

INCORPORATING RISKY ASSETS IN DIVISIA MONETARY AGGREGATES

*Leigh Drake**
*Andy Mullineux***
*Juda Agung****

Abstract

Capital uncertain or risky assets are typically excluded from traditional broad monetary aggregates. Barnett et al (1997), however, extend the Divisia aggregation methodology to incorporate such assets. In addition, recent evidence provided by Drake et al (1998) suggests that risky assets are close substitutes for monetary assets. This paper constructs "wide" Divisia monetary aggregates which include risky assets such as unit trusts (mutual funds), equities and bonds, and contrasts their empirical properties with conventional Divisia and simple sum broad money aggregates. The key finding in the paper is that a "wide" monetary aggregate, which incorporates unit trusts, exhibits a stable long run and dynamic money demand function, has good leading indicator properties in the context of Granger causality tests, and tends to outperform all other aggregates on the basis of non-nested tests.

JEL : E41, C43, E52

* University of Loughborough, **University of Birmingham, *** Bank Indonesia
Corresponding address : Leigh Drake, Department of Economics, Loughborough University Loughborough, LE11 3TU, UK. This paper published in Discussion Paper No. 98.25, Department of Economics of University of Birmingham

I. Introduction

The issue of monetary aggregation continues to be a highly contentious area of monetary economics. It is now widely acknowledged that the simple sum procedure traditionally used by central banks to aggregate monetary assets is inappropriate in the absence of perfect substitutability between the component assets. This has resulted in the increasingly widespread use of weighted aggregation procedures such as the Divisia index number methodology, first pioneered in this context by Barnett (1980, 1984). The Bank of England, for example, has for the past few years published Divisia monetary aggregates together with its conventional simple sum aggregates. There is much less agreement, however, concerning which financial assets should enter into the monetary aggregate. While there is a wide consensus regarding the appropriateness of including traditional “narrow money” assets, such as cash and non-interest bearing sight deposits in monetary aggregates such as M1, no such consensus exists with respect to wider monetary aggregates which incorporate “near money” or “quasimoney” assets.

In the face of continuing financial innovation, deregulation, and periods of significant narrow money demand instability (such as the “missing money” episode in the US in the mid 1970’s), Central Banks have typically introduced a series of broader monetary aggregates such as M2, M2+ and M3 in the US, and M2, M3 and M4 in the UK. The introduction of broad monetary aggregates by central banks has tended to be somewhat ad-hoc, however, with the addition of progressively broader “near-money” assets such as Money Market Deposit Accounts (MMDAs) and Money Market Mutual Funds (MMMFs) in the US, and building society deposits (the equivalent of deposits with US Savings and Loan Institutions) in the UK. Often the inclusion of such assets in official monetary aggregates has occurred in response to evident destabilising substitutions between such assets and assets within the official narrower aggregates, as was the case with MMDAs in the US in the early 1980s and building society deposits in the UK in the mid 1980s (see Bank of England, 1986).

A typical maintained hypothesis in both monetary aggregation and money demand studies, however, is that non-capital certain assets or “risky” assets, such as bond or equity mutual funds (unit trusts in the UK), do not provide monetary services and hence can be excluded from the analysis. This general approach is in accordance with a proposition due to Ando and Shell (1975), which has been generalized by Spencer (1986, Appendix I pp 184-193) and implicitly used by Spencer (1994) to justify the exclusion of risky assets from the Divisia monetary aggregates he constructs for the UK. Broadly, the argument is that, since non-risky monetary assets are available to meet demands for money transmission services, individuals will not hold risky assets for these purposes. However, a contrasting argument can be derived from the proposition in Hicks (1935) that falling transaction costs and rising

wealth would lead to the inclusion of a greater proportion of risky assets in households' financial asset portfolios.

It is also relevant to note that financial innovation over the past couple of decades has enhanced the liquidity of many financial assets, and particularly "risky" assets. Furthermore, money transmission services (MTS) are now provided in association with financial assets previously not regarded as monetary assets, such as mutual funds (unit trusts) and particularly MMMFs. Given the increased liquidity of such assets and/or their association with MTS provision, the question arises as to whether such assets should now be regarded as monetary assets? If the answer is yes, then these risky assets should be included in the monetary aggregates used as indicators for guiding the conduct of monetary policy.

This type of analysis has already been conducted in the US in response to the so-called "missing M2 episode" in the US in the early 1990s. The significant decline in official M2 holdings, and a corresponding rise in M2 velocity, was generally attributed to the substantial shift into bond and equity mutual funds in response both to the low interest rates on deposits in the low inflation environment of the early 1990s and the attractive returns on alternative bond and equity mutual fund investments. The empirical properties of so called M2 + aggregates, which incorporate bond/equity (stock) mutual funds, has been examined in the US by, for example, Orphanides et al (1994) Collins and Edwards (1994) and Duca (1995). However, all these studies rely on simple sum aggregation with the implicit assumption that all asset components are perfect substitutes. While this is an unreasonable assumption with respect to conventional monetary assets such as cash and various types of deposit assets (which are providing a joint product of monetary services and investment return under capital certainty), it is even less appropriate for non-capital certain assets, which have risk dimension in addition to providing an investment return, and possibly also monetary services.

Until relatively recently, a suitable methodology was not available to incorporate risky assets into the Divisia aggregation methodology. Such a methodology has now been developed (see Barnett and Liu, 1995, and Barnett, Jensen and Liu, 1997) and this methodology has been utilised by Drake, Fleissig and Mullineux (1998) to investigate the substitutability between risky assets and both cash and deposit assets. The results suggest that these assets are unambiguously substitutes in demand, but that the statistically significant elasticities of substitution are generally in the range 2 to 2.5. This suggests that a weighted aggregation procedure, such as the Divisia index number approach, is much more appropriate than simple sum aggregation. More significantly, however, the results indicate that risky assets, such as unit trusts (mutual funds), bonds and equities, are often closer substitutes for cash (narrow non-interest bearing MI assets) than are deposit assets. Clearly, as the latter are generally added to MI Assets to produce broad money aggregates, this result implies that, as

in the US, the properties of UK monetary aggregates which incorporate risky Assets warrant investigation.

