DM/86/30

INTERNATIONAL MONETARY FUND

Research Department

Weighted Monetary Aggregates and Monetary Policy

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May 5, 1986

Summary

In recent years, the acceleration of financial innovation and deregulation have sharpened attention upon the difficulties that currently face central banks in defining and measuring the monetary aggregates. One important branch of this research effort attempts to weight all assets included in the monetary aggregate by their degree of moneyness. This paper presents an empirical analysis of alternative weighted monetary aggregates and assesses their usefulness for the purposes of monetary policy.

The present paper builds upon an earlier contribution by Horne and Martin (1985) and extends that analysis to include an empirical comparison of weighted monetary aggregates based on the Roper-Turnovsky methodology with aggregates derived by weighting methods proposed by Chetty (1969) and by Barnett (1980). The relative advantage of each weighting scheme is compared with respect to five properties: economic interpretation, predictability, controllability, flexibility, and practicality. A set of weighted monetary aggregates is derived from a common sample set based upon quarterly Australian monetary data, 1969(4) to 1983(2), and the properties of the weighted and unweighted aggregates are compared.

The policy implications of the analysis are discussed with respect to three issues: monetary targeting, financial innovation, and the benefits and costs to the monetary authorities of using weighted monetary aggregates. The conclusion reached is that weighted monetary aggregates are in general likely to be of potential use in the conduct of monetary policy. However, while the empirical results show that the Roper-Turnovsky aggregate presents a clear gain in income predictability, other criteria, including flexibility of weights and data requirements, may lead the authorities to favor a Barnett aggregate.

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I. Introduction

Recent changes in financial markets, including the deregulation of financial institutions and innovations in financial products and processes, have raised important issues concerning the appropriate definition and measurement of money. While the problem of defining money has a long history, a recent literature has emerged that attempts to measure more accurately the monetary aggregates. An important branch of this research effort attempts to weight all assets included in the monetary aggregate by their degree of moneyness. 1/ Although most observers agree that a weighted monetary aggregate is superior in principle to an unweighted aggregate, there is no consensus in favor of a particular weighting method on theoretical grounds. Hence, the choice between weighted and unweighted monetary aggregates is an issue that is best resolved empirically.

The purpose of this paper is to assess the usefulness of weighted monetary aggregates for the purposes of monetary policy. The analysis builds upon an earlier contribution by Horne and Martin (1985) that shows how the concept of an optimum monetary aggregate discussed in Roper and Turnovsky (1980) can be estimated and made operational for the purposes of monetary policy. The present paper extends that analysis to include an empirical comparison of the Roper-Turnovsky aggregate with monetary aggregates based upon weighting methods proposed by Chetty (1969) and Barnett (1980). By including the Chetty and Roper-Turnovsky weighted aggregates, the scope of the analysis is enlarged considerably beyond that of recent surveys that have been restricted to an evaluation of the Barnett index-number schemes (see Barnett, Offenbacher, and Spindt (1984), Boulton and Johnson (1984), Batten and Thornton (1985), and Lindsey and Spindt (1986)).

A reliable empirical measure of money that bears a predictable relationship with nominal income and is controllable is critical for the effective operation of monetary policy. The classification of the monetary aggregates that is currently used by many central banks is a dual one, based upon the functional characteristics of money and the institutional distinction between banks and nonbanks. The rapid pace of financial innovation in the past decade and the accompanying deregulation of the financial system in many industrial countries have undermined both criteria by increasing the degree of substitutability among assets on both the demand and supply side. In response to these developments, some central banks, notably the Federal Reserve Board in 1980, have attempted to redefine the monetary aggregates. 2/

1/ Another branch of the literature attempts to improve the informational content of the monetary aggregates using various filtering techniques. See Tinsley, Spindt, and Friar (1980), Kareken, Muench, and Wallace (1973), and Mitchell (1980).

2/ For a discussion of the U.S. redefinitions, see Simpson (1980).

Even if there were general agreement concerning the appropriateness of national redefinitions, the problem of the correct measurement of the monetary aggregates would remain. The monetary aggregates that are currently used by central banks are simple sum or unweighted aggregates. This practice implicitly assumes that the assets included within the aggregate are perfect substitutes, i.e., that the consumption characteristics of a unit of currency are identical to those of a unit of the other components of the aggregate. Although this restrictive assumption is unlikely to be met in practice, the monetary aggregates do tend to move together during periods of relative financial stability. However, during periods of considerable monetary instability, there are likely to be shifts among assets, resulting in divergent movements among monetary aggregates and a possible breakdown in previously stable money-income relationships. A simple-sum monetary aggregate may no longer provide an accurate measure of the flow of monetary services in the economy, and may also give misleading signals to the private sector for the formation of interest rate and price expectations.

Attempts to weight monetary aggregates have a long history, extending back to Gurley (1960) and Chetty (1969), with important contributions by Roper and Turnovsky (1980), Barnett (1982), and Spindt (1985). Two main weighting methods based upon functional and policy criteria have been adopted. The functional method takes as its departure point the key functions of money, emphasizing in particular its uses as a means of exchange and as a store of liquidity. For example, the Spindt velocity turnover weights are based upon the transactions function while the weighting schemes adopted by Chetty and Barnett utilize the liquidity property. 1/ In contrast, the policy-oriented approach adopted by Roper and Turnovsky follows in the spirit of Friedman and Schwartz (1970), who argue that the definition of money should be related to a particular problem of monetary policy. Roper and Turnovsky define the optimal monetary aggregate as that which minimizes the forecast variance in nominal income, and they derive a set of weights that meets this property. The advantages and disadvantages of these alternative weighting methods are discussed in further detail below.

