Öneri.C.6.S.21.
Ocak 2004.ss.153-160.

TESTING THE VALIDITY OF FORWARD-LOOKING BUFFER STOCK MODEL USING WEIGHTED MONETARY AGGREGATES

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***Abstract:** Buffer stock models of monetary aggregates accept temporary departures from equilibrium in the market. On the other hand, Divisia monetary aggregates approach argue that the economic agents continuously decide on the amount of monetary services they would like to receive, which, in turn, establishes equilibrium. However, both of these theories depend on the existence of a money demand function to reach their outcomes. This study tries to analyze whether it is possible to incorporate the dynamics of these two well-known approaches by testing the validity of the Divisia monetary aggregates in the buffer-stock models of money for the United States. Both the simple-sum aggregates and the Divisia series seem to be well-equipped to cure the breakdown of the real money balances function in the 1970s onwards. However, Divisia M1 stands out as the dominant aggregate.*

Keywords: Divisia, Money Demand

GELECEĞE DÖNÜK TIPA-STOK MODELİNİN TARTILI PARASAL BÜYÜKLÜKLER KULLANILARAK GEÇERLİLİĞİNİN TEST EDİLMESİ

***Özet:** Tıpa stok parasal büyüklükler modeli ekonomilerde geçici denge bozukluklarını savunmaktadır. Buna karşın, Divisia parasal büyüklükler modeli ise ekonomik bireylerin (devamlı olarak) ihtiyaçları olan parasal servis miktarına karar verdiklerini, ve bu kararında ekonomik (parasal) dengeyi oluşturduğunu ileri sürmektedir. Birbirine zıt gibi görünse de, özünde her iki teoride açıklanabilir bir para talebi fonksiyonuna dayanmaktadır. Bu makale bu iki teorinin dinamiklerinin birleştirilir olup olmadığını analiz etmek amacını taşımaktadır.*

Bunun için tıpa-stok parasal modellerinde Divisia tartılı para arzlarının geçerliliği Amerika Birleşik Devletleri verileri için test edilmiştir. Divisia tartılı para arzları en az toplam para arzları kadar reel para dengesi fonksiyonun 1970'lerden bu yana uğradığı kırılmayı iyileştirmekte başarılı olmaktadır. Kullanılan parasal büyüklükler içinde Divisia M1 en hakim parasal büyüklük olarak göze çarpmaktadır.

Anahtar Kelimeler: Divisia, Para Talebi

I. INTRODUCTION

The search for a stable long-run relationship between the demand function for real balances and an interest rate given some measure of real economic activity (or volume of transactions) has been one of the most distinguished topics of the economic literature. The complicated nature of this research has been pointed out long ago with the fallacy of the partial adjustment model. Argues [1]: "The first and most important result of this survey is that the evidence supporting the existence of a reasonably stable demand for money function would seem to be overwhelming. This is true both of long-term evidence covering the last seventy years or so and of the evidence from the postwar period until 1973".

The stability of the demand for money is important because mainstream macroeconomic models depend on it. For many years, the central theme of monetarist models has been the proposition of a stable long-run aggregate demand for real balances. From a monetarist perspective, the view is that monetary growth causes inflation and has no influence on output and employment in the long-run, although there may be significant short-run influences on real variables. The monetarist prescription has been that a target growth rate for base money should be set at a fixed level designed to achieve zero or low (one-two percent) inflation after allowance for 'normal' productivity and output growth. Along with the monetarist arguments, the stability of money demand is an important element in the New Classical view of monetary effects. In addition, it appears in some New Keynesian analyses and in some empirical real business cycle models that incorporate the aggregate price level and inflation.

The inability of the literature to provide robust specifications has been outlined as [2]: "...the evidence in favor of the kind of long-run stability of the money-income relationship that cointegration represents has become weaker over time, so much that any presumption in favor of such a relationship must reflect prior beliefs, rather than evidence contained in the data..."

The research of the last twenty years in monetary economics has provided three major theories while trying to correct the deficiencies of the partial adjustment model.

Namely these are the buffer stock models, the Divisia aggregates approach and error correction models. Recent studies [3-5] demonstrate the superiority of the first two of these theories. In the context of these latest developments, this paper tries to incorporate the essentials of those two specifications while analyzing the dynamics of the long-run money demand function.