The objective of this paper is to utilise the methodology of Barnett and Liu (1995) and Barnett, Liu and Jensen (1997) in order to derive, and investigate the empirical properties of monetary aggregates which include risky assets. More specifically, the conventional and “risk-adjusted” Divisia aggregation methodologies are utilised to construct a range of alternative monetary aggregates. For completeness, since they are still utilised by most central banks, we also construct some simple sum aggregates for comparison. The empirical properties of these various aggregates are then examined using: cointegrating/error correction money demand analysis; Granger causality tests to establish leading, indicator properties; and non-nested testing criteria to statistically discriminate between the various aggregates in the context of a St Louis type nominal spending equation.

The remainder of the paper is structured as follows : Section 2 details the methodology adopted in respect of the incorporation of risky non-capital certain assets into Divisia monetary aggregates; Section 3 outlines the data set utilised; Section 4 provides estimations and results pertaining to the comparative empirical properties of the various constructed monetary aggregates, and section 5 summaries and Concludes.

2. The Incorporation of Risky Assets

2.1. *Divisia Monetary Aggregates*

Using an approach such as the Divisia index number technique for the construction of monetary aggregates requires data on both the prices and quantities of the relevant assets. With respect to the latter these are generally taken to be the real per capita holdings of the assets. In the case of prices, however, the appropriate specification depends upon the particular assets under investigation. In the case of capital certain assets, Barnett (1978) has demonstrated that the appropriate prices are the rental Prices, or user costs, of the assets, which can be thought of as the one-period holding costs. The appropriate formula for the rental price of the i th capital certain asset in period t (π_{it}) can be expressed as;

$$\pi_{it} = (R_t - r_{it}) / (1 + R_t) \quad (1)$$

Where R_t is the benchmark rate of return in period t , and r_{it} is the own rate of return on the i th asset at time t . Hence, when the rental prices calculated in (1) are combined with the associated quantities of monetary assets using an appropriate aggregation procedure, such as “Divisia” (Barnett 1980, Barnett et al 1992), the resulting aggregate will be measuring the monetary/liquidity services of the assets having “stripped out” the investment returns of the

“broader assets”. These are assets which provide investment services in the form of a non-zero return as well as monetary/liquidity services. Typically, in the case of capital certain assets, the benchmark rate is taken to be the rate of return available on an asset which is held as a store of value and is assumed to provide no monetary services, ie, government bonds. It is often the case, however, that capital certain assets in some periods have a higher return than those on government bonds. Hence, an alternative is to use an envelope approach, which amounts to searching across the range of assets to find the highest return in each period. This highest return then becomes the benchmark rate for each period.

As noted previously, it has generally been assumed that non-capital certain risky assets do not provide monetary services. Hence, an implicit weak separability assumption is invoked and risky assets are excluded from the monetary aggregation and money demand analysis (Drake and Chrystal 1994, Drake 1996). However, increasing attention is now being paid to the potential incorporation of risky assets (which increasingly do provide some monetary services) into monetary aggregates. The next sub-section, therefore, addresses the issue of precisely how risky assets can be incorporated into monetary aggregates and hence into money demand analysis.

2.2. *The CAPM Extended Divisia Monetary Aggregate Under Risk*

Recently, Barnett and Liu (1995) have demonstrated that it is possible to adjust the rental price formula expressed in (1) in order to take account of the “riskiness” of non-capital certain assets. Hence, whilst (1) takes account of the two dimensional trade-off between investment return and monetary/liquidity services in capital certain assets, it becomes necessary to take account of a three dimensional trade-off incorporating risk when non-capital certain assets are included. Provided that the rental prices are appropriately adjusted for risk, any subsequent aggregation of risky assets (using Divisia aggregation) should again measure the monetary/liquidity services provided by these assets.

Invoking the simplifying assumptions of the Consumption CAPM (CCAPM), Barnett and Liu (1995) demonstrate that the required risk adjustment amounts to subtracting a risk premium from the individual asset returns. For notational convenience, Barnett and Liu convert the nominal rates of return r_{it} and R_t into real total rates of return, $1 + r_{it}^*$ and $1 + R_t^*$ such that :

$$1 + r_{it}^* = P_t^* (1 + r_{it}) / P_{t+1}^* \quad \text{and} \quad 1 + R_t^* = P_t^* (1 + R_t) / P_{t+1}^*$$

where r_{it}^* and R_t^* defined in this way can be termed real rates of excess return, and P_t^* is the consumer goods price index. utilising the typical CAPM simplifying assumptions of either quadratic utility or Guassianity (ie, (r_{it}^*, c_{t+1}) is assumed to be a bivariate Gaussian process

for each asset $i = 1, \dots, k$, and where c_{t+1} is real aggregate consumption at time $t+1$). Barnett and Liu demonstrate that the adjusted user cost or rental price for the i th risky asset at time t (Π_{it}) can be calculated as:

$$\Pi_{it} = \frac{E_t R_t^* - (E_t r_{it}^* - \Phi_{it})}{1 + E_t R_t^*} \quad (3)$$

where

$$\Phi_{it} = Z_t \text{Cov}\{r_{it}^*, c_{t+1}/c_t\} \quad (4)$$

In (3), Z_t is the Arrow-Pratt measure of relative risk aversion and c_{t+1}/c_t is a measure of the consumption growth rate. Hence, the risk premia depend upon the coefficient of relative risk aversion multiplied by the covariance between the asset returns and real per capita consumption growth, where we define consumption as an aggregate of consumption of durables, non-durables and services (see Drake, Fleissig and Swofford, 1997).

In the context of (3), it should also be noted that a further conventional CAPM assumption is invoked in that the benchmark rate is treated as deterministic, or already “risk-adjusted”, such that R_t^* can be interpreted as a risk free rate. This amounts to an assumption that the risk premium has been extracted from the benchmark rate. In practice, however, the benchmark rate will automatically be “risk-adjusted” since each individual asset return will initially be ‘risk-adjusted’ and then the benchmark rate will be computed as the upper envelope of the “risk-adjusted” component rates.