Empirical evaluation of the alternative weighting methods has been limited to comparisons of the performance of unweighted and weighted monetary aggregates constructed from Barnett liquidity weights or Spindt transactions weights. A recent survey by Barnett, Offenbacher, and Spindt (1984) uses a comprehensive range of tests to evaluate the performance of U.S. official monetary aggregates M1, M2, and M3, together with

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1/ The weighting method proposed by Spindt (1985) is excluded in the empirical comparison because of data limitations.

the broader aggregate L, with their Barnett-weighted counterparts for the sample period 1959-82. The tests include Granger-causality, velocity behavior, estimation of money demand functions, and reduced-form equations relating the monetary aggregates to nominal income. The authors conclude that although no single aggregate dominates the others on all criteria under consideration, the broadest weighted monetary aggregate, Divisia L, proves to be superior on overall performance. 1/

The above finding in favor of weighted monetary aggregates contrasts with two recent surveys based upon a more limited range of tests by Batten and Thornton (1985) and Boulton and Johnson (1985). 2/ Batten and Johnson (1985) compare the performance of U.S. M1 against two broader weighted monetary aggregates, MQ (based upon Spindt weights) and MS14 (based upon Barnett weights). 3/ They conclude that M1 performs at least as well as the two weighted aggregates based upon stability of velocity behavior. A recent study by Boulton and Johnson (1985) uses Australian monetary data (1971(1) to (1983(2)) to compare the official monetary aggregates, M1, M2, and M3 with their Barnett-weighted counterparts. The authors conclude that there is no strong case to support the use of weighted monetary aggregates based upon a comparison of the behavior of the monetary aggregates, velocity, and reduced-form relationships between the monetary agregates and nominal GDP.

The case for weighted monetary aggregates appears somewhat inconclusive on the basis of the above empirical findings. However, these surveys exclude the important contributions of Chetty and Roper and Turnovsky. In contrast, the present paper is considerably broader in coverage, and uses the three main weighting methods to derive a set of aggregates from a common sample set based upon quarterly Australian monetary data for the period 1969(4) to 1983(2). Australian data provide the opportunity to examine the behavior of the monetary aggregates during a period of

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1/ The broader monetary aggregate L is defined as M3 plus the nonbank public holdings of U.S. savings bonds, short-term Treasury securities, commercial paper and bankers' acceptances, net of money market mutual fund holdings of these assets.

2/ Barnett originally called these aggregates "Divisia monetary aggregates" because a Divisia index was used to construct them. However, in Batten and Thornton (1985), the monetary aggregates constructed from Barnett weights use the revised method discussed in Farr and Johnson (1985) and are called "monetary services indexes."

3/ In addition to M1, MQ includes money market deposit accounts, money market fund shares, and savings deposits subject to telephone transfer; MS14 adds to MQ non-medium-of-exchange assets (see Batten and Thornton (1985), p. 31).

extensive deregulation of the financial system and rapid financial innovation. Australian data also offer the additional advantage of not having been studied as extensively as U.S. data.

The plan of the paper is as follows. Section II presents an overview of the main methods of weighting monetary aggregates. In Section III, the weighting methods proposed by Barnett, Chetty, and Roper and Turnovsky are used to derive a set of weights from quarterly Australian monetary data for the sample period 1969(4) to 1983(2). A number of tests are performed that compare the properties and behavior of the weighted and unweighted monetary aggregates. In Section IV, the implications of the analysis for various issues relating to monetary policy are discussed. These issues include monetary targeting, financial innovation, and the benefits and costs to policymakers of adopting weighted monetary aggregates. Finally, the main conclusions are presented in Section V.

II. Overview of Weighted Monetary Aggregates

The properties and characteristics of money are determined by the role and functions that it is considered desirable for money to perform. This point is especially highlighted in the weighted monetary aggregate literature as the method of deriving the weights is directly linked to the functions that each author has deemed to be most important for monetary assets.

1. Simple-sum aggregation

The earliest work in the theory of monetary aggregation was based on the medium-of-exchange property of money. It was argued that both currency and demand deposits constitute money since demand deposits can be used for transaction purposes via the use of check facilities (see Friedman and Schwartz (1970)). 1/ Friedman (1959) extended the definition of money to include time deposits by arguing that money serves to bridge the gap between the receiving and making of payments. This immediately raises the problem of determining the degree of substitution between various assets. If an asset is shown to be less than a perfect substitute for currency or demand deposits, a further issue arises as to whether it should be included in the monetary aggregate, and if so, the weight that it is to be given. The approach of assigning zero weight to less than perfect substitutes, that is, excluding them from the aggregate

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1/ Pesek and Saving (1967) also argue that money simply consists of currency plus demand deposits since these two components represent net wealth. However, this argument has been discredited by Johnson (1969) and Laidler (1969).

was adopted by Feige (1964). In contrast, Friedman (1964) is associated with the approach of assigning a unit weight to imperfect substitutes for currency. It was not until the contribution of Chetty (1969) that less than perfect substitutes for currency received an intermediate weight.

The identification of a larger class of substitutes for currency than simply demand and time deposits, as well as the need for the monetary authorities to be able to control the money supply, led Gurley and Shaw (1960) to adopt a broader definition of money that included not only the assets of banks, but also the assets of financial intermediaries. An emphasis on the controllability property of money represents an important departure from standard ways of defining money, since it links the functions of money to the goals of monetary policy. The link between the definition of money and monetary policy was further strengthened by observing that the effectiveness of monetary policy depends upon its ability to predict income. Predictability in turn is largely dependent upon the stability of the demand for money. If stability is achieved with a narrow definition of money then, it is argued, the narrow definition should suffice. The controllability and predictability properties of monetary policy emphasize two different parts of the market--the former relates to money supply while the latter relates to money demand. The emphasis upon defining money according to the predictability property of monetary policy can be viewed as an extension of the earlier definitions that focused attention upon the factors governing the demand for money. In contrast, the emphasis on defining money according to the controllability property shifts the focus of attention to the supply side of the market.