First, unlike most studies of monetary phenomena in the 1980s which attribute changing empirical relationships to some aspects of financial innovations, this paper follows [6,7] by making use of the Divisia aggregates. Deriving from Barnett, Belongia [8,9] emphasize that the reported simple-sum monetary aggregates are flawed index numbers and they fail to represent the thrust of monetary policy. This is due to the aggregation problems inherent in the weighting scheme of these variables. In this respect, simple sum-aggregates are liable to spurious shifts that would suggest a change in the utility derived from money holdings though no such change has occurred.

Second, due to its sound microfoundations, the latest "forward-looking" version of the buffer stock model is employed. Mizen [4] presents a detailed survey of the buffer stock literature as well as testing the validity of the forward-looking version for the UK data. Although Mizen [5] outlines the problems inherent in the Divisia aggregates approach, he does not refute the fact that Divisia models appear to correct "one unpleasant feature of simple sum aggregation". That is the weights of the Divisia aggregates absorbing the shocks in the data. In this respect, it is worth to incorporate the essentials of the two approaches by simply using the Divisia series while testing the validity of the buffer stock models for the US. This will not only eliminate the defects of the simple sum aggregation but also examine the robustness of the buffer stock models.

The organization of this paper is as follows: In section II, there is a brief summary of the empirical literature on the long-run demand function for real balances in the United States. In section III, the advantages of using the Divisia aggregates for testing the validity of forward-looking approach is discussed while the sound microfoundations of the buffer stock models are presented. Section IV involves the empirical analysis, and section V is a brief conclusion.

II. HISTORICAL BACKGROUND OF THE LONG-RUN MONEY DEMAND FOR THE US

Consumers, firms and other economic units hold monetary assets for various purposes like transactions, speculation and contingencies. These assets include (but are not limited to) currency, checkable deposits, money market mutual fund shares, and savings and time deposits. The aggregate quantities of monetary assets play significant roles in macroeconomics. In many nations, the monetary authorities publish the sum monetary assets in aggregate forms like M1, M2, M3 and L. In the United States, for example, the asset aggregates include:

M1 = Currency and Travelers Checks' + Demand Deposits Held by Consumers + Demand Deposits Held by Businesses + Other Checkable Deposits + Super NOW Accounts Held at Commercial Banks + Super NOW Accounts Held at Thrifts

M2 = M1 + Money Market Mutual Fund Shares + Money Market Deposit Accounts at Commercial Banks + Money Market Deposit Accounts at Thrifts + Savings Deposits at Commercial Banks + Savings Deposits at Savings and Loans (S&Ls) + Savings Deposits at Mutual Savings Banks (MSBs) + Savings Deposits at Credit Unions + Small-Time Deposits and Retail RPs at Commercial Banks + Small Time Deposits at S&Ls and MSBs and Retail RPs at Thrifts + Small Time Deposits at Credit Unions

M3 = M2 + Large Time Deposits at Commercial Banks + Large Time Deposits at Thrifts + Institutional Money Market Funds + RPs at Commercial Banks and Thrifts + Eurodollars

L = M3 + Savings Bonds + Short-term Treasury Securities + Bankers' Acceptances + Commercial Paper.

These constitute the simple sum monetary aggregates. With such a summation procedure, a weight of unity is implicitly attached to each monetary asset. This means the owners of these monetary assets regard them as perfect substitutes. However, most economic agents hold a portfolio of monetary assets (ranging from currency and deposits to bonds and stocks) and these assets have different opportunity costs. Thus, it is hard to believe that the simple summation procedure captures the true dynamics of the asset demand theory. It is obvious that the simple sum monetary aggregates are flawed index numbers [8, 9]. In the words of Barnett [7], "one can add apples and apples, but not apples and oranges."

Starting from the late 1950s and early 1960s, empirical studies of the demand for real balances examined the long-run income and interest elasticity estimates. Their usual outcome was failing to reject a unitary long-run income elasticity with a coefficient ranging from -0.6 to -0.7 on the long-run interest elasticity [10,11]. The inadequacy with these studies is found in their interpretation of long-run as a reference to the time span of the data series rather than to the equilibrium of demand and supply curves for real balances.