In this paper we assume, for simplicity, that the expected return on a non-capital certain asset in time t ($E_t r_{it}^*$) can be modelled as a simple AR process on past returns. We also assume that the coefficient of relative risk aversion (Z_t) is equal to unity, which appears to be consistent with most of the available empirical evidence. Finally, although we have so far only been discussing the issue of the computation of risk-adjusted rental prices in the context of non-capital certain assets, but it is clear that in principle, this risk adjustment could also be applied to capital certain assets. Even though these assets are capital certain they will typically have variable interest rates and the interest rate will not be known at the beginning of the period. This implies a potential non-zero covariance between r_{it}^* and c_{t+1}/c_t in (4). In turn, this implies the potential need to “risk adjust” the rental prices for these assets prior to their use in the computation of Divisia monetary aggregates.

In practice, however, Barnett et al (1994) have shown that in these cases there is a negligible difference between the risk-adjusted and non-risk-adjusted Divisia aggregates. However, they do emphasize that this type of adjustment is likely to be important if assets contributing substantially to household risk, such as common stock or bond funds, are to be

incorporated into monetary aggregates. Hence, for the purposes of this paper, we assume that risk adjustment is required only in the case of non-capital certain assets. For capital certain assets we continue to use the standard rental price formula given in (1).

3. Data

In the case of capital certain assets, data on the personal sector nominal asset holdings, together with the corresponding interest rates (yields) were provided by the Bank of England. These assets are :

NC	-	Notes and Coins.
NIBS	-	Non-Interest Bearing Sight Deposits.
IBS	-	Interest Bearing Sight Deposits.
TD	-	Bank Time Deposits.
BSD	-	Building Society Deposits.
NS	-	National Savings.

Fisher, Hudson and Pradhan (1993) provide details on the own rates of return for the interest bearing assets IBS, TD, BSD. In the case of NS, the representative own rate is taken to be the National Savings Investment Account Rate. The own rates of return on NC and NIBS are taken to be zero although clearly the opportunity cost and hence the rental prices of these assets are not zero in practice.

With respect to non-capital certain assets, three categories are identified, i.e., equities, government bonds and unit trusts. Data on the nominal holdings of these assets by the personal sector was provided by *Datastream*. Data on the quarterly total returns on UK unit trusts were provided by *Micropal*. For equities, the total return is made up of the quarterly dividend yield together with the quarterly percentage capital gain or loss. These are calculated on the basis of the Financial Times All Share Index. Similarly, for Government bonds the total return is measured by the quarterly yield on Long Term Government bonds together with the quarterly percentage capital gain or loss as measured by the Financial Times Actuaries Long Term Government Bond Price Index.

Prior to utilizing the “envelope method” (see Section 2) of calculating the benchmark rate of return, the quarterly total returns on the non-capital certain assets were first risk-adjusted. The benchmark rate each period was then found as the maximum return across all the assets. In practice, in order to ensure that all rental prices are non-zero, benchmark rate is defined as the maximum “risk-adjusted” rate per period plus epsilon (where epsilon is a very small number) Once the benchmark rate is established, the rental prices for both capital

certain and capital uncertain assets can be calculated (see Barnett and Liu 1995). Together with the nominal asset quantities these can be used to construct Divisia monetary aggregate quantity indices and also the dual price (rental price) indices.

We construct two Divisia aggregates that incorporate risky assets, RDM9 (i.e. six capital certain assets and the three capital uncertain assets: unit trusts, bonds, and equities) and RDM7 (i.e. six capital certain assets and unit trusts alone). These two “Risky Divisia” aggregates are then compared to Divisia aggregates that consist only of capital certain assets, RDNR and RDM4, where RDNR is Divisia non-risky assets containing the five capital certain assets, i.e. the M4 asset components¹ and national saving and RDM4 is Divisia M4. It should be noted that these two aggregates were constructed with the same risk-adjusted benchmark rates of return, R_t^* , being used to construct RDM9 and RDM7. We also compare these “risky” Divisia aggregates to two conventional capital certain Divisia aggregates, CDM4 and CDNR, whose user cost is calculated by using equation (1), and also with the simple-sum aggregates, SM4 and SNR. Following Patterson (1991), Drake (1996; 1997) and Drake and Chrystal (1997), the benchmark rate, R_t , in equation (1) is taken as the upper envelope of the various rates of return on non-risky assets and the Halifax Building Society maximum retail deposit interest rate.

Given that simple sum aggregates imply that the component monetary aggregates are all perfect substitutes, the appropriate price dual is the Leontief index. Hence, for the simple sum aggregates, SM4 and SNR, we take as the price variables the minimum user cost derived from the maximum rate of return and from using equation 1. These simple sum user costs are denoted as UCM4 and UCNR respectively.

The comparison of the usefulness of the various monetary aggregates for monetary policy analysis is based on a series of empirical tests: long and short-run money demand stability analysis, non-nested tests and causality tests. With respect to the money demand stability analysis, other variables utilised include: the scale variable real consumer expenditure (REXP); the retail price index (RPI), and the (dual) rental price indices of the corresponding Divisia aggregates (i.e. P9, P7, PNR, PM4, PNRC and PM4C) or Leontief indices (UCM4 and UCNR) for simple sum aggregates.

In the non-nested testing procedure we use variants of the standard St Louis nominal spending equation. In order to be consistent with the money demand and causality analysis, However, we use the first difference of nominal consumer expenditure as the dependent variable.

¹ M4 consists of NC, NIBS, IBS, TD, and BSD.

4. Empirical Results

In this section, the various monetary aggregates described in the previous section are compared using the various empirical tests listed above. Firstly, the long-run relationships between the alternative aggregates, the scale variable, the general price level and the opportunity cost variables are analyzed using cointegration analysis. We use real consumer expenditure as the scale variable and the retail price index as the proxy for the general price level² and corresponding Divisia user costs (rental price indices) or Leontief indices for simple sum aggregates. Should a long-run relationship exist, the next step is the estimation of short-run error-correction models incorporating the long-run relationship. Secondly, we conduct Granger causality tests based on the specification of a VAR system of first differenced variables incorporating the lagged error correction terms in order to capture the long-run information from the preceding cointegration analysis. Finally, we follow Drake, Chrystal and Binner (1994) in comparing the alternative aggregates using St Louis nominal spending equations and non-nested tests to identify superior informational content.

