

Modelling Short-run Money Demand for the US

Marcus Scheiblecker

Correspondence: Marcus Scheiblecker, Austrian Institute of Economic Research, Austria.

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Abstract

There is a vast amount of empirical evidence concerning the cointegrating relationship between money demand, some kind of interest rate and income. In contrast to this, short-run dynamics are still opaque. In the existing literature, the return to steady state is modeled quite differently. The range goes from simple error correction models to non-linear approaches.

We herewith propose a method for considering not only disequilibria between money demand and its steady state for the last period only, but also for such of the recent past in a parsimonious and economically meaningful way. As different from multicointegration, weights for cumulating steady-state deviations are geometrically decreasing, the more they are located in the past. This model possesses an ARMA (1,1) representation and leads to an ARMAX-model, if combined with a conventional error correction model. This approach is shown to track money demand short-run dynamics better and more parsimoniously than partial-adjustment models.

Keywords: short-run money demand, cumulative error-correction model

1. Introduction

Nowadays, modeling long-term money demand is largely straightforward. There is a vast amount of empirical evidence concerning the existence of a cointegrating relationship between real money demand, some kind of interest rate and income. Examples for the US are Hoffman and Rasche (1991) or Stock and Watson (1993), for the UK Ericsson, Hendry and Prestwich (1998) and Teräsvirta and Eliasson (2001), or for the euro area Calza and Zaghini (2006) or Dreger and Wolters (2010).

In contrast to this, the short-run dynamics is still opaque. Theoretically, the existence of portfolio adjustment costs is frequently used to explain the sluggish return to steady state. In this case, the money amount held by the economic agent acts as a “buffer stock” (Laidler, 1984) for smoothing the differences between income and expenditure streams. In the empirical literature, there are many different approaches to modeling the inertia of the adjustment process back towards the long-run relation. Goldfeld (1973) applied a so-called partial adjustment model by including a lagged dependent variable to model the inertia of return. With the upcoming popularity of error correction models, Baba, Hendry and Starr (1992) and Duca (2000) are prominent examples for attempts to model short-run dynamics in money demand. Since simple error correction models in some cases did not produce satisfying statistical results, several authors applied non-linear versions. Hendry and Ericsson (1991) and Escribano (2004) tested a cubic polynomial error correction model. Examples for regime-dependent adjustment dynamics are Lütkepohl, Täresvirta and Wolters (1999) or Teräsvirta and Eliasson (2001).

1.1 The Problem

The reason for the large amount of different approaches towards modeling the return to steady-state may be that the disequilibrium - which has to be balanced by economic agents - is not defined correctly. All these models consider the disequilibrium to be balanced by short-run dynamics as the gap between money demand and its steady state for the last period only, disregarding disequilibria in earlier periods. But there seems to be no convincing argument why agents should balance only the disequilibrium of the most recent period. This goes especially for cases of higher-frequency (daily, weekly, monthly or quarterly) data. Ignoring deviations from steady state that occurred further back in the past fail to account for money stockpiling by economic agents. Positive deviations from steady state of past periods may be cumulated [?] and used for transaction or saving purposes in the current period without making it necessary to balance the deviation of the most recent past. These cumulated deviations from steady state of the past form a further variable which, if not considered, could lead to mis-specification of the model.

1.2 Objective of the Study

We herewith present a model that accounts not only for the most recent deviation from the long-run relation in the short-run adjustment process, but also for disequilibria that occurred further back in the past. With this type of model we need no assumptions concerning sluggish adjustment due to adjustment costs. Only the fact that deviations from steady state located earlier than in the most recent period may be relevant. The outline of the paper is as follows. Section 2 presents the so-called cumulative error correction model. In Section 3 this model is applied to the dataset used by Ball (2012) where the same long-run relationship is used and just short-run dynamics compared. Section 4 concludes.

2. Method

The idea of accounting also for disequilibria further in the past than in the most recent period within the framework of error correction models (ECM) is not new. Granger and Lee (1989) presented a model where all past deviations from steady state are summed up with equal weights until the starting period of the time series. In their example, the mismatch between production and sales for any lag leads to the accumulation of inventories. In such a situation, the application of a standard ECM would result in a specification error¹. Apart from the cointegrating relationship between the flows (first-level cointegration), there may be another one from stock levels which the authors called second-level cointegration. This new series emerging from the accumulation of past disequilibria form a further cointegrating relationship called multicointegration. Whereas usually the number of cointegrating relationships among n variables is at most $n-1$, it can be n as well within this framework. A drawback of this approach is that the second-level cointegrating relationship contains $I(2)$ variables, constructed by the summation of $I(1)$ flow variables, which complicates the estimation process.

