check to the ML results.

The cointegrating relationships are estimated in two variants, both with and without the term structure. The results

(2)
$$\begin{aligned} ec_{1,ML} &= (m-p) - \underset{(0.115)}{0.955}\, y - \underset{(0.005)}{0.031}\, y^* + \underset{(0.791)}{6.743}\, \pi \\ ec_{2,ML} &= (m-p) - \underset{(0.080)}{1.096}\, y - \underset{(0.004)}{0.029}\, y^* + \underset{(0.566)}{5.534}\, \pi + \underset{(0.959)}{4.855}(R-r) \end{aligned}$$

(3)
$$\begin{aligned} ec_{1,S2S} &= (m-p) - \underset{(0.090)}{1.249}\, y - \underset{(0.004)}{0.025}\, y^* + \underset{(0.617)}{3.895}\, \pi \\ ec_{2,S2S} &= (m-p) - \underset{(0.064)}{1.297}\, y - \underset{(0.003)}{0.023}\, y^* + \underset{(0.450)}{3.348}\, \pi + \underset{(0.761)}{3.233}(R-r) \end{aligned}$$

are similar for the different estimation methods (standard errors in parantheses). The inclusion of the term structure of interest rates contributes to slightly more precise estimates. The S2S parameters seem to be more stable than their ML counterparts. After controlling for a structural break in the income elasticity, the long run relationship appears to be stable over time.

Because of its improved properties, the model including the term structure is used in the subsequent analysis. Under the assumption that r approximates the own rate of M3 the term structure may be interpreted as the opportunity costs of holding bonds. However, all the results remain valid when the more compact version is used. The mean-adjusted deviations from the long run relation are displayed in figure 3 for the ML and S2S estimation methods. Overall, the deviations on the base of the ML procedure seems to produce larger deviations from equilibrium, thereby reflecting deficits of this approach in small samples. However, no abnormal behaviour can be detected over the whole period.

-Figure 3 about here-

The money overhang can be revealed from the error correction terms, as they show the deviations from the long run. At the end of the observation period, real money balances exceed their equilibrium by 0.3 (S2S) or 1.6 (ML) billions of euro. These numbers are far below 0.1 percent of the real money stock. Therefore, the actual monetary evolution provides no risk to price stability.

5 Error correction modeling

Whether or not the cointegrating relationship can be interpreted in terms of a money demand function is inferred from the error correction model. However, as we are mostly interested in the stability of a money demand equation, the analysis is concentrated on conditional single equation models. A conditional model may lead to constant coefficients even if a shift is present in the reduced form. Given the identification problems in full systems, a structural model for an individual variable might be easier to develop using the single equation context[4].

[4] The single equation error correction model can be even justified by testing on weak exogeneity. If the S2S estimator is used, all variables can be classified as weakly exogeneous with respect to the cointegrating relationship, apart from real money balances. Detailed results are available from the authors upon request.

At the initial stage of the estimation process, the contemporaneous values and the first four lags of the changes of all variables, a constant and the two impulse dummies are considered in addition to the error correction terms, ec_{ML} and ec_{S2S}, specified in (2) and (3). Again, the versions augmented by the term structure are used. Variables with the lowest and insignificant *t*-values are eliminated subsequently (0.1 level). The final money demand relationship is (*t*-values in parantheses)

$$\begin{aligned}\Delta(m-p)_t = &\underset{(7.93)}{0.028} - \underset{(6.15)}{0.039}\, ec_{ML,t-1} + \underset{(8.13)}{0.034}\, d902 + \underset{(7.25)}{0.031}\, d011 - \underset{(6.19)}{0.204}\, \Delta(\pi_t) \\ &+ \underset{(2.61)}{0.173}\, \Delta(m-p)_{t-1} + \underset{(2.45)}{0.158}\, \Delta(m-p)_{t-3} - \underset{(2.89)}{0.193}\, \Delta(m-p)_{t-4} + \underset{(3.38)}{0.253}\, \Delta r_t + \hat{u}_t\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta(m-p)_t = &-\underset{(5.41)}{0.048} - \underset{(6.28)}{0.055}\, ec_{S2S,t-1} + \underset{(8.13)}{0.034}\, d902 + \underset{(6.99)}{0.030}\, d011 - \underset{(5.90)}{0.185}\, \Delta(\pi_t) \\ &+ \underset{(2.48)}{0.165}\, \Delta(m-p)_{t-1} + \underset{(2.28)}{0.146}\, \Delta(m-p)_{t-3} - \underset{(3.05)}{0.201}\, \Delta(m-p)_{t-4} + \underset{(3.15)}{0.234}\, \Delta r_t + \hat{u}_t\end{aligned} \tag{5}$$

T=96 (1983.1-2006.4).