4.1. Cointegration Analysis

The performance of the alternative aggregates can be evaluated in the context of whether there exists a plausible long run relationship between the aggregates and both the scale variable (REXP), the price level (RPI) and the relevant rental prices/opportunity costs. The existence of such a relationship can be established by the use of cointegration to test whether a linear combination of the *non-stationary* I(1) variables, is in fact stationary overtime. We employ the Johansen maximum likelihood (JML) technique (Johansen, 1988 and Johansen and Juselius, 1990) in testing for cointegration³.

Prior to testing for cointegration, it is necessary to investigate the order of integration of the data series. In doing this we use the augmented Dickey-Fuller (ADF) tests for levels and first differences, which are reported in Table 1. It is clear from Table 1 that for the majority of the variables, the null hypothesis of a unit root in levels cannot be rejected. Hence, we can reject the hypothesis of stationarity in the levels of the variables, ie, most variables are not I(0). The variables LP4, LPNR and LPPI are more marginal, however, as the hypothesis of

2 We also experimented with real GDP as the scale variable and the GDP deflator as the price variable. However, the short-run dynamic models indicated that models with consumer expenditure and the retail price index performed better. Furthermore, given that we are dealing with personal sector financial data, the use of consumer expenditure and the retail price index is justified.

3 The Johansen technique is chosen in preference to the Engle - Granger (EG) two-step procedure (Engle and Granger, 1987). It is well known that in the EG procedure the parameters of the long run relationship will depend on which variables is normalised as the endogenous variable. Moreover, The EG procedure cannot deal with the possibility of multiple cointegrating vectors. The JML method avoids such normalization problems and can estimate and test for the presence of multiple cointegrating vectors. The JML results may, however, depend on the selection of the lag length in the VAR and the estimates may be sensitive in small sample.

stationarity in levels is accepted at the 5% level but rejected at the 1% level. When the variables are expressed in first differences however, the null hypothesis of a unit root is unambiguously rejected at the 1% level. Hence, all variables appear to be $I(1)$, with the possible exception of LP4, LPINR and LRPI which may be borderline $I(0)/I(1)$. Hence, we can proceed with the Johansen cointegration analysis given that we have predominantly $I(1)$ variables and no $I(2)$ variables.

As mentioned previously, the Johansen cointegration test is sensitive to the choice of lag length (k). One possibility is to use some information criteria such as the Schwartz information criteria in determining the lag length. A more appropriate method, however, is to combine this with misspecification tests by choosing the lag length to ensure that the underlying assumptions of the VAR model are satisfied (Johansen, 1995, pp20). In particular, to check whether the residuals in the Johansen VAR are free from serial correlation, conditional heteroscedasticity and that distribution of the residuals is normal. Our experimentation using a range of lags (VAR lag lengths of 4- 8), based on the Schwartz and the Hannan-Quinn information criteria and the misspecification tests, suggested that a lag length of 6 is optimal.

In testing for cointegration, the question of whether a constant and trend should enter the long-run relationship also arises. Allowing for a non-zero drift in the data, we restrict the constant to the short run VAR. Furthermore, given that the data tends to exhibit a linear deterministic trend in the levels, the trend is forced to lie in the cointegration space. This is consistent with Hendry and Mizon (1993) and Hendry and Doornik (1994), which advocate restricting the trend to the cointegration space order in to take account of long-run exogenous growth not already included in the model.

Table 2 reports both the unadjusted trace statistics and the degrees of freedom adjusted trace statistics given the fact that the Johansen procedure can tend to over reject the null hypothesis (Reimers, 1992). The coefficients are normalised with respect to the monetary aggregate variables in order to derive coefficient estimates for the long run money demand specifications. The first point to make about the results in is that all monetary aggregates appear to be cointegrated with the scale variable (REXP), prices (RPI) and their corresponding rental prices. However, if we use the adjusted trace statistics, the results indicate that no cointegration exists for the conventional Divisia aggregates (CDM4 and CDNR) and for RDNR.

The results suggest that the elasticities on REXP in all cointegrating relationships are around two but the elasticities on the general price level tend to vary across the monetary aggregates. It is noticeable, however, that the elasticities on prices for the adjusted Divisia aggregates are close to unity, while in the context of the expected price homogeneity, the price elasticities for the simple sum counterparts appear to be “too large” and those for the conventional (non risk-adjusted) Divisia aggregates “too small”.

Given the intense financial deregulation and innovation which has taken place in the UK financial system in the past two decades, and the problems associated with monetary targeting during the 1980s, the stability of the long-run money demand relationship has become an important issue. In the UK, for example, Hall et al. (1989) found evidence of instability in the demand for broad monetary aggregates and this result echoes a large amount of previous money demand research, both in the UK and US. Furthermore, it is also well known that the cointegrating relationships obtained using the Johansen methodology can be sensitive to the sample period utilised. To address these two issues, therefore, we performed recursive estimations of the Johansen VARs and derived the associated recursive eigenvalues for the cointegrating vectors presented in Table 2. These recursive eigenvalue estimates can be viewed as an indicator of the stability of the cointegrating relationship (and hence the long run money demand relationship) as they are analogous to the recursive parameter estimates in a single regression (Hendry and Doornik, 1995). Figure 1 illustrates the recursive eigenvalues for the various cointegrating vectors and clearly indicates that the long-run relationship obtained for all the monetary aggregates appear to be highly stable.

4.2. Dynamic Error Correction Models

Having established that the monetary aggregates, real consumer expenditure, the price level, and the relevant opportunity cost variables are cointegrated, then, according to Representation Theory (Engle and Granger, 1987), there must exist a dynamic adjustment process, or error correction model (ECM) representing the short-run behavior of the relationship among those k variables. The general ECM model employed is as follows :

$$\Delta MA_t = \alpha + \gamma ec_{t-1} + \sum_{i=1} \beta_{1i} \Delta MA_{t-1} + \sum_{i=0} \beta_{2i} \Delta REXP_{t-1} + \sum_{i=0} \beta_{3i} \Delta RPI_{t-1} + \sum_{i=0} \beta_{4i} \Delta P_{t-1} \quad (5)$$

where MA is logarithm of the alternative monetary aggregates, RXEP is real consumer expenditure, RPI is retail price index, P is corresponding rental price, and ec_{t-1} is the lagged error-correction term obtained from Table 2.