2. Aggregation functions

The main problem with the approaches discussed above is that the writers have considered only zero or unity weights and have not allowed for the possibility that near monies be given an intermediate weight. 1/ The work of Chetty (1969) provides the first attempt to obtain empirical estimates of monetary weights that are not constrained to be either unity or zero. The Chetty weights are based on constrained utility maximization principles where the aggregation (utility) function captures the services received by agents from holding money while the budget constraint depicts the total stock of wealth which agents possess. This gives rise to a set of asset demand equations that are used to derive estimates of

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1/ All weighting methods do not require that the weights lie between zero and unity; for example, the policy approach of Roper and Turnovsky (1980) can give rise to both negative weights, and weights greater than unity. However, for the Chetty weights to be theoretically consistent, the weights must lie between zero and unity.

the elasticity of substitution between various assets and a "reference" asset that is designated to be the most liquid asset. Following the earlier approach of Teigen and Friedman, the reference asset is usually chosen to be currency.

The pioneering work of Chetty has been extended to allow for homotheticity in the utility function (Boughton (1981)), while Husted and Rush (1984) have derived a more theoretically appealing relative price variable. Horne, Martin, and Bonetti (1986) have applied the method to time series data for Australia, while Goldschmidt (1981) has applied the method to cross-sectional U.S. data. Similar types of asset demand equations have been estimated by Barnett (1980) that have been generalized by the use of more flexible functional forms such as the translog functions (Ewis and Fisher (1984)) and Laurent demand systems (Barnett (1983)).

A desirable feature of the Chetty weights is they are directly based on economic theory and thus can be easily interpreted. However, a potential problem with deriving the Chetty weights is that it is necessary to have data on asset stocks and relative price variables that may not be readily available. An additional problem occurs at the estimation stage when it is necessary to assume that the relationships between the variables are stable. In view of the recent pace and magnitude of recent financial innovations, this assumption is unlikely to be satisfied. 1/ Possibly the most limiting aspect of monetary aggregates derived from aggregation functions is that they are based upon the estimation of unknown parameters that may not be acceptable to the primary users of these aggregates--the monetary authorities. 2/ Whether or not the suspicions of the monetary authorities are well-founded, this represents a serious handicap to the implementation of these types of weighted monetary aggregates.

3. Statistical index numbers

The desire to overcome the problems of deriving a weighted aggregate based on estimated parameters and the need to impose strong stability restrictions on the parameters of the model led Barnett (1980) to use statistical index numbers. Following Friedman (1956), Barnett views monetary assets as durable assets in the sense of providing a number of

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1/ Consideration of the implications of financial innovations for the Chetty approach have largely been ignored with the exception of Boughton (1981) and Horne, Martin, and Bonetti (1986). A fruitful approach would be to allow the estimated parameters to vary over time as a result of financial innovations. One suitable functional form would be the logistic function. These sorts of complications remain to be explored and represent an important area of future research.

2/ See Barnett (1983), p. 9.

services to users over time. Unlike the Chetty aggregate, the Barnett aggregates are not directly based upon economic theory, thereby making their behavior difficult to interpret. However, the Barnett aggregates do pass certain statistical index-number tests including the factor reversal test. In addition, the weighted monetary aggregates are not based upon estimated parameters, making them potentially more attractive to central banks.

A recent application of the Barnett index number approach by Spindt (1985) adopts a narrow definition of money. Spindt considers only the medium-of-exchange property of money in deriving a weighted monetary aggregate whose weights are based on each asset's turnover in purchasing final output. This method does have some theoretical justification since it can be related to Fisher's quantity equation. However, by focusing only upon the medium-of-exchange function of money, other theories of the demand for money are ignored. Perhaps the major practical limitation of the Spindt method is that it requires the use of data on turnover rates that may not be readily available.

4. Policy approach

The policy-oriented weighting scheme adopted by Roper and Turnovsky (1980) marks a distinct departure from both the Chetty and Barnett approaches by its emphasis upon the role of monetary policy. In this approach, money is defined so as to minimize instability in a policy target such as the variance of nominal income. The weights depend, among other factors, upon the structural parameters of the model and the relative size of shocks to the economy. Although the Roper-Turnovsky weights have an economic interpretation, for even simple systems containing just two assets and one target variable, this relationship can become very complicated. A recent extension of this approach by Horne and Martin (1985) shows how the Roper-Turnovsky model can be made operational within a vector autoregressive system by use of the Kalman filter. This approach has a further advantage as it is related to other areas of monetary theory including the indicator and intermediate target literature (see Tinsley, Spindt, and Friar (1980)), the combination policy literature (see Poole (1970)), and the information variable literature (see Kareken, Muench, and Wallace (1973)). However, in common with the Chetty approach, one problem with the Roper-Turnovsky weights is that they need to be estimated and may therefore be less attractive to policymakers than the Barnett aggregates. However, this approach does represent a more general method since it can, in principle, incorporate the theoretical specifications of the Chetty framework.

5. Factor analysis

A purely statistical technique of deriving weights is to use either principal components or the more general method of factor analysis (see Koot (1975)). The main advantage of these methods is that they represent the most efficient way to compress data. Furthermore, the relative information content of each variable can be determined, and this can be used to provide a way of discriminating among potential "money" candidates. Other advantages are, the first principal component is less affected by random elements in the data, and data requirements are less than most of the previous approaches since only data on asset stocks are required. The main disadvantage of these purely statistical techniques is they are devoid of any economic theory and fail to take into account the theoretical properties of money.

6. Summary

To summarize this section, we list the desired properties of a weighted monetary aggregate that might be of particular relevance for monetary policy, as suggested by the preceding discussion. These properties are economic interpretation, predictability, controllability, practicality, and flexibility.

A desirable property of a weighted monetary aggregate is that it be derived from an underlying theoretical model in order that a clear-cut economic interpretation can be placed on its behavior. For policy purposes, it is important to be able to interpret the behavior of the weighted monetary aggregates and to explain any divergences that might occur between the weighted and unweighted aggregates. The second property, predictability, refers to the usefulness of the weighted monetary aggregate as a predictor of a final target such as nominal income. This property is of particular relevance in situations in which the monetary authorities have adopted intermediate monetary targets with a view toward minimizing income fluctuations. The controllability of the weighted monetary aggregate is also important for monetary targeting, and more generally for the effectiveness of monetary policy. However, as is well recognized, the criteria of predictability and controllability may involve a trade-off, especially if the choice is between narrow and broadly defined monetary aggregates.