With the supply shocks in 1970s, the economic literature had lost its faith in the conventional money demand functions. The so-called **Goldfeld puzzle** [12] of too little money and too much velocity accompanied by the too much money and too little velocity in 1981-1983 underlined the fundamental changes associated with the demand for real balances. In this context, the failure of the profession to explain the dynamics of the short-run money demand function accompanied with the difficulties in analyzing the long-run money demand have led economists to believe that money's effects on economic activity and its role in monetary policy are issues wide-open for debate.

As a result, the main line of attack has focused on specifications that pay adequate attention to the long-run nature and short-run dynamics of money demand. However, as a stable long-run money demand is the key ingredient in the monetary theory of the balance of payments and monetary theory of exchange rate determination, the main focus has been on determining a robust long-run relationship.

During the 1980s, conventional money demand equations (employing M1 as the monetary aggregate) failed at least on two occasions. In 1982-83, they were unable to predict the large decline in M1 velocity, and in 1985-86, they missed the explosive growth in M1.

Economists have sought to fix conventional money demand equations by focusing on specifications that pay adequate attention to the long-run nature and short-run dynamics of the money demand function. These attempts can be classified in three categories.

The first approach tried to reformulate money demand regressions [13,14]. The second approach chose to apply recently developed econometric techniques [15,16].

The last category includes studies that use a different span of the data compared to the previous studies [17,18].

The general conclusions emerging from these studies have been the documentation of long-run stationarity for money demand only in the case of broad-aggregated monetary measures (typically only M2, and occasionally M1). However, the stability of the long-run money demand is still considered as an unresolved issue in much of the current literature [19,20].

III. DIVISIA AGGREGATES AND BUFFER STOCK MODELS

Although there is consensus on the variables which determine the money holdings, there has been far less agreement on how to measure the aggregate quantity of money in the economy [19,20].

It is a well-known feature of microeconomic theory that rational decision makers chose corner solutions when allocating resources over perfect substitutes. Therefore, simple sum monetary aggregation is only consistent with microeconomic theory in the case where economic agents hold only one monetary asset in their portfolio.

The appropriate method of aggregating monetary assets is an important question in macroeconomics. Although the microfoundations of money have been widely discussed [21,22] prior to Barnett [7] only a few studies had been concerned with application of aggregation and/or index number methods to monetary assets [23,24]. Despite being a strong advocate of M2, Friedman and Schwartz [25] emphasized the deficiencies related to high level simple sum aggregates as:

"The [simple sum aggregation] procedure is a very special case of the more general approach...[which]...consists of regarding each asset as a joint product having different degrees of "moneyness", and defining the quantity of money as the weighted sum of aggregates value of all assets, the weights for individual assets varying from zero to unity with a weight of unity assigned to that asset or assets regarded as having the largest quantity of "moneyness" per dollar of aggregate value. The procedure we have followed implies that all weights are either zero or unity. The more general approach has been suggested frequently but experimented with only occasionally. We conjecture that this approach deserves and will get much more attention than it has so far received".

Following this presumption, Barnett [7] introduced the application of index number theory to the construction and estimation of monetary aggregates while underlining the deficiencies associated with the simple-sum aggregation. He argues that economic agents must be able to treat a monetary aggregate as the quantity of a meaningful single good in their decisions. Hence, it is possible for individuals to select their desired aggregate quantity of the monetary aggregate without regard to its composition. Beside, changing the relative quantities of the components within the monetary aggregate must not influence any change in tastes or technology over any other goods. In this respect, Barnett [7] demonstrates the invalidity of simple sum index number formula. Introducing the notion that each asset has a user cost, he calculates that term depending on the foregone interest. In discrete time, this is

$\pi_{it} = (R_t - r_{it}) / (1 + R_t)$, where r_{it} is the own rate of return on monetary asset i, and R_t is the rate of return on the benchmark asset, which is the asset that is held solely as an investment. Hence, the benchmark asset does not provide any services other than its investment rate of return, R_t.

Drawing on Barnett [26], Barnett [3] and Belongia [8] argue that simple sum aggregates are flawed index numbers because aggregating any set of commodities with equal weights means that each good is a perfect substitute for every other good in the group. However, this is not the condition as empirical evidence shows. Hence, the simple-sum aggregates are liable to internalize pure substitution effects as they are prone to spurious shifts. These shifts may be the reasons for the instability of the money demand functions, using simple-sum aggregates as their dependent variable. Replacing the simple-sum monetary aggregate by its Divisia counterpart, Belongia [8] finds reversed qualitative inferences in four of five cases examined.