A critical element in specifying the dynamic error correction model is the order of the lag structure on the first difference terms. We employ Hendry's well-established general to specific methodology whereby the ECM is initially estimated using 8 lags and sequentially "tested down" to obtain a parsimonious dynamic model. These results are reported in Table 3.

Generally, the error correction models pass most of the diagnostic tests including tests for autocorrelation, normality, ARCH and heteroscedasticity. Exceptions are SM4 and RDM9

which fail the normality test, and CDM4 which fails the autocorrelation test. The stability of the error correction models are also tested by recursive residuals and Chow tests (one step F-test, breakpoint F-test and forecast F-test) and these results are presented in Figures 2-9. These stability tests suggest that the error correction models for the two simple-sum aggregates and for RDM9 exhibit some dynamic instability.

With the exception of CDM4, all the error correction terms are negative and significant as would be expected. Furthermore, it is interesting to note that all the ECM estimates tend to indicate relatively low speeds of adjustment back towards long run equilibrium. However within the risk-adjusted Divisia class of aggregates, RDM9 and RDM7 tend to exhibit slightly faster speeds of adjustment than do RDM4 and RDNR.

4.3. Causality Tests

In order to investigate whether the alternative monetary aggregates have potentially useful leading indicator properties for output/expenditure (in this case, consumer expenditure) and retail prices, this section reports the relevant Granger causality tests specified in a bi-VAR relationship between the alternative monetary aggregates and real consumer expenditure and the retail price index respectively. The bi-VAR is specified in first-difference terms given the general non-stationarity of the variables. Furthermore, in order to avoid misspecification, the lagged error-correction terms from a prior cointegration analysis are also incorporated into the first difference analysis in doing this we can attempt to identify two aspects of Granger causality, namely long-run and short-run causal effects (see Masih and Masih, 1996). While the significance of the first differences of the independent variables (using the appropriate Wald test) provides an indication of short-run causality, the significance of the error-correction terms indicates the presence of a long-run causal relationship.

The Granger causality results are detailed in Table 4. The lag length in the cointegration tests are chosen using the methods employed in section 4.1. The Johansen cointegration results suggest that both real consumer expenditure and prices are cointegrated with the alternative monetary aggregates. Furthermore, it can be noticed that RDM7, together with RDM4 and RDNR, “Granger-cause” the price level both in the short run and in the long run, while the other aggregates display a two way causality. With regard to the causality between money and consumer expenditure, the results indicate that RDM4, RDNR and RDM7 “Granger cause” expenditure, both in the short run and in the long run, and that casualty from expenditure to RDM7 is indicated in the short-run. Although the finding of long run money-output / expenditure causality is at odds with the generally acceptable notion of long run money neutrality, the latter is by no means universally accepted. Tobin (1965), for example, maintained that higher monetary growth should induce faster capital accumulation and

productivity growth as economic switch out for monetary assets and into capital assets. Furthermore, in their review of the theoretical literature regarding the introduction of money into economic models, Orphanides and Solow (1990) observe that:

“For those who can bring themselves to accept the single consumer, infinite-horizon model as a reasonable approximation to economic life, superneutrality is a defensible presumption. All others have to be ready for a different outcome” (Page 225).

4.4. *Non-Nested Tests*

A traditional linear test of a variable's usefulness as a monetary indicator is its performance in an aggregate spending equation. In this section, therefore, we compare the performance of all our monetary aggregates in the environment of a modified St Louis nominal spending equation, and use non-nested tests to identify superior information content. Although there are acknowledged difficulties with the use of St Louis equations, they do offer simplicity and transparency and provide a feel for the properties of the data in question. Furthermore, unlike the previous money demand and causality analysis, non-nested testing in the context of a St Louis equation specification does provide a direct means of discriminating between the various aggregates.

Although St Louis nominal spending equations are usually with the first difference of nominal GDP as the dependent variable, we elect to use the first difference of nominal consumption, given that the data set pertains to the personal sector and in order to achieve consistency with the earlier cointegration and causality analysis. The independent variable is the first difference of the relevant monetary aggregate with a specified lag structure of order 8. Although there are a whole range of non-nested testing procedures, these can often produce indeterminate and sometimes conflicting results. We utilise the Schwartz and the Akaike Information Criteria since each of these statistics provides an unambiguous result in terms of the superior information content of one specification over another (in this case, alternative monetary aggregates as regressors). Furthermore, in the whole series of bilateral tests performed, these two statistics consistently provided the same rankings.

Clearly, with 8 different monetary aggregates, there are no less than 28 sets of non-nested tests. Hence, for reasons of brevity, we do not report the details of these non-nested tests in full. Instead, we report in Table 5 the rank ordering of the aggregates based upon the full range of bilateral non-nested tests using these criteria. It is clear from Table 5, therefore, that RDM7 (the risky divisia aggregate containing unit trusts) outperformed all other aggregates. In other words RDM7 displayed superior information content when contrasted sequentially with all the other aggregates in the context of the nominal spending equation. This result, together with the evidence provided by the previous causality and money demand

analysis suggests that a strong case can be made for broad money aggregates to be expanded still further to include risky assets such as unit trusts/mutual funds. Interestingly, the other aggregate containing risky assets, RDM9, is ranked as the worst aggregate in terms of information content. Since this aggregate includes both government bonds and equities as risky assets, in addition to unit trusts, this outcome suggests that bonds and equities are probably too volatile to be usefully combined within a wide monetary aggregate. This issue is discussed more fully in Section 5.

In the context of non-risky assets, it is notable that the Divisia aggregates which utilise the risk-adjusted benchmark procedure unambiguously outperform the conventional Divisia aggregates. RDNR and RDM4 are ranked 2nd and 4th respectively, while CDNR and CDM4 are ranked only 6th and 7th respectively. This result suggests that, when utilising the Divisia methodology it is very important to consider fully the practicalities of their construction, such as the appropriate way to construct the benchmark rate of return series. It is evident from Table 5 that this can make a significant difference both to the empirical results and to the usefulness of the aggregates from the perspective of the monetary authorities.