Suppose that y_t and x_t are both $I(1)$ and are cointegrated $CI(1,1)$ so that

$$z_t = y_t - \phi x_t \quad (1)$$

is $I(0)$. (1) defines the so-called first-level cointegration relationship. Granger and Lee (1989) propose to sum up all past deviations from steady state with the same weight 1 to a new stock variable $s_t = \sum z_t$. If now s_t cointegrates with either $\sum x_t$ or $\sum y_t$ we get another cointegration relationship (second-level cointegration) so that $s_t - \kappa y_t$ again forms a stationary relationship

$$s_t - \kappa y_t = \sum_{j=1}^t y_j - \phi \sum_{j=1}^t x_j - \kappa y_t \quad (2)$$

with s_t being $I(1)$ and $\sum y_t$ and $\sum x_t$ being $I(2)$ as both are summed $I(1)$ variables.² Granger and Lee (1989) solved the estimation problem by a two-step method as typically used for $CI(1,1)$ variables. In a first step, they estimated the first-level cointegration relation. The residuals representing deviations from steady state were summed up and, in a second stage, regressed on the cumulated variables (summed y_t) for estimating the second-order cointegrating relationship.

Engsted et al. (1997) have shown that in case of a two-step method, the first cointegrating relationship (of flows) must not be estimated, but derived by another method. Otherwise the test statistics of the second one will have a different limiting distribution compared with normal settings. Furthermore, for $I(2)$ -based models usual asymptotic χ^2 inference is invalid and Johansen (2006) pointed out that it can be used only if a multicointegration relation is assumed with properties hardly met in reality.

2.1 The Cumulative Error Correction Model

The model presented here instead, uses weights for cumulation which are geometrically decreasing the more the disequilibria are located in the past. According to Koyck (1954), such models possess an ARMA (1,1) representation. The combination of the Koyck-model with the error correction approach leads to an ARMAX model which is shown to be in some cases capable to track money demand short-run dynamics better and more parsimoniously than partial-adjustment models. Probably, even adjustment structures modeled by non-linear ECM can be explained better

¹ See for this Engsted and Johansen (1997) or Lee (1992)

² In the case of multicointegration, the corresponding ECM considers adjustment mechanisms for the stock as well as

the flow variables with $\Delta x_t = c + \alpha_1 (s_{t-1} - \kappa y_{t-1}) + \alpha_2 \xi_{t-1} + \text{lagged} (\Delta x_t, \Delta y_t) + u_t$

by this model type.

This model has recently been put forward by Scheiblecker (2013) for the empirical application of modeling private consumption in the US.

The typical ECM

$$\Delta y_t = \alpha \xi_{t-1} + \gamma \Delta x_t + c + u_t \quad (3)$$

with y_t and x_t being observed flow variables, c a scaling factor, u_t an iid error term and $\xi_{t-1} = y_{t-1} - y_{t-1}^*$ which measures the distance between the steady state y^* and the time series y one period ago. As usual, the EC parameter ($0 < \alpha < 1$) partly settles deviations occurred at time $t-1$ in t .

Based on considerations that deviations located further in the past than $t-1$ could influence current balancing activities, a transformation of (3) in

$$\Delta y_t = \beta \sum_{i=0}^{\infty} \lambda^i \xi_{t-1-i} + \gamma \Delta x_t + c + u_t \quad (4)$$

with the weight $\lambda < 1$, is proposed.

Koyck (1954) was the first one to put forward the transformation of an ADL model of the type

$$F_t = c + \delta \sum_{j=0}^{\infty} \lambda^j S_{t-j} + \varepsilon_t \quad (5)$$

into an ARMAX(1,1) model

$$F_t = (1 - \lambda)c + \delta \lambda^0 S_{t-0} + \lambda F_{t-1} + \varepsilon_t - \lambda \varepsilon_{t-1} \quad (6)$$

where λF_{t-1} represents the autoregressive [AR] part, $-\lambda \varepsilon_{t-1}$ the moving average [MA] part and S_t the exogenous regressor, which is therefore called the Koyck model. The summing weights λ (called the retention rate) are defined over $0 \leq \lambda \leq 1$ such that their size is decreasing geometrically giving less weight to more distant observations.

If we replace S_{t-i} in equation (5) and (6) for ξ_{t-i-1} (so that $S_t = \xi_{t-1}$), F_t corresponds to the right hand side of equation (4)³. So (4) can be transformed into

$$\Delta y_t = (1 - \lambda)c + \beta \xi_{t-1} + \lambda \Delta y_{t-1} + \gamma \Delta x_t - \lambda \varepsilon_{t-1} + \varepsilon_t \quad (7)$$

which is the ARMAX representation of our cumulative ECM given in (5). It is straightforward that as long as $\lambda < 1$ all terms on either side of the equation are I(0) and hence the usual test statistics can be applied in order to determine the cointegrating relationship.