For both variants we end up with the same specification with very similar coefficients and extremely high *t*-values for the error correction coefficients. According to their negative values, excess money lowers money growth, as one expects in a stable model. Moreover, changes in inflation are significant. The results point to substantial inertia in the adjustment of real money balances, as the adjustment to the long run equilibrium is very low and up to four lagged changes of money demand are relevant in the specifications. Finally, as the *t*-values indicate, the impulse dummies *d*902 and *d*011 should enter these equations.

Standard specification tests are largely supportive for the model, see table 2. *LM* is a Lagrange Multiplier test for autocorrelation in the residuals up to order 1, 4 and 8. The *p*-values show, that no problems with autocorrelated residuals occur. *ARCH* is a Lagrange multiplier test for conditional heteroskedasticity. Again, the residuals do not exhibit such kind of behaviour. Furthermore, they are distributed as normal, as indicated by the Jarque-Bera test. Moreover, the Ramsey *RESET* test does not point to a misspecification of the equation. The cusum of squares test does not indicate any structural break in the regression coefficients, see figure 4. Overall, the empirical evidence in favour of a stable money demand equation for the euro area is strongly supported by the error correction analysis.

-Table 2 and figure 4 about here-

6 Conclusion

In this paper we analysed money demand behaviour in the euro area, where special emphasis is given to the issue of stability. In fact, many researchers have detected instabilities especially when data after 2001 are included in the analysis. Such a result casts serious doubts concerning the rationale of monetary aggregates in the monetary strategy of the ECB. In contrast to the bulk of the literature, we report strong evidence in favour of a stable money demand relationship. This result can be achieved by including inflation in the cointegration vector, i.e. the short run homogeneity restriction between money and prices is not imposed. Furthermore a permanently higher income elasticity since 2002 is taken into account. This break coincides with the introduction of euro coins and banknotes to the public. In this setup, a stable long run money demand relationship is identified. The result is robust over different estimation methods. The corresponding error correction model survives a wide range of specification tests.

Monetary aggregates play a crucial role in the monetary strategy of the ECB. The rationale of the strategy requires a stable relationship between money and fundamental economic variables, which is re-established in the paper.

Excess liquidity refers to the difference between observed and equilibrium money balances. There are at least two different concepts to define the equilibrium development of M3. Using the ECB's reference value of 4,5% for annual money growth rates implies an equilibrium path which grows from an arbitrary chosen starting value linearly, that is a linear trend with slope 0.045 (Masuch, Pill and Willeke, 2001, p134). This might be problematic since M3 develops more or less as an I(2) variable. Therefore we strongly prefer the money overhang as a measure of excess liquidity, as the economic situation and the statistical properties of the data are taken into account. The overhang is given by the error correction term. Applying this concept there is no problem with excess liquidity since 2001, see figure 3. This is in the line with Carstensen (2006) who used equity returns and a constructed measure for stock market volatility to get a stable money demand function.