Finally, a further important result to emerge from Table 5 is the finding that the simple sum aggregates SNR and SM4 clearly outperform the conventional Divisia aggregates CDNR and CDM4. Indeed, this result sheds some light on one of the puzzles which has emerged in the money demand/ monetary aggregation literature. Specifically, while it is generally accepted that the Divisia aggregation methodology is theoretically superior to simple sum aggregation (see Barnett, 1980 and Barnett et al, 1992), studies which have empirically evaluated both types of monetary aggregates have tended to find that the empirical superiority of Divisia aggregates is much less clear cut than their apparent theoretical superiority. Furthermore, a number of central banks have often declared a degree of scepticism over the use of Divisia aggregates, largely due to the perceived practical difficulties associated with constructing and using such aggregates (see Fisher, Hudson and Pradhan, 1993). One of the most frequently cited of these practical difficulties is the choice/construction of the appropriate benchmark rate. In empirical work, for example, this has often been specified as a corporate bond rate or a long term government bond rate. While this rate should in theory be the maximum risk free/risk-adjusted rate available, the benchmark rate is typically not risk-adjusted in empirical applications. Furthermore, given variations in the slope of the yield curve, it is often the case that the notional benchmark return is own-rate, dominated over some portion of the sample period. In the case of the Bank of England's approach to Divisia aggregation, for example, they elect to use the 3 month. Local Authority rate as the appropriate benchmark, but add an ad hoc 3% to this rate to ensure that the constructed benchmark produces positive user costs for all assets over the sample period (see Fisher, Hudson and

Pradhan, 1993).

It is apparent from Table 5, therefore, that practical issues such as the appropriate construction of the benchmark rate are extremely important in terms of the empirical performance of Divisia aggregates. Furthermore, these results suggest that the failure of previous studies to rigorously address this issue, and other issues such as the potential inclusion of risky assets, may well have adversely impacted on the empirical performance of Divisia monetary aggregates vis-a-vis simple sum aggregates.

5. Summary and Concluding Comments

This paper investigates the issue of whether non-capital certain (“risky”) assets can be regarded as “monetary” assets and hence included in the monetary aggregates used for guiding the conduct of monetary policy. Given the increased liquidity of such asset and recent evidence of their strong substitutability with the components of narrow and broad money aggregates (Drake, Fleissig and Mullineux, 1998), we incorporated these risky assets into Divisia monetary aggregates and test their money demand and leading indicator properties relative to the conventional (non-risk-adjusted) Divisia and simple sum monetary aggregates.

The relative performance of the various aggregates was evaluated using a battery of tests: long-run and short run demand for money analysis, non-nested tests in a modified St Louis equation and first difference Granger causality tests. The findings indicate that all the aggregates under consideration are cointegrated with real consumer expenditure, prices and an opportunity cost term; indicating that a stable, long-run money demand relationship exists for all our alternative aggregates. However, the combined evidence from the error correction models, non-nested tests and causality tests suggests that risk-adjusted Divisia aggregates (and especially RDM7, which incorporates the risky asset unit trusts), tend to outperform the other aggregates.

This result is consistent with the approach adopted in the US, under which bond and equity mutual funds have been added to the traditional M2 aggregate (see Duca, 1995, and Orphanides et al 1995). Mutual funds have exhibited rapid growth in recent years, both in the UK and US. Furthermore, such assets have increasingly tended to offer via the process of financial innovation, money transmission services and increased liquidity. Hence, it would seem logical to consider the further widening of conventional broad money aggregates to include these assets; provided that this is done using an appropriate methodology, such as the risk-adjusted Divisia approach. It is interesting to note, therefore, that US research in this area (Duca, 1995, Orphanides et al, 1995) continues to adopt the traditional simple sum approach to monetary aggregation.

It is clear that asset holdings of equities and bonds (as opposed to mutual funds) tend to provide less monetary services (liquidity, money transmission services, etc). Hence, these assets are less obvious candidates for inclusion in a wide monetary aggregate. Notably, the US research cited above includes equity and bond mutual funds in the so called M2 + aggregate, but does not include actual holdings of equities and bonds. The evidence concerning the instability of RDM9 in this paper suggests that these assets (and hence the resulting aggregate), are too volatile to provide a useful guide for monetary policy purposes.

The simple sum aggregates SM4 and SNR also show evidence of short run money demand instability, in addition to violating the long run price homogeneity postulate. This result is in line with other previous research demonstrating that the simple sum methodology is inappropriate (see Barnett et al, 1992; Drake, Fleissig, and Mullineux, 1998).

In conclusion, the adoption of the risk-adjusted Divisia methodology does seem to offer an improvement over both simple sum aggregates and the conventional Divisia broad money aggregates. Hence, central banks should consider further expanding existing broad monetary aggregates to include risky assets such as mutual funds/unit trusts. With continuing financial innovation, central banks run the risk that conventional broad monetary aggregates will be periodically destabilised by substitutions between assets within the official aggregate and risky assets, such as unit trusts outside it. Such a problem was faced by the US authorities in the so-called “missing M2” episode in the early 1990s. As Barnett (1980) has pointed out, however, such destabilizing substitutions could be completely internalised by specifying an appropriately wide aggregate and aggregating the component assets using a suitable procedure such as the risk-adjusted Divisia approach.

References

Ando, Albert and Shell, Karl (1975) Annex to Ando, A and Modigliani, Franco “Some Reflections on Describing Structures of Financial Sectors” pp 560-563 in G. Fromm and Klein L (ed) “The Brookings model: Perspectives and Recent Developments”, Amsterdam : North Holland.

Bank of England (1986), “Financial change and broad money”, Bank of England Quarterly Bulletin. 26(4), 499-507.

Barnett, William A. (1978), “The User Cost of Money”, Economics Letters, Vol 1(2), 145-49.

Barnett, William A. (1980) “Economic Monetary Aggregates: An Application of Index Number Theory and Aggregation Theory”, Journal of Econometrics 14(1), 11-48.

Barnett, William A., Fisher, D. And Serletis, A. (1992) "Consumer Theory and the Demand for Money", *Journal of Economic Literature*, Dec, 2086-2119.

Barnett, William A., Kirova, Milka, Liu, Yi, and Zhou, Ge, (1994) "Beyond the Risk Neutral Utility Function", Mimeo.