This approach is very parsimonious as only one parameter more (the retention parameter λ) than in the conventional ECM has to be estimated. It is also noteworthy that if the parameter δ in (6) is zero (i. e. no cointegration exists between the two series) the retention parameter λ can not be retrieved from the model. On the other side, if λ is zero we obtain the conventional ECM, and if it is 1 we arrive at the multicointegration method with equal weights as proposed by Granger and Lee (1989).⁴

2.2 Economic Interpretation of the Cumulative Error Correction Model

This time series representation of an ECM attenuates somewhat the reproach against ARIMA models for their lack of theoretical content. This form seems to be based on economic theory no less than the conventional ECMs and the multicointegration method, as the retention rate λ is located between both approaches. Equation (7) is an ARMAX model type that implicitly includes I(1) variables in levels – as represented by their I(0) deviations from steady state – as well as an AR and a MA term. The only difference to a typical ARMAX model is that (7) requires the AR parameter to equal the MA one with different signs and that both terms are restricted to be of order one.

³ Disregarding for a moment the regressor Δx_t .

⁴ In this case the specification of the model is not exactly correct because the second-level cointegrating relationship is not considered explicitly here.

Scheiblecker (2013) has shown that this type of model has interesting features concerning its stability, defined as the situation where a time series is only driven by its exogenous short-term variables (Δx_t) and the error term (ϵ_t). For the conventional ECM this is the case if the error of the past period was zero. For the cumulated ECM it is the case if the weighted sum of disequilibria of the past is zero. Such a situation can even occur outside steady state, at least for a short time.

3. Modeling US Short-run Money Demand

3.1 The Theory of Short-run Money Demand

Ericsson, Hendry and Prestwich (1998) developed the notion that one of the reasons for the demand for money is to act as an inventory in order to smooth differences between income and expenditure streams. If this is true, it makes sense to account not just for the inventory of money resulting from the disequilibrium of the most recent past but also from earlier periods. For this reason, a cumulated ECM (cumECM) makes sense and serves to model the short run money demand for the US.

As referred to in the introduction, modeling short-run movements around the long-run path of money demand is not straightforward. Many economists have tried to model this relation by very different models. As the intention of this paper is not to challenge the existence or structure of possible long-run relationships, but just to concentrate on the short-run dynamics, I use the same data set as well as the same steady-state parameters as published by Ball (2012).

3.2 Alternative Models

According to Ball (2012), the assumption of opportunity costs is necessary to explain the sluggish, arbitrarily chosen AR(2) adjustment in a partial-adjustment model. While we use the same interest rate here, the inertia does not stem from opportunity costs of adjustment, but from stockpiling of past periods. From a theoretical point of view, this difference is important as sluggish behavior due to adjustment costs is a different motivation than rapid reaction triggered by some disregarded stock variable.

Based on this, following Stock and Watson (1993), Ball (2012) estimated for the US a semi-logarithmic long-run money demand function of the form

$$m - p = \alpha + \theta_y y + \theta_R R + \varepsilon \quad (8)$$

where price homogeneity is assumed to be valid in the long-run. m represents the logarithm of M1, p the logarithm of the GDP deflator, y the log of real US-GDP, R is the interest rate of “near money” and ε the error term showing deviations from steady state. Ball (2012) estimated the cointegrating relationship by Dynamic OLS as introduced by Stock and Watson (1993), obtaining a long-run income elasticity θ_y of 0.47 and an interest rate semi-elasticity θ_R of -0.082.

In order to model the short-run dynamics around the steady state, the author used a partial adjustment model where desired money holdings deviate from the steady state value (m^*) and are represented by $m^* + \eta$ with η being a shock that is assumed to follow an AR(2) process. The reasoning behind this is that the adjustment of money stock is costly and therefore takes place only gradually towards the desired equilibrium, following an AR(2) process.

Ball (2012) has furthermore shown that his approach possesses an ECM representation of the form

$$\begin{aligned} \Delta m = & k(1 - \rho_1 - \rho_2) + \mu(1 - \rho_1 - \rho_2)(m^*_{-1} - m_{-1}) \\ & + (\rho_1 - \mu\rho_1 - \mu\rho_2)\Delta m_{-1} + (1 - \mu)\rho_2\Delta m_{-2} \\ & + \mu\Delta m^* + \mu\rho_2\Delta m^*_{-1} + \mu v \end{aligned} \quad (9)$$

with restrictions to the parameters used as compared with a conventional ECM. In this formula, k is a scaling parameter, μ the speed of adjustment of money holdings, ρ_1 and ρ_2 the two parameters of the AR(2) process determining the development of η over time and v an iid error term. $(m^*_{-1} - m_{-1})$ is the traditional EC-term which only considers the deviation from steady state in the most recent past (period $t-1$). This ECM is supplemented with an AR(2) process in order to capture residual auto-correlation stemming from sluggish adjustment.