An additional trade-off arises between the criteria of practicality and flexibility. For operational purposes, it is important that the weighted monetary aggregate can be constructed easily, and that the appropriate data are available to compute the weights. At the same time, during periods of rapid institutional change and financial innovation, it is important that the weights be flexible to incorporate these changes. The conflicting demands of practicality and flexibility may impose a dilemma for the authorities who may wish to use the weights constructed from an earlier period to make projections of the future behavior of the monetary aggregates.

It is clear from the above discussion that no single weighting scheme is likely to meet all the desired criteria. The selection of a "best" monetary aggregate is a difficult task for policy purposes with the relative importance of each criteria varying according to the particular economic circumstances and policy constraints that face the authorities over any given period.

III. Empirical Assessment

This section presents a quantitative assessment of the relative merits of simple sum monetary aggregates and weighted monetary aggregates derived from Chetty, Barnett, and Roper and Turnovsky (R-T). The sample set used consists of quarterly Australian monetary data for the period 1969(4) to 1983(2). For the purposes of empirical comparison, the six assets used by the Reserve Bank of Australia in their classification of M1, M2, and M3 have been adopted with an additional broader (unofficial) aggregate, M3*. 1/ The definitions of the variables used in this study are:

A_0 = currency in hands of public (reference asset)

A_1 = current deposits of trading banks

A_2 = fixed deposits of trading banks

A_3 = certificates of deposit of trading banks

A_4 = ordinary savings accounts

A_5 = savings-investment accounts

A_6 = total outstandings of permanent building societies

r_0 = nominal return on the reference asset (r_0 = 0)

r_i = nominal return on asset i (i = 1, 2, ... 6; r_1 = 0)

π = rate of inflation

Y_t = real income

S_j = seasonal dummy (j = 1, 2, 3)

1/ The definitions of the Reserve Bank of Australia are:
M1 = currency in the hands of the public plus current deposits.
M2 = M1 plus trading bank fixed deposits plus certificates of deposit.
M3 = M2 plus ordinary savings accounts plus saving-investment accounts.
and M3* is defined in this study as M3 plus permanent building society deposits.

where all asset stocks are denominated in real terms by deflating by the consumer price index for Australia.

Until January 1985, M3 was used for projection purposes in Australia, and it remains a key variable for control purposes. Hence, particular attention will be focused on comparing the behavior of weighted and unweighted M3. The broader monetary aggregate, M3* is also of interest because it includes an important nonbank liability, building society deposits. During the pre-1980(4) period of regulated returns on bank interest rates, building society deposits acted as an important asset substitute for small savers in Australia.

The set of assets also includes two new financial instruments that were introduced by the banking sector in 1969, negotiable certificates of deposits and saving-investment accounts. Both new instruments can be described as circumventive financial innovations in the sense that the banks were motivated by a desire to overcome existing regulations in the financial sector. The introduction of new financial instruments raises an estimation problem for the Chetty and R-T weights that use regression methods. During the diffusion or adoption phase of new innovations, private agents may not be on their desired long-run demand schedules. However, explicit allowance can be taken of these disequilibrium effects by specifying a partial stock-adjustment model. 1/

1. Estimating strategies for deriving the weights

The estimating strategies used for each weighting method are outlined briefly below. 2/

a. Chetty weights

The Chetty weights are derived from the utility maximization of an individual wealthholder subject to a budget constraint.

1/ Experimentation with a stock-adjustment model for estimating the Chetty weights did not lead to improved estimates (see Horne, Martin and Bonetti (1986)). The R-T weights were estimated using a vector autoregression (VAR) model, in which each variable is a lagged function of itself and other variables, and hence can be interpreted as catching lagged adjustment effects.

2/ For estimation purposes, all components of current accounts are aggregated assuming a zero nominal return. Trading bank deposits in Australia are made up of non-interest and interest-bearing accounts. During the estimation period, the latter were limited to special groups and paid about 4 percent per annum. The weighting methods strictly require that these interest-bearing components (constituting about 5 percent of total trading bank deposits) be treated as a separate instrument. An additional problem arises because the non-interest bearing component carries an implicit return.

The utility function is given by (1) and the budget constraint by (2):

$$M(A) = U = [\sum_{i=0}^{6} \alpha_i A_i^{-\beta_i}]^{-1/\sigma} \quad (1)$$

$$W = \sum_{i=0}^{6} f(\bar{r}_i)A_i \quad (2)$$

where

$\alpha_i > 0$ is the share parameter of the ith asset

$-1 < \beta_i < 0$ is the substitution parameter of the ith asset

A_i is the real stock of asset i at the end-of-period

σ is the overall substitution parameter

W is real stock of wealth at beginning-of-period, and $f(\bar{r}_i)$ is the inverse of the real rate of interest and is given by $1/(1+\bar{r}_{it} - \pi)$ where r_i is the nominal interest rate, and π is the rate of inflation.

By maximizing (1) subject to (2), we obtain an expression for the real demand of the i^{th} asset. This expression is given by equation (3):

$$\log A_{it} = a_0 + a_{1i}S_1 + a_{2i}S_2 + a_{3i}S_3 + a_{4i} \log \frac{1+r_{it}-\pi_t}{1+r_{0t}-\pi_t} + a_{5i} \log A_0 \quad (3)$$

$$i = 1, 2, \ldots, 6$$

where the share and substitution parameters are obtained from the following expressions:

$$\beta_0 = a_5(1+\beta_j)-1 \quad \forall j \quad (4)$$

$$\beta_1 = (\frac{1+\beta_0-a_{5j}}{a_{5j}}) \quad j = 1 \quad (5)$$

$$\beta_j = -(1 - \frac{1}{a_{4j}}) \qquad j = 2, \ldots, 6 \tag{6}$$

$$\alpha_j = \frac{\alpha_0 \beta_0}{\beta_j} \exp\,[a_{0j}(1+\beta_j)] \qquad j = 1, 2 \ldots, 6 \tag{7}$$

where the share parameters are normalized by setting $\alpha_0 = 1$. 1/

The above system was estimated by seemingly-unrelated regression (SUR) methods with an adjustment for a vector autoregressive error structure. The cross-equation restriction as implied by the expression for β_0 was tested and found to be acceptable at the 5 percent level of significance. 2/ The Chetty monetary aggregate was then derived by substituting into equation (1) the estimated values of α_i and β_i. For simplicity, σ was chosen to be equal to minus one.

b. Barnett weights

The Barnett weights (S_{it}) are defined as the user cost-evaluated expenditure shares of the ith component asset on monetary services and are given by:

$$S_{it} = \frac{P_{it}\ A_{it}}{\sum_{i=0}^{n-1} P_i\ A_i} \tag{8}$$

where

P_{it} is the price of the ith asset, and

A_{it} is the quantity of the ith asset.