Barnett William A and Liu, Yi (1995), "The CAPM - Extended Divisia Monetary Aggregate with Exact Tracking under Risk", Working Paper No 195, Department of Economics, University of Washington in St Louis.

Barnett, William A, Jensen, Mark C, and Liu, Yi (1997), "The CAPM Risk Adjustment for Exact Aggregation over Financial Assets," *Macroeconomic Dynamics*, 1(2), May, 485-512.

Collins, S.C. and Edwards, C.L. (1994). "An alternative Monetary Aggregate: M2 Plus Household Holding of Bond and equity Mutual Funds", *Federal Reserve Bank of St. Louis Review*, Nov./Dec., pp. 7-29.

Drake, Leigh (1992), "The Substitutability of Financial Assets in The UK and the Implications for Monetary Aggregation", *Manchester School of Economics and Social Studies*, V 60(3), 221-248.

Drake, Leigh. (1996), "Relative Prices in the UK Personal Sector Money Demand Function", *Economic Journal*, 106 (September), 1209 -1227.

Drake, Leigh (1997), "Non-Parametric Demand Analysis of Personal Sector Decisions On Consumption, Leisure and Monetary Assets", *Review of Economics and Statistics*, 79(4), 679-682.

Drake, Leigh and K Alec Chrystal (1994), "Company-Sector Money Demand: New Evidence on The Existence of a Stable Long-Run Relationship for The United Kingdom", *Journal of Money Credit and Banking Vol 26/3* (August 1994, Part 1).

Drake, Leigh and K Alec Chrystal and Jane Binner (1994), "Weighted Monetary Aggregates for the UK", *Loughborough University Discussion Paper 94/9*.

Drake, Leigh., Adrian R., Fleissig, and James L. Swofford. "A Semi Nonparametric Approach to Neoclassical Consumer Theory and Demand for UK Monetary Assets", *St Louis University Research Paper*, 1997.

Drake, Leigh., and K. Alec Chrystal., "Personal Sector Money Demand in the UK". *Oxford Economic Papers*, 49(2) April, 1997, 188-206.

Drake, Leigh, Adrian.R Fleissig, and Andy Mullineux (1998), "Are Risky Assets Substitutes for monetary Assets", forthcoming in *Economic Inquiry*.

Duca, John V "Should Bond Funds be Added to M2?", *Journal of Banking and Finance* 19, 1995, 131-52.

Engle, R.F. and Granger, C.W.J. (1937). Cointegration and Error-Correction: Representation, Estimation and Testing. *Econometrica* 55, pp 251-76.

Fisher, P., Hudson, S. and Pradhan, M. (1993). "Divisia Indices for Money: An Appraisal of Theory and Practice", Bank of England Working Paper Series, April, 9.

Hendry, D.F., and Doornik, J.A. (1994) Modelling Linear Dynamic Econometric Systems. *Scottish Journal of Political Economy*, Vol 41, pp. 1-33.

Hendry, D.F., and Mizon, G.E. (1993). Evaluating dynamic econometric models by encompassing the VAR. In P.C.B. Phillips (ed.), *Models, Methods, and Applications of Econometrics*, Oxford: Basil Blackwell, pp. 272-300.

Hicks J R (1935), "A Suggestion for Simplifying the Theory of Money", *Economica*, February 1-19.

Johansen, S (1988) "Statistical Analysis of Cointegrating Vectors", *Journal of Economic Dynamic and Control*, 231-54.

Johansen, S (1995) "Likelihood-based Inference in Cointegrated Vector Autoregressive Models", New York: Oxford University Press.

Johansen, S and Juselius, K (1990) "Maximum likelihood estimation and inference. on cointegration- with applications to the demand for money", *Oxford Bulletin of Economics and Statistics*. May, 1-15.

Orphanides A. and R.M. Solow (1990), "Money, Inflation and Growth", in B.M. Friedman and F.H. Hahn (eds), *Handbook of Monetary Economics*, Amsterdam: North Holland.

Orphanides, A., B. Reid, and D.H. Small. "The Empirical Properties Of A Monetary aggregate That Adds Bond and Stock Funds To M2," *Federal Reserve Bank of St.Louis Review*, 76(4), 1994, 31-51.

Patterson, K.D. (1991), "A Non-Parametric Analysis of Personal Sector Decision on Consumption, liquidity Assets and Leisure", *The Economic Journal*, V 101(408), 1103-1116

Reimers, H.E. (1992). Comparison of tests for multivariate cointegration. *Statistical Papers*, Vol. 33, pp. 335-59.

Spencer, Peter D, (1986), *Financial Innovation, Efficiency and Disequilibrium*, Oxford University Press, Oxford

Spencer, Peter D. (1994), "Portfolio Disequilibrium: Implication for the Divisia Approach to Monetary Aggregation" *The Manchester School* 4 XII(2) 125-50

Tobin J (1965) "Money and Economic Growth", *Econometrica*, 33, 671-84.

Table 1.
Unit Root Tests

Variables	ADF t-statistics	
	Levels ^a	First differences ^b
LSM4	-1.902	-3.547**
LSNR	-0.825	-3.252*
LDM4C	0.672	-5.229**
LDNRC	0.636	-5.067**
LDM4	-1.098	-4.015**
LDNR	0.162	-3.899**
LDM7	0.275	-4.115**
LDM9	1.151	-7.998**
UCM4	-2.053	-8.500**
UCNR	-2.586	-9.887**
LP4C	-1.916	-9.068**
LNRC	-1.947	-9.400**
LP4	-3.615*	-13.802**
LPNR	-3.556*	-13.781**
LP7	-3.392	-14.553**
LP9	-2.261	-13.574**
LRPI	-4.081*	-5.117**
LREXP	-1.941	-9.324**

Notes: * significant at 5%, significant at 1%

^a Constant and trend included. critical values: 5% = -3.481, 1% = -4.108

^b Constant included, critical values : 5% = -2.908, 1% = -3.538.