Contrary to the partial adjustment model which is an AR(2) model, the proposed cumulative ECM is an ARMA (1,1) model with the restriction that the AR and the MA term are of the same size, but with different signs. As a MA(1) possesses an AR(∞) representation, the cumulative ECM is capable of capturing higher autoregressive dynamics than AR(2). In order to quantify (9), six parameters have to be estimated to model short-run dynamics of this kind.

3.3 The Data

For the sake of comparison, we use the same data as in Ball (2012). The Appendix presents these data on a quarterly frequency between IIQ1959 and IVQ1993. Income is represented by real GDP (chain linked in US-Dollars) downloaded from the Federal Reserve Data Base (FRED) in May 6, 2013. M1 and the GDP deflator (representing prices) also originate from this data base. Instead of using the Treasury Bill rate or a commercial paper rate as a proxy for the short-term market interest rate like in many other studies, Ball (2012) constructed an average return rate of “near monies” which is used in our model as well, as shown in the table. This interest rate for “near money” should better reflect the opportunity cost of holding money than other short-term interest rates. It includes interest rates for all non-M1 components of M2, except time deposits. This synthetic interest rate represents a weighted average of interest rates for saving accounts with zero maturity, retail money market mutual funds and money market deposit accounts.

Figure 1 gives the logs of M1 as well as its steady state as represented by (8). Differences between both lines represent the deviations from the steady state which are used to set up ECMs.

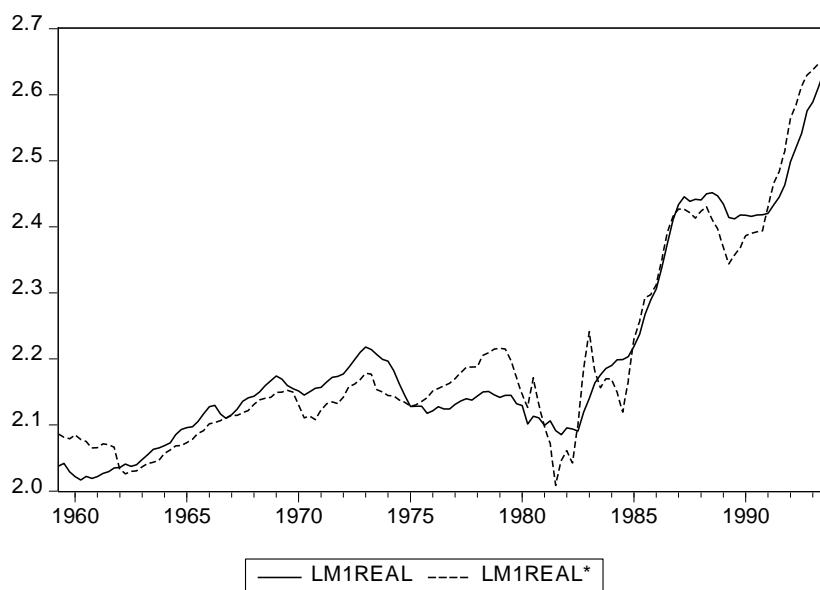


Figure 1. Headline and steady state demand for M1

Source: FRED retr. May 6, 2013, Ball (2012)

3.4 Application of the Cumulative Error Correction Model

The cumulative ECM used here for estimating short-term movements of US money demand between 1960 and 1993 on a quarterly basis is

$$\Delta m_t = (1 - \lambda)c + \beta \xi_{t-1} + \lambda_{AR} \Delta m_{t-1} - \lambda_{MA} \varepsilon_{t-1} + \gamma_y \Delta Y_t + \gamma_R \Delta R_t + \varepsilon_t \tag{10}$$

or explicitly respecting the restriction of $\lambda_{AR} = -\lambda_{MA}$

$$\Delta m_t = (1 - \lambda)c + \beta \xi_{t-1} + \lambda(\Delta m_{t-1} - \varepsilon_{t-1}) + \gamma_y \Delta Y_t + \gamma_R \Delta R_t + \varepsilon_t \tag{11}$$

with m_t being the log of real M1, $(1-\lambda)c$ a constant scaling parameter, ξ_{t-1} the deviation of real M1 from its steady state as estimated by Ball (2012), Y the log of real GDP and R the interest of near money.