In Barnett, money is viewed as a durable good and its price is defined as its user cost. For estimation purposes, the definition of user cost can be simplified to equal the differential between the maximum

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1/ The method of normalization chosen is solely for convenience and does not affect the estimates of the substitution parameters. For an alternative normalization whereby the share parameters sum to unity, see Boughton (1981).

2/ A detailed discussion of the estimation strategy is given in Horne, Martin, and Bonetti (1986).

available expected holding-period yield in the economy (benchmark interest rate) and the own interest rate on the ith asset component, that is:

$$P_{it} = R_t - r_{it} \tag{9}$$

where R_t is the benchmark interest rate which is taken to be the maximum interest rate at each point in time of the interest rates of the seven assets included for estimation purposes and r_{it} is the own interest on asset i.

The Barnett-weighted monetary aggregate is then given by equation (10):

$$M(A) = \sum_{i=0}^{6} S_{it} A_{it} \tag{10}$$

c. <u>Roper-Turnovsky weights</u>

The R-T weighted monetary aggregate in nominal terms is defined as that which minimizes the forecast variance in the target variable nominal income, and is given by equation (11):

$$M(A) = \sum_{i=0}^{6} \lambda_i P_{it} A_{it} \tag{11}$$

where the optimal weights are given by $\lambda_i \gtrless 0$. To derive the weights, a VAR system with eight variables was estimated consisting of nominal income, Y_t, and the seven nominal asset stocks. By regressing the residual from the income equation against the residuals from the seven asset equations the Kalman coefficients ϕ_i, i=0, 1, ..., 6, were derived. The optimal weights were then obtained from the Kalman coefficients by use of the following equations: 1/

$$\lambda_0 = \frac{1}{1 + \frac{1}{\phi_0} \sum_{i=1}^{n} \phi_i} \tag{12}$$

$$\lambda_i = \phi_i / \phi_0 \tag{13}$$

1/ Derivation of the solutions and explanation of the method is given in Horne and Martin (1985).

2. Properties of the weighted and unweighted monetary aggregates

a. Weights

Table 1 compares the estimated weights that are obtained using the Barnett and Roper-Turnovsky methods, and the share and substitution parameters that together determine the Chetty weighted aggregate. 1/ The second column of Table 1 shows the shares of each component in M3*. On the basis of these results, several observations can be made. First, both the Barnett and Roper-Turnovsky methods attach a relatively high weight to cash and current deposits, the combined weight being 57 percent (Barnett) and 34 percent (R-T) compared to their 27 percent share in M3*. 2/ The higher weight attached to the most liquid assets, currency and current deposits in the Barnett agregate arises from the fact that both assets have the greatest user cost. In contrast, the Roper-Turnovsky aggregate need not necessarily attach the greatest weight to the most liquid assets. In this case, the high weight given to both currency and current deposits reflects the relative strength of the response of income disturbances to shocks in both assets. 3/ Second, both the Barnett and R-T methods attach a relatively high weight to ordinary savings deposits. The close correspondence between the (unweighted) share of saving deposits in M3* and the Barnett weight reflects the high regulation of nominal returns on this asset throughout most of the sample period. The high partial elasticity of substitution between currency and ordinary savings account also lends support to the view that savings deposits functioned effectively as a source of liquidity during this period rather than as an investment asset. Third, building society deposits, in contrast to their

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1/ The statistical properties of the estimated Chetty parameters are discussed in Horne, Martin and Bonetti (1986). Note that tests of significance cannot be applied to the Roper-Turnovsky weights because the equations used to derive the weights involve reciprocals.

2/ The method used in deriving the Chetty weights assumes that cash and current deposits are perfect substitutes. Since the share parameters for both assets are set to unity, and the substitution parameters equal unity, the weights are the same. The relatively smaller weight attached to cash compared to current accounts in the Barnett aggregate reflects the smaller share of cash in M3* since both assets are assumed to have a zero nominal explicit interest return.

3/ In a simple two-asset model, $\lambda_0 = \frac{1}{1 + \phi_1/\phi_0}$ and the larger is ϕ_1/ϕ_0 (the ratio of the Kalman coefficients), the larger is λ_0. In the seven-asset system, the larger are ϕ_0/ϕ_1, $\phi_0/\phi_2, \ldots, \phi_0/\phi_6$, the larger is λ_0. Given λ_0, the larger are the ratios, $\phi_1/\phi_0, \ldots, \phi_6/\phi_0$, the larger are $\lambda_1, \ldots, \lambda_6$, respectively.

Table 1. Monetary Weights and Estimated Parameters 1/

Asset	Share in M3*	Barnett Weights 2/	Roper-Turnovsky Weights	Chetty Parameters: Share parameters α	Chetty Parameters: Substitution parameters β	Chetty Parameters: Partial elasticity of substitution parameters 3/
Cash	0.08	0.16	0.20	1.00	-1.00	∞
Current deposits	0.19	0.41	0.14	1.00	-1.00	∞
Trading bank fixed deposits	0.19	0.06	-0.16	1.17	-0.95	86.2
Certificates of deposits	0.03	0.001	0.03	1.01	-0.91	14.0
Ordinary savings deposits	0.31	0.30	0.41	1.43	-0.89	46.2
Saving-investment accounts	0.08	0.04	0.43	1.25	-0.90	21.4
Permanent building society deposits	0.13	0.04	-0.03	1.18	-0.94	43.4

1/ Based on the sample period 1969(4)-1983(2) for Australia.