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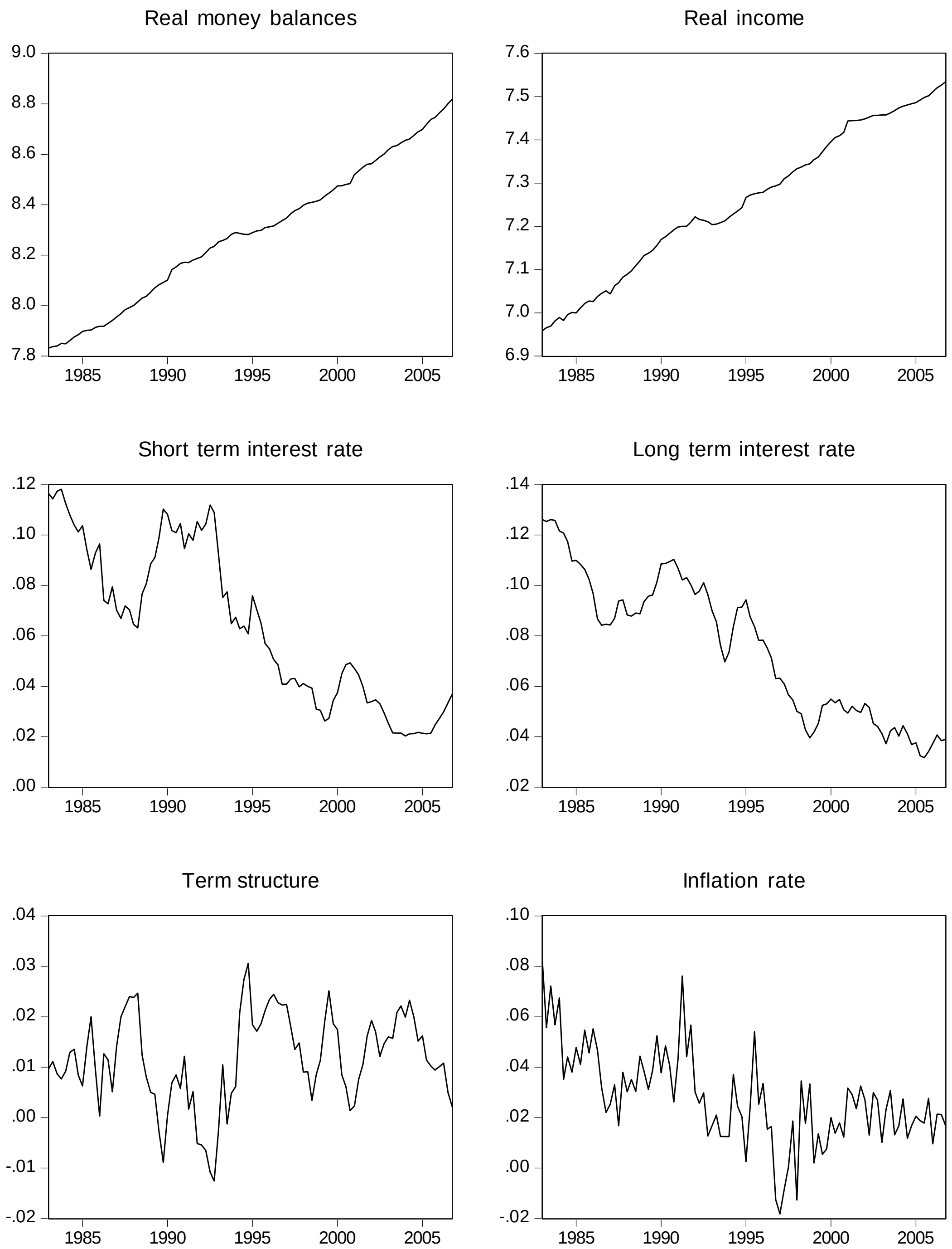