According to this approach, five parameters have to be estimated: the constant (if necessary at all), the EC parameter β , the retention rate λ , the income elasticity γ_y and the interest semi-elasticity γ_R . As shown in (7) the retention rate appears twice in (10): once as an AR-parameter (λ_{AR}), and the second time with the same value, but with a different sign as the MA-parameter ($-\lambda_{MA}$).

3.5 Results

For estimation in practice, there are two possibilities: either to restrict the parameters to be equal with different signs ($\lambda_{AR} = -\lambda_{MA}$) as given in (11), or to estimate them independently, like proposed in (10). The first approach has the advantage of one parameter being saved, but at the cost of a more complicated estimation procedure. Fransens and van Oest (2007) have shown that such a restriction requires maximum likelihood estimation and errors are non-normally

distributed because of the so-called Davies (1987) problem. They propose several alternative test statistics, of which we use here the average absolute t-statistics in order to test the significance of the estimated parameters.

On the other hand, estimating both parameters independently allows verification of whether they have the same absolute value (irrespective of the sign) and hence the appropriateness of assuming geometrically decreasing weights. We follow both approaches here, and the results are given in Table 1.

Table 1. Parameters of the short-run Money Demand

	Unrestricted	Restricted ⁵
β	-0.024 ***	-0.016 ***
λ_{AR}	0.701 ***	0.701 ***
λ_{MA}	-0.431 ***	-0.701 ***
γ_y	0.167 ***	0.165 ***
γ_R	-0.018 ***	-0.019 ***

*** = significant at a 1% confidence level

All estimated parameters have been found to be highly significant. Furthermore, in none of the approaches an outlier in 1980q3 considered by a dummy variable - as found by Ball (2012) - turned out to be significant. The EC parameter β is somewhat higher with -0.024 in the unrestricted case than in the restricted (-0.016). From (9) one can derive Ball's EC-parameter of t-1 with a value of 0.05 that is higher than in the cumECM case. The short-term income elasticity and the interest semi-elasticity are practically the same in both approaches. According to these, a one- percent rise in income in the US leads to a higher demand for real M1 of around 0.167 percent. A one-percentage- point higher interest rate for near monies leads to a reduction of real M1 of 0.018 percent.

In the unrestricted approach, the AR parameter λ_{AR} and the MA parameter λ_{MA} are quite different, apart from their sign. Unfortunately, the 5% confidence intervals did not overlap, hence the Wald-test for the equality of parameters failed. This inconsistency hints at a retention rate that does not decrease according to a geometric pattern, but in some other, e. g. triangular form. Interestingly, the restricted model supports a retention rate of the same magnitude as the unrestricted AR parameter. Usually, in this case the restricted form shows a parameter located somewhere in the middle between the unrestricted AR and MA parameter (see e. g. Scheiblecker, 2013). Nevertheless, the restricted retention rate turned out to be highly significant. Figure 1 shows the decrease over time of the weights given to past deviations from steady state with a retention rate of 0.70.

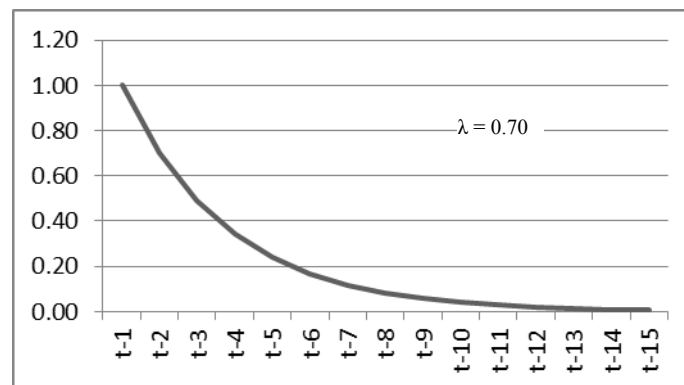


Figure 2. Retention rate over periods

In the first period t-1, the retention rate λ is one (λ^0) so that the attraction toward steady state is fully determined by the EC parameter β like in conventional ECMs. In the period before (t-2), the retention rate reduces the weight of the EC parameter by the factor 0.7 and so on. In the current period, deviations from steady state that occurred 8 quarters in the past still have a weight of around 0.10. After 14 quarters, the effect has completely faded out and disequilibria before that time do not influence short-term movements of money demand in the current period.

The Jarque-Bera statistics concerning the residuals of the restricted and the unrestricted model yielded a value of 1.281

⁵ Critical values for testing $\beta=0$ are taken from Fransens and van Oest (2007) Table 2 page 294. For a sample size of 1000, the critical value of a 95% confidence level is 1.80.

(probability: 0.527%) or 0.730 (probability: 0.694%), respectively. So their normality in distribution could not be rejected by far. Furthermore, no auto-correlation in the residuals was found.