One of the indices Belongia [8] uses is the Divisia, constructed by calculating expenditure shares for the financial assets to be aggregated and using these shares as the index weights, derived from Barnett [7]. In this formulation, the household's utility function is assumed to be weakly separable in monetary assets. Hence, the marginal rate of substitution between any two monetary assets becomes independent of the quantities of all other goods. The household solves its utility maximization problem in two stages.

In the first stage, the shares of total household expenditure to be spent on real monetary services and on quantities of individual non-monetary goods and services is chosen. In the second stage, not exceeding the expenditure on monetary services selected in the first stage, the household determines the real stocks of monetary assets that will provide the largest possible quantities of monetary services.

In this respect, to incorporate the pure substitution effects and track the true, but unknown, subutility function associated with the monetary service flow from holding a given set of assets, monetary aggregates need to be constructed using an index formula from the class of superlative index numbers [27,28].

Following these studies, recently Anderson, Jones and Nesmith [29] have developed the Monetary Service Index (MSI), approximating many monetary aggregates. The monetary services indices are sometimes called as Divisia monetary aggregates as their construction uses a discrete approximation to Divisia [30]'s continuous time index.

Anderson, Jones and Nesmith [31] explained that the MSI includes the monetary quantity aggregate, and its dual user cost index. Unlike the official monetary aggregates published by the Board of Governors of the Federal Reserve System, the MSI and their dual user cost indices are statistical index numbers, based on economic aggregation and statistical index number theory depending on the theoretical advances of Barnett [6,7,26] and Diewert [27]. Beside, the theoretical procedures used in the construction of MSI database are valid only under the assumption of risk neutrality.

Namely, the MSI contains monetary services indices constructed over the same set of assets (levels of aggregation) as the simple sum monetary aggregates M1A, M1, MZM, M2, M3 and L. These indices are both chained superlative index numbers, and have the same theoretical and statistical properties as other chained superlative index numbers, like the Gross Domestic Product (GDP) and GDP deflator produced by the Department of Commerce. In this framework, the methodology for construction of MSI is compatible with the mainstream of current macroeconomic research. Moreover, the MSI approach follows the contemporary general-equilibrium business cycle models which often begin with the hypothesis of an optimizing microeconomic agent [32].

The vast literature on buffer stock models underlines the general notions of their premises [4,33]. Buffer stock models accept temporary departures from equilibrium in the market, arguing that these depend on the commonly accepted microeconomic principles as costs of adjustment, revision of expectations and time spent to respond. The advocates of the buffer stock models choose two distinct types, namely the expectations-incorporated type known as the shock absorber approach (and its following extensions) and the inventory principle approach.

The shock-absorber approach lies its roots in Carr and Darby [34] where they allow real money balances off the individual demand for money function in the short run by introducing variables to capture these discrepancies. Their equation is

$$m_t = p_t + \lambda m_t^{*} + (1-\lambda)m_{t-1} + \alpha\, y_t^{T} + \phi(m_t - m_t^{a}) + u_t$$

where they tested for the statistical significance of ϕ (the term for unexpected nominal money supply shocks) and α (the term for transitory income). The outcomes were supportive of the shock-absorber approach.

Further extension of the model-known as the forward-looking version-has been introduced by Cuthbertson [35], Cuthbertson and Taylor [36,37].

They generalize the minimisation of costs of adjustment into a multi-period framework. This is accomplished by incorporating forward-looking behavior as they allow the individual money balances to be influenced by shocks to current monetary policy and expectations of future monetary policy. Hence, deviations in equilibrium are not only due to unexpected events but also because of the anticipated events ahead of the current time period. Mizen [4] offers an extended empirical testing of forward-looking approach for UK using quarterly data for the period 1966(1) to 1989(2). The results of Mizen [4] provide favorable evidence for the forward-looking rational expectations buffer stock models although the broad money measure (M4) performs better than the narrow one (M1).