2/ The weights are based on sample means $\sum_{i=0}^{T} \frac{S_{it}}{T}$; i = 0, 2, ..., 6; T is length of sample period.

3/ Evaluated at mean value of each asset.

relatively high share in M3*, receive a low weighting in both the Barnett and R-T schemes. These low weights conflict somewhat with the relatively high partial elasticity of substitution shown between building society deposits and currency based on the estimated Chetty share and substitution parameters. Fourth, on the basis of the Barnett and R-T weights, the "moneyness" ranking of certificates of deposits (CDs) lies below that of saving-investment accounts. In this respect, it is worth noting that the official definitions of M2 and M3 reverse this ranking by including CDs and excluding saving-investment account in M2.

b. Statistical properties of weighted and unweighted monetary aggregates

Table 2 shows that with the exception of the Chetty series, the weighted monetary aggregates had, on average, lower annual growth rates than either unweighted M3 or M3* during the sample period. This result is a plausible one, since the sample period of the 1970s was characterized by rising interest rates and inflation. During this period, there was a shift away from the more liquid assets toward less liquid, interest-bearing assets. Since the R-T and Barnett-weighted series tend to place a higher weight on the more liquid assets, and a relatively lower weight on the less liquid, interest-bearing assets, their average growth rates tend to lie somewhat below that of M3 and M3*. 1/

A comparison of the relative variability (as measured by the coefficient of variation) of the weighted and unweighted series reveals mixed results. The R-T M3 series show the most striking fall in average variability that is almost half that of M3. However, with respect to M3* both the R-T and simple-sum series reveal similar variability. The Chetty weighted series tracks very closely the behavior of M3 and M3* as measured by the mean and coefficient of variation of unweighted M3 and M3* with only marginally lower average variability for M3. In contrast, the Barnett series (in nominal terms) show a somewhat higher variability than either M3 or M3*. 2/

1/ The higher average growth rate of M3* compared to M3 reflects the shift away from banks to nonbank financial institutions (building society deposit liabilities are captured in the latter) primarily caused by the effect of government regulations on the banks.

2/ A similar finding for the Barnett-weighted monetary aggregates is given in Boulton and Johnson (1984) although the average variability of their constructed Barnett series lies somewhat below the estimates in Table 2 (coefficient of variation equals 0.44 for the sample period 1972(1) -1983(6)). However, for the lower-order monetary aggregates, Boulton and Johnson find that the average variability of the Barnett series falls below that for M1 and M2.

Table 2. Analysis of Twelve-Month Growth Rates of Monetary Aggregates: 1970(4)-1983(2)

	Monetary Aggregate	Average Growth Rate	Coefficient of Variation
Simple-sum			
Nominal	M3	12.5	0.4
	M3*	13.6	0.4
Real	M3	2.1	0.4
	M3*	2.9	0.6
Barnett			
Nominal	M3	8.6	0.7
	M3*	8.6	0.7
Real	M3	-1.6	-0.3
	M3*	-1.5	-0.3
Roper-Turnovsky			
Nominal	M3	10.3	0.2
	M3*	10.1	0.5
Real	M3	-0.3	-0.1
	M3*	-0.2	-0.04
Chetty			
Real	M3	2.0	0.4
	M3*	2.9	0.6

A more detailed comparison of the behavior of the annual growth rates of the weighted and unweighted monetary aggregates is given in Charts 1 and 2. As shown in Chart 1, the weighted and unweighted nominal aggregates diverge markedly in two distinct periods. In the period, 1970-1973(2) in which there was a rapid expansion of M3 and M3*, the weighted aggregates show a lower growth rate compared to the simple-sum aggregates. In the post-deregulation period, 1980-1981(2), the weighted series contract sharply while the growth rates of M3 and M3* remain relatively stable.

Chart 2 compares the behavior of the growth rates of M3 and M3* in real terms. 1/ The Chetty series tracks both unweighted aggregates very closely while the Barnett series behaves in a similar fashion to that discussed above.

Chart 3 compares the levels of velocity (normalized to 1969(4) = 1.0), 2/ of the weighted and unweighted aggregates. The weighted aggregates show a much sharper rise in velocity at the end of 1974, and 1984 compared to the unweighted series. 3/ Thus, while the weighted M3 and M3* series suggest a sharper contraction in the flow of monetary services during the 1970s than indicated by the simple-sum aggregates, this was offset, to some degree, by the rising trend in the velocity levels of the weighted aggregates.

c. Predictability tests

For policy purposes, the usefulness of a weighted monetary aggregate depends to a large degree upon whether a sizable reduction in forecast income variance can be achieved through targeting the weighted monetary aggregates. The test of predictability that is used in the following discussion compares the forecast variance in nominal income that is obtained from a VAR system containing both nominal income and the unweighted monetary aggregate with the variance in income derived from a VAR system containing both income and the weighted monetary aggregate as regressors. If the weighted monetary aggregate is a superior predictor of income,

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1/ The Chetty series is derived in real terms. The R-T aggregates were derived assuming that the authorities wish to minimize nominal income variance: the resulting aggregates were then deflated by the CPI. If it were assumed that the authorities wish to minimize real income variance, the R-T aggregates would require re-estimation and are likely to have different weights. The Barnett weights remain the same in real or nominal terms.

2/ The velocities for the Barnett series are index numbers and are normalized to an arbitrary base period.

3/ The results are similar if growth rates of velocity of the weighted and unweighted aggregates are compared.

we can expect a reduction in the forecast variance of income when this variable is used as a regressor instead of the unweighted monetary aggregate in explaining variations in income.