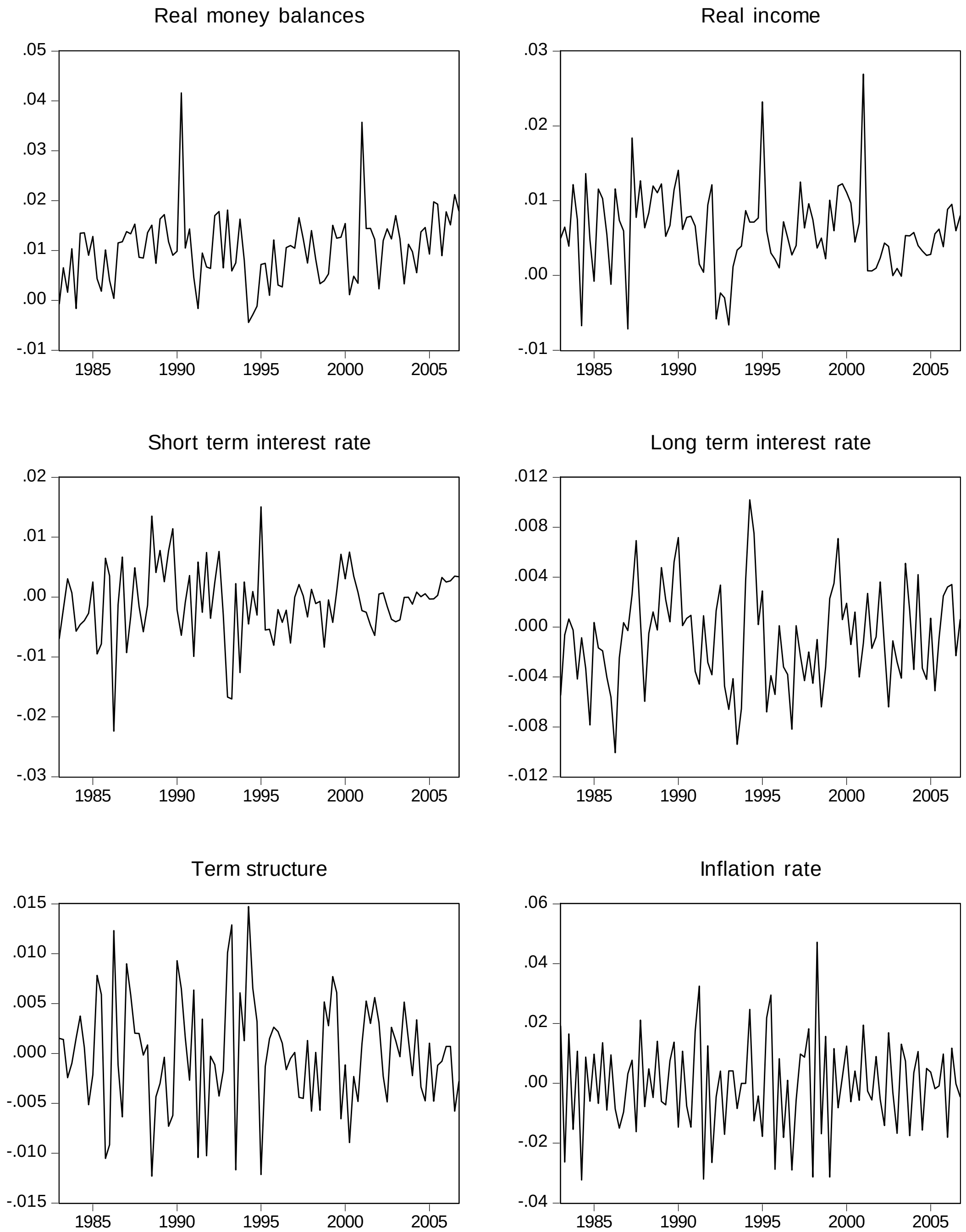
Figure 1: Variables used in the empirical analysis