3.6 Comparison with Other Model Results and Discussion

It is difficult to compare the results with those of Ball (2012), as different parameters had been estimated there. Furthermore, the author did not report many test statistics apart from those concerning the single parameters. In order to compare the quality of the models, I use several information criteria as suggested in the literature for discrimination between alternative models. As no values for such criteria are given in Ball (2012), his model had to be re-estimated for calculating three information criteria: the Akaike information criteria, the Schwarz criterion and the Hannan-Quinn criterion. Table 2 shows the respective results.

Table 2. Information criteria

	partial model	adjustment	cumECM unrestricted	CumECM restricted
Akaike	-7.089652		-7.100734	-6.260050
Schwarz	-6.939736		-6.972852	-6.153482
Hannan-Quinn	-7.028730		-7.048766	-6.216744

Since all three criteria show lower values for the unrestricted cumulative ECM than for the partial adjustment model, the unrestricted version should be the preferred one. However, the restricted version could not outperform the partial adjustment model as all its values are higher.

Above, it has been shown that the cumulative ECM nests the multi-cointegration model and the conventional ECM. As the partial adjustment model of Ball (2012) includes an AR(2) process and the cumulative ECM with its ARMA(1,1) process auto-regressive elements of any lag order, it is not astonishing that both models show roughly similar residuals in the underlying case. The partial adjustment model of Ball (2012) cuts-off influences from deviations from steady state located more than three periods in the past. This is not the case with the cumulative ECM, but the weights for those lags are decreasing rapidly, especially for low retention rates. Figure 2 shows the similarity of residuals of the partial adjustment model in the upper part, the restricted ECM in the middle and the unrestricted in the lower part of the graph.⁶ Nevertheless, the theoretical reasoning behind both approaches is quite different, and in other cases, the missing variable in the partial adjustment model could make for a larger difference between the two methods.

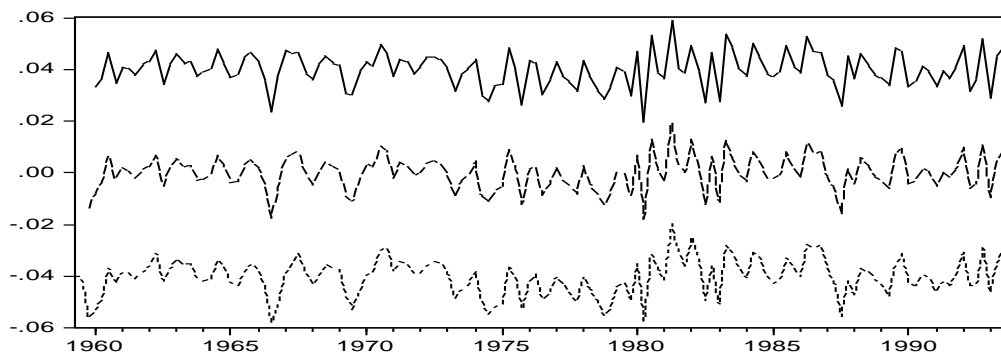


Figure 3. Residuals

4. Conclusions

It could be shown, that the proposed cumulative error correction model has several interesting properties like a meaningful economic interpretation and a robust and parsimonious model specification.

4.1 Model Properties

As different from the conventional ECM, the cumulative ECM accounts not only for the most recent deviation from the steady state, but also for those located further in the past, thereby allowing for some kind of stockpiling. For most economic problems, the inclusion of such activities is more adequate for modeling the behavior of economic agents.

Unlike the multi-cointegration model as proposed by Granger and Lee (1989), where all past deviations are assigned equal weights back to the start of the time series, we assume (and test) geometrically decreasing weights and estimate the related retention rate – which captures the size of the weights as well as their fading over time – from the data. This

⁶ The residuals have been shifted with a constant term, for better comparison in the graph.

leads to a more parsimonious and easier-to-estimate specification over a broad range of applications.

A strong property of the cumulative version is that the common ECM is completely nested as the retention rate can even be zero. On the other hand, if the retention rate is one, the multi-cointegration model emerges, but in this case the cumulative ECM will not be correctly specified as it does not explicitly allow for the second-level cointegrating relationship. Likewise, the partial adjustment model is nested as the cumECM covers auto-regressive movements of any lag order, due to its ARMA(1,1) representation.

Estimated conventional ECMs sometimes suffer from autocorrelation in the residuals. For practical purposes, this is often dealt with by including AR-terms. Sometimes this is done without any theoretical justification; in other instances - like in the case of the partial adjustment model - the reasoning is based on opportunity costs leading to sluggish adjustment. In the case of the cumECM, such assumptions are not necessary since the inclusion of an ARMA process is based only on theoretical grounds whereby disequilibria of past periods may also matter.