IV. COINTEGRATION ANALYSIS

Most economic variables are proposed to follow volatile paths, hence it is always a matter of question whether economic variables tend to revert back to some long-run trend following a shock or random walk process. In this respect, the underlying characteristics that generated the time series is to be examined in detail to discriminate spurious from real relationships. Foremost in this agenda is the use of recently developed cointegration techniques that allows one to estimate the long-run relationship using data with a frequency of measurement appropriate to the study of monetary policy issues.

Previous cointegration analyses of time series are primarily based on residual-based tests following the two step procedure of Engle and Granger [38]. However, since its introduction [39,40], Johansen method has been widely used. Its' superiority lies in the fact that it takes into account the error structure of the data and allows for interactions in the determination of the relevant economic variables, within the context of vector autoregressions. The procedure developed by Johansen [39] builds on the cointegration literature by providing a maximum likelihood technique for estimating and testing for cointegration.

This paper examines the existence of a stable long-run relationship between the economic variables proposed to determine the demand for real balances. Cointegration is the approach to follow as it is at least a necessary (but not always sufficient) condition for economic variables to have a stable long-run (linear) relationship.

IV.1. Empirical Evidence

Using the above discussed framework, this study employs the real simple sum monetary aggregates, M1 (SSM1) and M2 (SSM2) and the real MSI aggregates of Divisia (Div) M1 and Divisia (Div) M2 as the appropriate measures of money. The chain index of real gross domestic product calculated by the Department of Commerce is used as the scale variable. Lucas [41] and McCallum [42] demonstrate utility theoretic models of money demand which indicate that the appropriate scale variable is total expenditure), the gross domestic product, the three month T-bill rate as the opportunity cost variables. The price variable used is the CPI as it is also a superlative chain index. All variables are in their natural logarithms except the interest rates. The sample period is determined by the availability of consistent measures of the aggregate in question. The data is quarterly and data runs from 1970.1 to 2000.4. The first step is to test for the integration order of the variables. Table.1 show the results of the Dickey-Fuller test [43,44,45] for levels and differences and Table.2 for the Kwiatkowksi *et. al.* (KPSS) [46] test for levels and differences.

Table.1: Augmented Dickey-Fuller Unit Root Tests

Variable	Case	Lags	Level	Case	Lags	Diff.
Div M1	Trend	3	-2.46	No Trend	6	-4.86**
SSM1	Trend	3	-2.38	No Trend	6	-3.77**
Div M2	Trend	3	-3.29*	No Trend	0	-4.65**
GDP	Trend	2	-3.30*	No Trend	0	-9.25**
CPI	Trend	3	-1.98	No Trend	7	-2.99**
RTB3	No Trend	7	-2.23	No Trend	6	-5.56**

The critical values for the case with No Trend are -3.51, -2.89, and -2.58 for 1%, 5% and 10% significance levels, respectively. The critical values for the case with Trend are -4.04, -3.45, and -3.15 for 1%, 5% and 10% significance levels, respectively. (*) denotes significance at 10 % level, and (**) denotes significance at 5 % level.

Table.2: --- KPSS Unit Root Tests

Variable	Case	Lags	Level	Case	Lags	Diff.
DivM1	Trend	4	0.49**	No Trend	4	0.13
SSM1	Trend	4	0.46**	No Trend	4	0.13
Div M2	Trend	4	0.50**	No Trend	4	0.30
SSM2	Trend	4	0.45**	No Trend	4	0.33
GDP	Trend	4	0.33**	No Trend	4	0.09
CPI	Trend	4	0.46**	No Trend	4	0.50**
RTB3	Trend	4	0.51**	No Trend	4	0.06

The critical values for the case with No Trend are 0.739, 0.463, and 0.347 for 1%, 5% and 10% significance levels, respectively. The critical values for the case with Trend are 0.216, 0.146, and 0.119 for 1%, 5% and 10% significance levels, respectively. (*) denotes significance at 10 % level, and (**) denotes significance at 5 % level.

As the above tables show all of our series have a unit root and no deterministic trend. However, the CPI is order 2 in the KPSS test, and order of 1 in the Dickey-Fuller test. We proceed according to the Dickey-Fuller test due to its common acceptance in the literature.