A levels

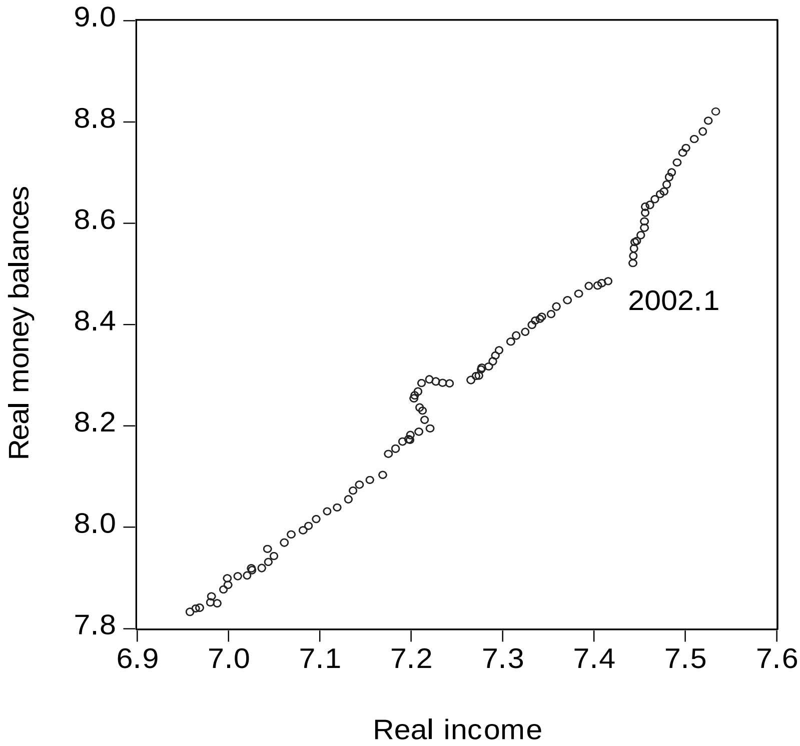


B First differences



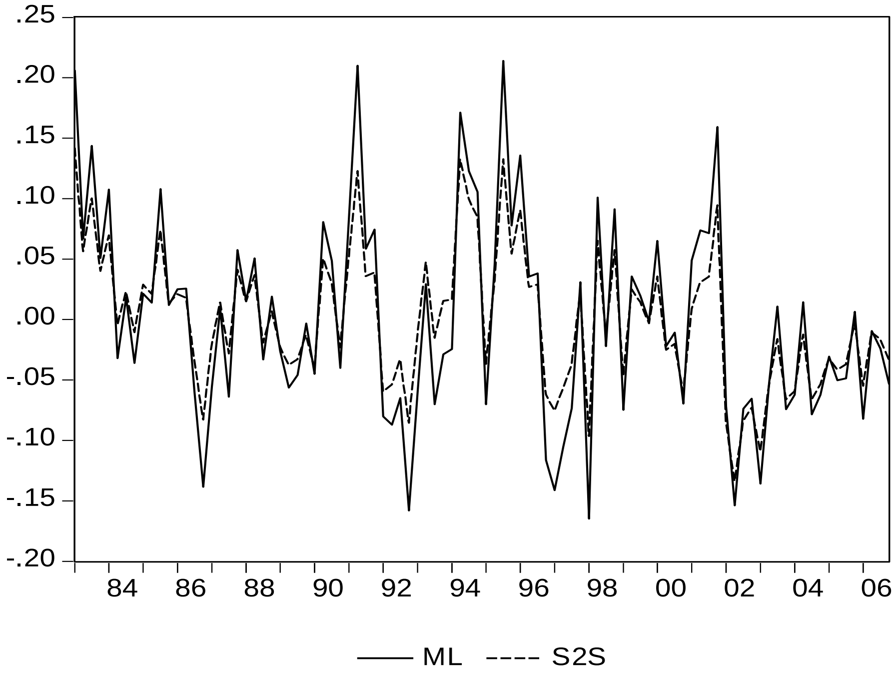
Note: Sample period 1983.1-2006.4. Real money and real GDP in logs. Inflation calculated on the base of the GDP deflator.

Figure 2: Structural break in income elasticity



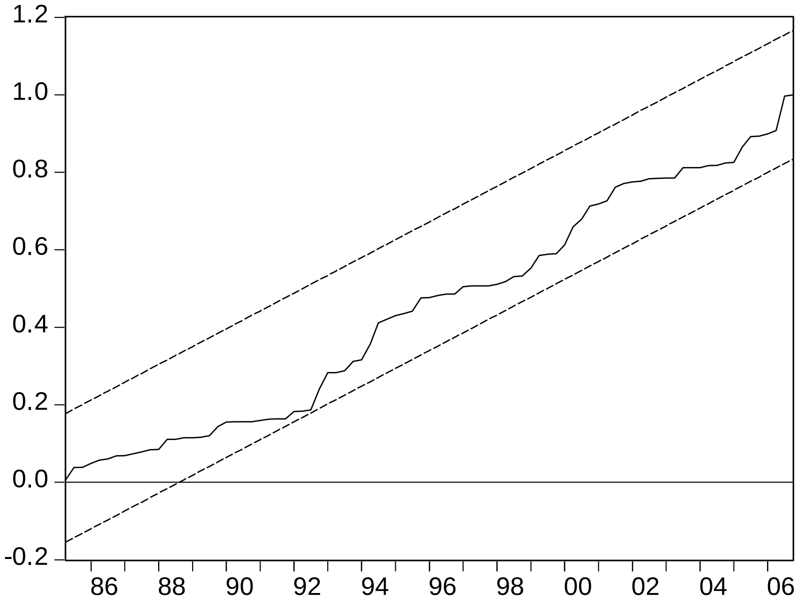
Note: Sample period 1983.1-2006.4. Increase in income elasticity from 2002.1 onwards.