4.2 Economic Findings

The results of the applied cumECM show that stockpiling activities in past quarters contribute to considerable extent to the explanation of demand for M1 money. For the US a retention rate of 0.7 indicates that deviations from steady state demand of the past 2 years (8 quarters) play a significant role for short-term demand. On the other side, the classical EC parameter - reflecting the reaction to the steady state deviation in the most recent period - shows a lower value than in other studies, i.e. only half the size as in a comparable study by Ball (2012).

In order to interpret the most recent money demand changes correctly, economic policy should give greater consideration to stockpiling behavior in the past. The zero lower bound environment following the Great Recession of the years 2007/2008 has changed substantially the dynamics of money demand.. In this regard, there is strong need for further research.

Acknowledgements

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Appendix

Date	r_star	Yr	Py	M1
1959 Apr	2.36	2776.4	18.314	140.533
1959 Jul	2.41	2773.1	18.366	141.533
1959 Oct	2.46	2782.8	18.443	140.300
1960 Jan	2.51	2845.3	18.521	139.900
1960 Apr	2.57	2832.0	18.579	139.600
1960 Jul	2.62	2836.6	18.648	140.900
1960 Oct	2.66	2800.2	18.700	140.833
1961 Jan	2.69	2816.9	18.743	141.533
1961 Apr	2.72	2869.6	18.785	142.567
1961 Jul	2.84	2915.9	18.843	143.400
1961 Oct	2.99	2975.3	18.908	144.700
1962 Jan	3.50	3028.7	19.020	145.633
1962 Apr	3.65	3062.1	19.047	146.600
1962 Jul	3.66	3090.4	19.092	146.467
1962 Oct	3.66	3097.9	19.152	147.267
1963 Jan	3.66	3138.4	19.196	148.800
1963 Apr	3.67	3177.7	19.233	150.167
1963 Jul	3.75	3237.6	19.272	151.700
1963 Oct	3.76	3262.2	19.418	153.167
1964 Jan	3.76	3335.4	19.477	154.167
1964 Apr	3.76	3373.7	19.529	155.233

1964 Jul	3.76	3419.5	19.607	157.767
1964 Oct	3.77	3429.0	19.703	159.833
1965 Jan	3.86	3513.3	19.801	161.033
1965 Apr	3.87	3560.9	19.887	161.967
1965 Jul	3.88	3633.2	19.960	163.867
1965 Oct	3.96	3720.8	20.088	166.833
1966 Jan	3.97	3812.2	20.218	169.733
1966 Apr	3.97	3824.9	20.391	171.567
1966 Jul	3.97	3850.0	20.601	171.033
1966 Oct	3.97	3881.2	20.791	171.533
1967 Jan	3.97	3915.4	20.886	173.233
1967 Apr	3.97	3916.2	20.997	175.633
1967 Jul	3.97	3947.5	21.203	179.500
1967 Oct	3.97	3977.6	21.438	182.433
1968 Jan	3.97	4059.5	21.672	184.833
1968 Apr	3.98	4128.5	21.899	188.000
1968 Jul	3.99	4156.7	22.115	191.667
1968 Oct	4.00	4174.7	22.426	195.800
1969 Jan	4.00	4240.5	22.660	199.333
1969 Apr	4.01	4252.8	22.952	200.933
1969 Jul	4.01	4279.7	23.280	201.833
1969 Oct	4.02	4259.6	23.581	203.467
1970 Jan	4.24	4252.9	23.915	205.633
1970 Apr	4.50	4260.7	24.247	207.167
1970 Jul	4.52	4298.6	24.438	209.900
1970 Oct	4.52	4253.0	24.752	213.667
1971 Jan	4.50	4370.3	25.126	217.233
1971 Apr	4.41	4395.1	25.455	221.833
1971 Jul	4.42	4430.2	25.711	225.667
1971 Oct	4.47	4442.5	25.918	227.767
1972 Jan	4.45	4521.9	26.319	232.233
1972 Apr	4.39	4629.1	26.475	236.033
1972 Jul	4.40	4673.5	26.731	240.967
1972 Oct	4.41	4750.5	27.083	246.867
1973 Jan	4.44	4872.0	27.403	251.800
1973 Apr	4.52	4928.4	27.828	254.767
1973 Jul	4.77	4902.1	28.370	257.700
1973 Oct	4.88	4948.8	28.932	260.967
1974 Jan	4.89	4905.4	29.488	265.267
1974 Apr	4.91	4918.0	30.192	267.767
1974 Jul	4.93	4869.4	31.085	270.133
1974 Oct	4.95	4850.2	32.015	273.400
1975 Jan	4.95	4791.2	32.757	275.100