Overall, our results show that we can reject the null of non-stationarity using ADF and KPSS at 10, 5 and 1 % significance levels in the differenced series. Thus we end up with I (1) series. This shows that all the series in question can be characterized as random walk processes. This is not surprising as economic series are bound to follow random walks due to fluctuations in economic activity.

Next, we employ tests for cointegration suggested in Johansen and Juselius [47] and called Johansen-Juselius (JJ). Haug [48] compares the power and size of distortions of these tests in a Monte Carlo study and finds that the JJ maximum eigenvalue tests have the least size distortions.

To determine the appropriate lag length for the residuals from the vector error-correction process in Johansen and Juselius's procedure, we employ the Akaike criterion and check all the residuals for white noise with the Box-Pierce Q statistic. We check the cases of simple-sum M1, simple-sum M2, Divisia M1 and Divisia M2. Dummy indicates a dummy variable used to capture the effects of shocks in the 1970s (The specification of the dummy variable could be requested from the author). The results are in Table.3 for the JJ.

Table.3: Johansen-Juselius (JJ) Cointegration Tests: Monetary Aggregates, Real Output, Interest Rates

		No Trend		Trend	
Variables	Null	Max E.	Trace	Max E.	Trace
DivM1,	r = 0	28.27*	31.02*	30.82*	43.20*
GDP,	r ≤ 1	2.68	2.75	9.72	12.39
RTB3	r ≤ 2	0.07	0.07	2.67	2.67
SSM1,	r = 0	27.13*	29.56*	29.01*	41.19*
GDP,	r ≤ 1	2.40	2.43	9.78	12.17
RTB3	r ≤ 2	0.03	0.03	2.40	2.40
DivM2,	r = 0	12.78	21.52	19.84*	37.59*
GDP,	r ≤ 1	8.36	8.74	9.61	17.75
RTB3	r ≤ 2	0.38	0.38	8.14	8.14
SSM2,	r = 0	23.33*	31.73*	26.15*	45.30*
GDP,	r ≤ 1	8.39	8.40	10.99	19.15
RTB3	r ≤ 2	0.01	0.01	8.16	8.16

The 10 % critical values for the Max E. test are 13.39, 10.60, and 2.71 for the No Trend case, and 16.13, 12.39, and 10.56 for the Trend case. The 10 % critical values for the Trace test are 26.70, 13.31, and 2.71 for the No Trend case and, 39.08, 22.95, and 10.56 for the Trend case. (*) denotes significance at 10 % level.

Like Mizen [4], we are able to detect the presence of a cointegrating vector in the JJ test. All of our equations end up providing comovement of the variables included. It is possible to argue that our series follow similar patterns as they have the same order of integration.

This finding is crucial because it demonstrates the establishment of the relationship between real money balances, income and interest rates. Hence in a sense this study is reversing the trend that has been followed by many studies which have failed to provide favorable evidence for the existence of a money demand relationship in the last 30 years.

Moreover, the maximal eigenvalue and trace statistics of the cointegration tests for the Divisia M1 are larger than the ones for the SSM1. This is a typical example of the dominant nature of the Divisia M1.

It is important to note that it is M1 that the economic agents deal with in their daily lives. Therefore, the decisions of economic agents are reflected in the behavior of the narrow monetary aggregates, in a special manner, which is better than the broad monetary aggregates. This is the reason why we see a reverse case for M2. As more and more financial components are found in a monetary aggregate the decisions of economic agents could have a nuisance. This is due to the commonly accepted microeconomic principles like costs of adjustment, revision of expectations and time spent to respond that create temporary disequilibrium in the short-run.

V. CONCLUSION

This study tried to incorporate the essentials of two well-known theories of money demand while trying to explain the dynamics of a stable long-run relationship between real money balances, an interest rate and GDP.

Our results are in support of the theoretical framework which was outlined (but could not be demonstrated) by some recent studies. The forward looking buffer stock model and the Divisia aggregates of Barnett are capable of providing an empirical explanation of the existence a stable long-run money demand function. Although we examined the matter from a buffer stock perspective, it is important to note that these findings also apply to a simple money demand function. Beside, it is important to notice that economic agents behaviors is reflected in the incorporation of the Divisia monetary aggregates and the buffer-stock models of money while making decisions on their real money balances. In this respect, this study is probably the first example of this nature in showing empirical support that links the two important approaches of monetary economics.

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