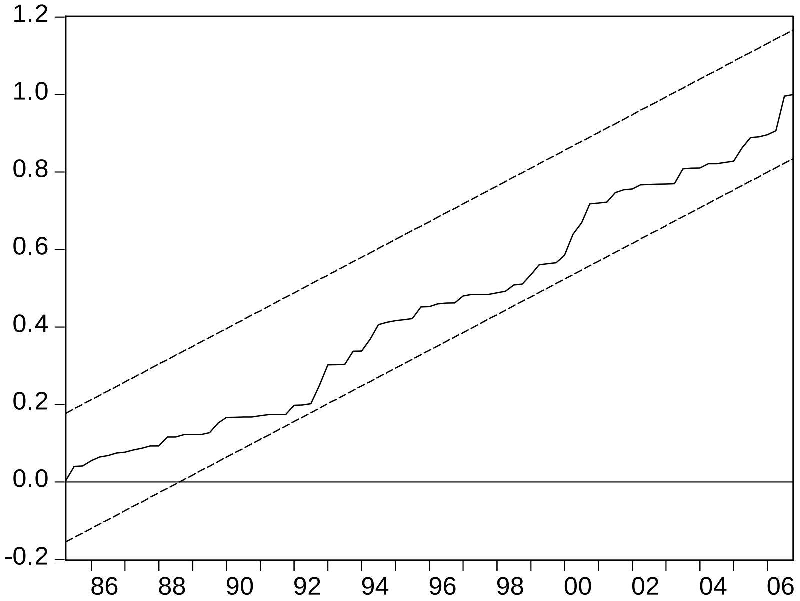
Figure 3: Mean-adjusted deviations from the long run



Note: Sample period 1983.1-2006.4. Long run estimated according to (2) and (3), variants include term structure.

Figure 4: Cusum of squares of the error correction models





Sample period 1983.1-2006.4. Dashed lines represent 0.05 significance levels. ML model (top) and S2S alternative.

Table 1: Cointegration tests for sample period 1983.1-2006.4

Variables	Rank null hypothesis	Johansen trace test	Finite sample correction
m-p, *y*	0	8.76	
	1	3.84	
*m-p, y, y**	0	21.33	
	1	4.83	
	2	0.21	
m-p, *y*, *π*	0	47.97**	46.47**
	1	8.10	
	2	0.20	
m-p, *y*, *R*	0	29.80	
	1	15.49	
	2	3.84	
m-p, *y*, *r*	0	22.02	
	1	9.03	
	2	1.38	
m-p, *y*, *y**, *π*	0	76.19**	73.02**
	1	18.44	
	2	4.37	
	3	0.08	
m-p, *y*, *y**, *R*	0	29.70	
	1	11.91	
	2	5.17	
	3	0.05	
m-p, *y*, *y**, *r*	0	35.58	
	1	15.15	
	2	5.77	
	3	0.83	

Note: All models estimated with unrestricted constant and impulse dummies for 1990.2 and 2001.1. The finite sample correction is due to Reimers (1992). A (*), *, ** denotes significance at the 0.1, 0.05 and 0.01 level. Critical values are from MacKinnon, Haug and Michelis (1999), and are also valid for the finite sample correction. Lag order of 1 in underlying VAR models (level specification), according to the Schwarz criterion.

Table 2: Standard specification tests of error correction models

	Equation (4)	Equation (5)
R2	0.66	0.66
SE	0.0042	0.0041
SC	-7.81	-7.82
JB	0.54 (0.76)	0.23 (0.89)
LM(1)	0.00 (0.99)	0.00 (0.95)
LM(4)	0.43 (0.79)	0.38 (0.82)
LM(8)	0.46 (0.88)	0.37 (0.93)
ARCH(1)	0.72 (0.40)	0.65 (0.42)
ARCH(4)	0.43 (0.79)	0.25 (0.91)
ARCH(8)	0.72 (0.68)	0.26 (0.98)
RESET(1)	0.02 (0.89)	0.15 (0.70)
RESET(2)	1.73 (0.18)	1.13 (0.33)
RESET(3)	1.19 (0.32)	1.06 (0.37)

Note: Sample period 1983.1-2006.4. R2=R squared adjusted, SE= standard error of regression, SC= Schwarz criterion, JB=Jarque-Bera test, LM=Lagrange multiplier test for no autocorrelation in the residuals, ARCH=Lagrange multiplier test against conditional heteroscedasticity, RESET=Ramsey test, *p*-values in parantheses.