Table 2.
Johansen Cointegration Tests

	Ho	Test Stat. λ _{trace}	λ _{trace} ^{nm}	Cointegration vectors		Price	Price User Cost	Dual Trend
				Money	Output			
SM4	r = 0	116.3***	71.28***	-1	2.26	2.16	-0.069	-0.019
	r < 1	56.51***	34.63					
	r < 2	23.98	14.70					
	r < 3	8.49	5.21					
SNR	r = 0	119.3***	73.10***	-1	2.52	2.11	-0.229	-0.026
	r < 1	66.34***	40.66					
	r < 2	22.96	14.06					
	r < 3	8.10	4.96					
CDM4	r = 0	101.9***	62.46	-1	2.15	0.56	-0.07	-0.007
	r < 1	57.89***	35.48					
	r < 2	23.15	14.19					
	r < 3	8.1	5.01					
CDNR	r = 0	102.4***	62.77***	-1	1.81	0.282	-0.16	-0.003
	r < 1	60.22***	36.91					
	r < 2	22.87	14.02					
	r < 3	7.54	4.63					
RDM4	r = 0	112.7***	69.04***	-1	3.47	1.19	-0.09	-0.022
	r < 1	57.60***	35.30					
	r < 2	28.59	17.52					
	r < 3	8.53	5.23					
RDNR	r = 0	96.92***	59.40	-1	2.69	1.21	-0.06	-0.017
	r < 1	51.73***	31.71					
	r < 2	27.80**	17.04					
	r < 3	7.17	4.39					
RDM7	r = 0	103.9***	63.69***	-1	2.11	1.29	-0.07	-0.011
	r < 1	62.49***	38.30					
	r < 2	29.11	17.84					
	r < 3	8.36	5.13					
RDM9	r = 0	112.0***	68.62***	-1	1.84	1.33	-0.01	-0.014
	r < 1	66.28***	40.63					
	r < 2	33.76***	20.69					
	r < 3	11.75	7.20					

**significant at 1% *significant at 5%

Table 3.
ECM Models

	ECM Coeff	Significant first difference lags		Price	Δ Dual price/user cost	R ²
		Money	Output			
SM4	-0.0683 (-4.567) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	1 = 0.108 (0.979) = 6.858 (0.032)** = 0.039 (0.997) = 0.536 (0.929)	2,3,4	5,7	3,4,5,6,7	0.8968
SNR	-0.0565 (-8.717) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	- = 1.292 (0.288) = 1.559 (0.459) = 0.253 (0.906) = 0.697 (0.798)	2,4,7	6,7	3,4,5,6,7	0.9033
CDM4	0.0122 (0.715) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	4,5 = 0.600 (0.664) = 0.191 (0.909)** = 0.458 (0.766) = 1.354 (0.225)	4	1,4	5,6,7	0.7579
CDNR	-0.1311 (-4.586) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	1,4,6 = 2.170 (0.090)* = 0.477 (0.787) = 1.537 (0.212) = 0.488 (0.951)	1,2,3,4	1,2	1,7	0.7973
RDM4	-0.0366 (-3.039) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	1,4,6,8 = 1.056 (0.391) = 3.402 (0.183) = 0.157 (0.959) = 0.248 (0.999)	4	1,3,4,6	1,3,4,7,8	0.8824
RDNR	-0.0535 (-2.734) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	1,2,6,8 = 0.235(0.917) = 3.707(0.157) = 2.083(0.108) = 0.093(1.000)	2,4,5,7	1,2,7	5,7,8	0.9196
RDM7	-0.0704 (-3.365) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	1,5,6 = 0.376 (0.824) = 0.689 (0.708) = 0.761 (0.557) = 0.969 (0.521)	2,4,7	1,4	1	0.8357
RDM9	-0.1517 (-5.867) Autocorrelation (LM test) Normality test $\chi^2(2)$ Autocorrelation ARCH -4 Heteroscedasticity (White test)	5 = 0.6222 (0.649) = 31.25 (0.00)*** = 0.963 (0.438) = 0.780 (0.667)	1	1,8	4	0.6621

Table 4.
Casualty Test

B. Money and Output

Monetary aggregates	Ho	Trace statistics		Money → Output Wald test	ECM (t-stat)	Money → Output Wald test	ECM (t-stat)
		λ_{trace}	$\lambda_{\text{trace-nm}}$				
SM4	r = 0	50.23**	36.83**	33.94 (0.000)***	-0.220 (-2.84)***	13.72 (0.186)	-0.210 (-2.04)**
	r < 1	8.39	6.15				
SNR	r = 0	41.61**	30.52**	21.28 (0.019)**	-0.273 (-2.94)***	17.66 (0.061)*	-0.248 (-2.65)**
	r < 1	4.30	3.16				
CDM4	r = 0	59.14**	43.37**	46.21 (0.000)***	-0.396 (-3.98)***	16.83 (0.078)*	-0.285 (-1.96)*
	r < 1	3.77	2.77				
CDNR	r = 0	53.70**	39.38**	34.02 (0.000)***	-0.321 (-3.31)***	15.41 (0.114)	-0.079 (1.26)
	r < 1	3.169	2.32				
RDM4	r = 0	47.57**	34.88**	34.28 (0.000)***	-0.206 (-2.95)***	10.60 (0.390)	-0.149 (-1.50)
	r < 1	6.87	5.04				
RDNR	r = 0	40.37**	29.60**	24.10 (0.007)***	-0.246 (-3.04)***	14.27 (0.160)	-0.186 (-2.09)**
	r < 1	3.91	2.87				
RDM7	r = 0	41.69**	30.57**	23.84 (0.008)***	-0.249 (-3.09)***	15.79 (0.106)	-0.168 (-1.86)
	r < 1	5.51	3.30				
RDM9	r = 0	36.05**	26.43**	19.00 (0.040)**	-0.101 (-2.27)**	18.19 (0.052)*	-0.254 (-2.37)**
	r < 1	5.42	3.98				

Notes : * significant at 10%, **significant at 5%, *** significant at 1%

Table 5.
Ranking of Monetary Aggregates Based On Non-Nested Tests

Rank Order	Monetary Aggregate
1	RDM7
2	RDNR
3	SNR
4	RDM4
5	SM4
6	CDNR
7	CDM4
8	RDM9

***Notes** : Results based on the schwartz and Akaike Information Criteria results obtained from non-nested belateral tests of alternative monetary aggregates in a modified St Louis equation.