The results that are given in Table 3 show that the R-T weighted aggregate is a superior predictor of income compared to an unweighted aggregate, and the alternative weighted aggregates. 1/ A small increase in income predictability also results from the Barnett aggregate while the Chetty aggregate predicts real income marginally better than the unweighted monetary aggregates. The R-T and Barnett aggregates also support the belief that, as the level of aggregation increases, further gains in income predictability can be achieved. 2/

Table 3. Percentage Reduction in Forecast Income Variance: 1970(1) to 1983(2) 1/

Weighting Method	M3	M3*
Barnett	2.5	4.9
Chetty	0.1	0.01
Roper-Turnovsky	6.6	16.4

1/ Percentage change in forecast income variance is defined as $\frac{v-v_w}{v}$ x 100 were v = forecast income variance in a VAR model with income and unweighted monetary aggregates as regressors; and v_w = forecast income variance in a VAR model with income and weighted monetary aggregates as regressors.

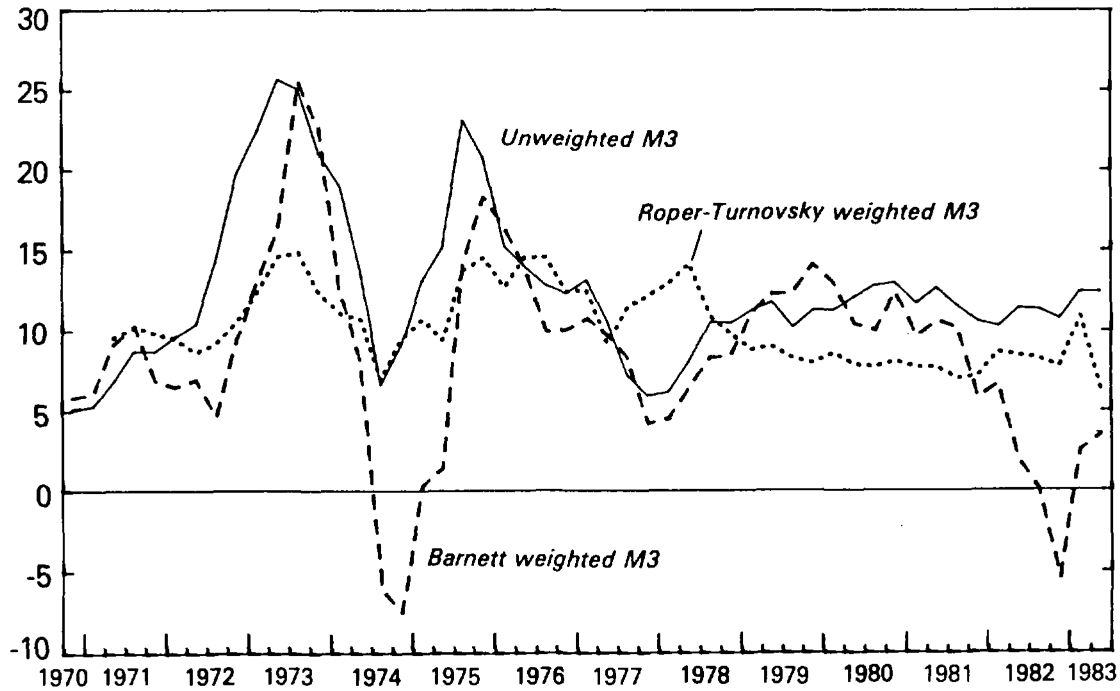
1/ Additional tests of income predictability applied to the R-T series provide further evidence of its superior income forecasting efficiency (see Horne and Martin (1985)). In particular, these tests suggest that the method of attaching equal weight to all financial assets included within the aggregate may result in a large efficiency loss in predicting nominal income.

2/ See Barnett, Offenbacher, and Spindt (1984, p. 1077) who show that the performance of the Divisia aggregates gradually improves as the level of aggregation increases.

CHART 1

AUSTRALIA

BEHAVIOR OF WEIGHTED AND UNWEIGHTED MONETARY AGGREGATES: ANNUAL NOMINAL PERCENTAGE CHANGES, 1970(4)-1983(2)