1975 Apr	4.97	4827.8	33.245	279.267
1975 Jul	5.00	4909.1	33.864	284.500
1975 Oct	5.01	4973.3	34.463	286.433
1976 Jan	5.01	5086.3	34.837	290.633
1976 Apr	5.00	5124.6	35.208	295.600
1976 Jul	4.99	5149.7	35.686	298.600
1976 Oct	4.98	5187.1	36.331	303.933
1977 Jan	4.96	5247.3	36.943	311.233
1977 Apr	4.96	5351.6	37.470	317.333
1977 Jul	4.96	5447.3	37.927	322.333
1977 Oct	4.96	5446.1	38.758	328.633
1978 Jan	4.97	5464.7	39.326	335.567
1978 Apr	4.98	5679.7	40.050	343.900
1978 Jul	4.99	5735.4	40.716	349.800
1978 Oct	4.99	5811.3	41.575	355.333
1979 Jan	4.99	5821.0	42.318	360.333
1979 Apr	5.01	5826.4	43.362	370.333
1979 Jul	5.26	5868.3	44.301	378.433
1979 Oct	5.59	5884.5	45.194	381.133
1980 Jan	5.92	5903.4	46.144	388.100
1980 Apr	6.04	5782.4	47.178	385.900
1980 Jul	5.49	5771.7	48.256	399.333
1980 Oct	6.08	5878.4	49.593	409.400
1981 Jan	6.60	6000.6	50.851	415.033
1981 Apr	6.87	5952.7	51.813	425.767
1981 Jul	7.72	6025.0	52.730	426.933
1981 Oct	7.18	5950.0	53.692	432.133
1982 Jan	6.91	5852.3	54.421	442.433
1982 Apr	7.17	5884.0	55.080	447.100
1982 Jul	6.45	5861.4	55.864	452.100
1982 Oct	5.42	5866.0	56.470	470.267
1983 Jan	4.79	5938.9	56.929	484.033
1983 Apr	5.65	6072.4	57.345	499.067
1983 Jul	6.07	6192.2	57.929	510.367
1983 Oct	6.02	6320.2	58.355	519.200
1984 Jan	6.14	6442.8	59.096	528.000
1984 Apr	6.48	6554.0	59.602	537.300
1984 Jul	6.90	6617.7	60.081	541.667
1984 Oct	6.38	6671.6	60.465	547.600
1985 Jan	5.65	6734.5	61.136	562.400
1985 Apr	5.38	6791.5	61.483	575.933
1985 Jul	5.02	6897.6	61.736	596.200
1985 Oct	5.01	6950.0	62.140	613.267

1986 Jan	4.88	7016.8	62.456	626.700
1986 Apr	4.44	7045.0	62.786	651.200
1986 Jul	3.99	7112.9	63.143	678.800
1986 Oct	3.72	7147.3	63.567	708.333
1987 Jan	3.62	7186.9	64.160	731.567
1987 Apr	3.69	7263.3	64.526	744.300
1987 Jul	3.80	7326.3	65.033	745.167
1987 Oct	3.99	7451.7	65.530	753.200
1988 Jan	3.89	7490.2	66.068	758.567
1988 Apr	3.88	7586.4	66.689	772.700
1988 Jul	4.15	7625.6	67.442	782.800
1988 Oct	4.40	7727.4	67.953	784.967
1989 Jan	4.79	7799.9	68.723	784.167
1989 Apr	5.14	7858.3	69.399	775.900
1989 Jul	5.02	7920.6	69.855	779.400
1989 Oct	4.91	7937.9	70.317	789.133
1990 Jan	4.73	8020.8	71.166	798.333
1990 Apr	4.72	8052.7	71.993	806.367
1990 Jul	4.69	8052.6	72.655	815.333
1990 Oct	4.62	7982.0	73.239	822.233
1991 Jan	4.15	7943.4	74.026	832.833
1991 Apr	3.76	7997.0	74.553	849.533
1991 Jul	3.57	8030.7	75.133	866.000
1991 Oct	3.21	8062.2	75.569	887.533
1992 Jan	2.66	8150.7	75.954	924.100
1992 Apr	2.47	8237.3	76.423	949.567
1992 Jul	2.19	8322.3	76.778	975.000
1992 Oct	2.04	8409.8	77.214	1014.767
1993 Jan	1.96	8425.3	77.677	1034.167
1993 Apr	1.89	8479.2	78.106	1062.900
1993 Jul	1.86	8523.8	78.466	1094.267
1993 Oct	1.85	8636.4	78.897	1122.300

Source: FRED ret. May 6, 2013, Ball (2012)

Notes: r_{star} in %, Y in billions of chained (2009) dollars, P_y is the GDP deflator, M1 in billions of dollars

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