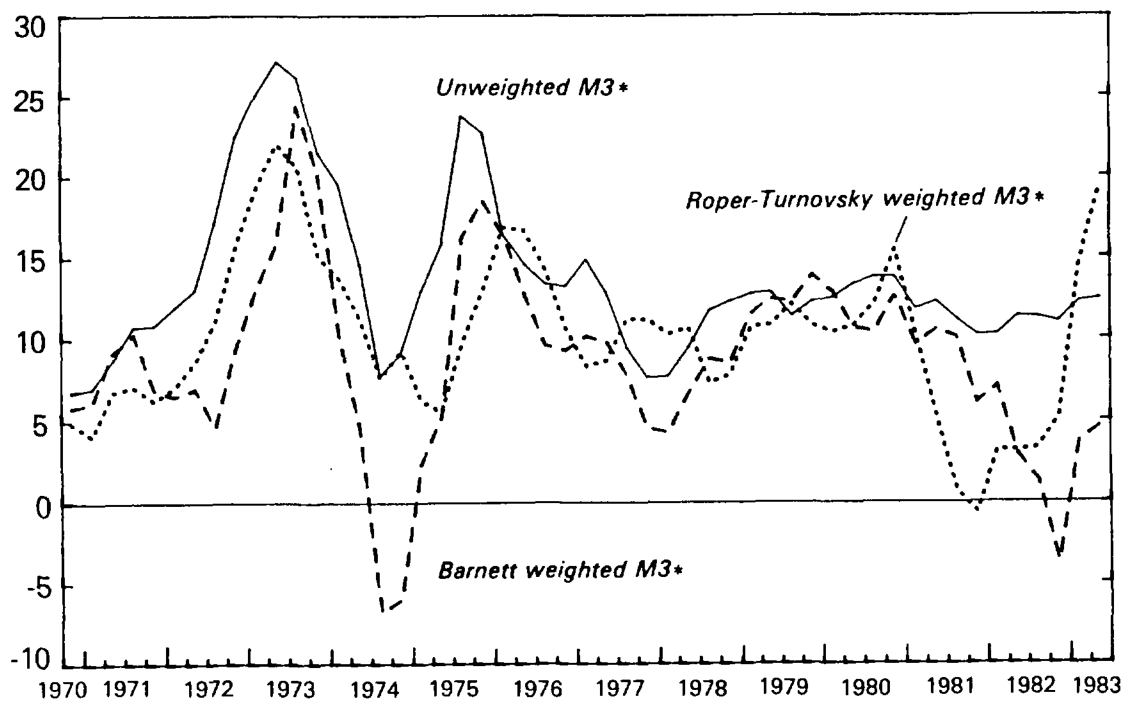
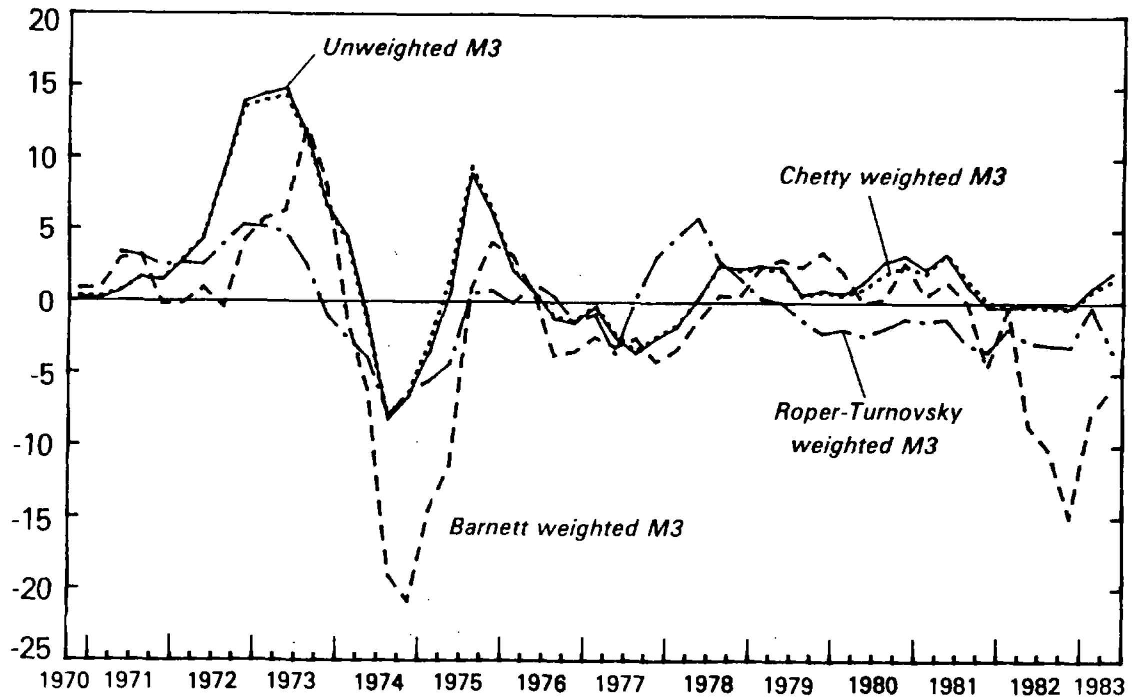


CHART 2

AUSTRALIA

BEHAVIOR OF WEIGHTED AND UNWEIGHTED MONETARY AGGREGATES: ANNUAL REAL PERCENTAGE CHANGES, 1970(4)-1983(2)



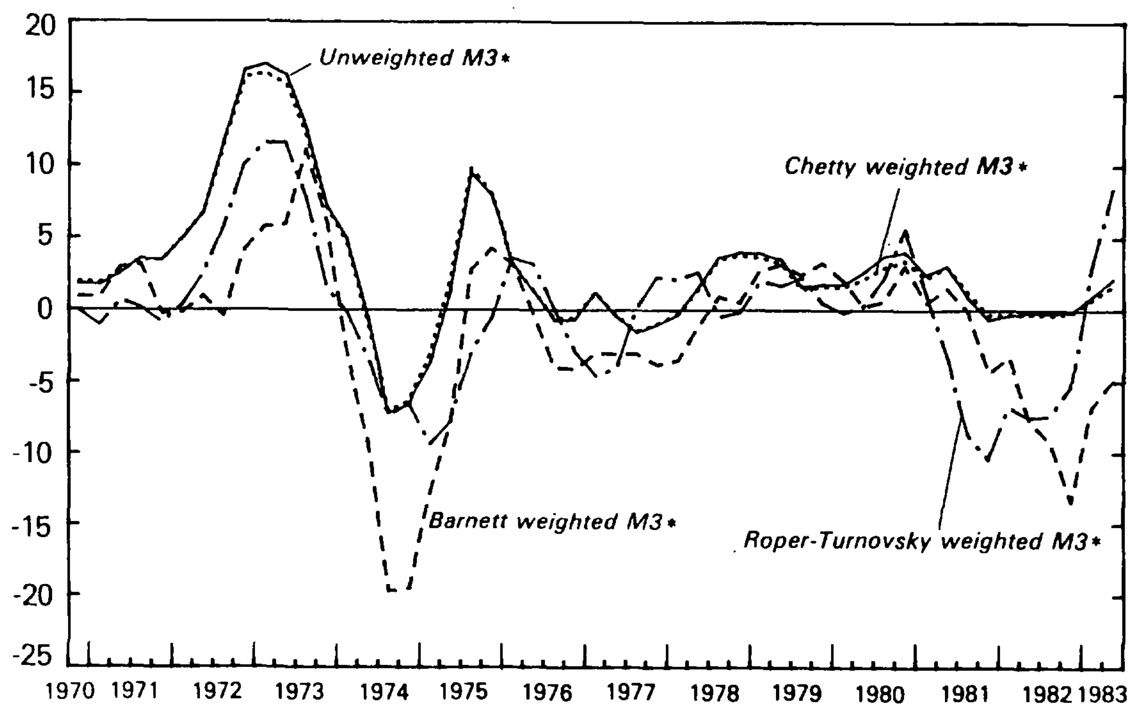
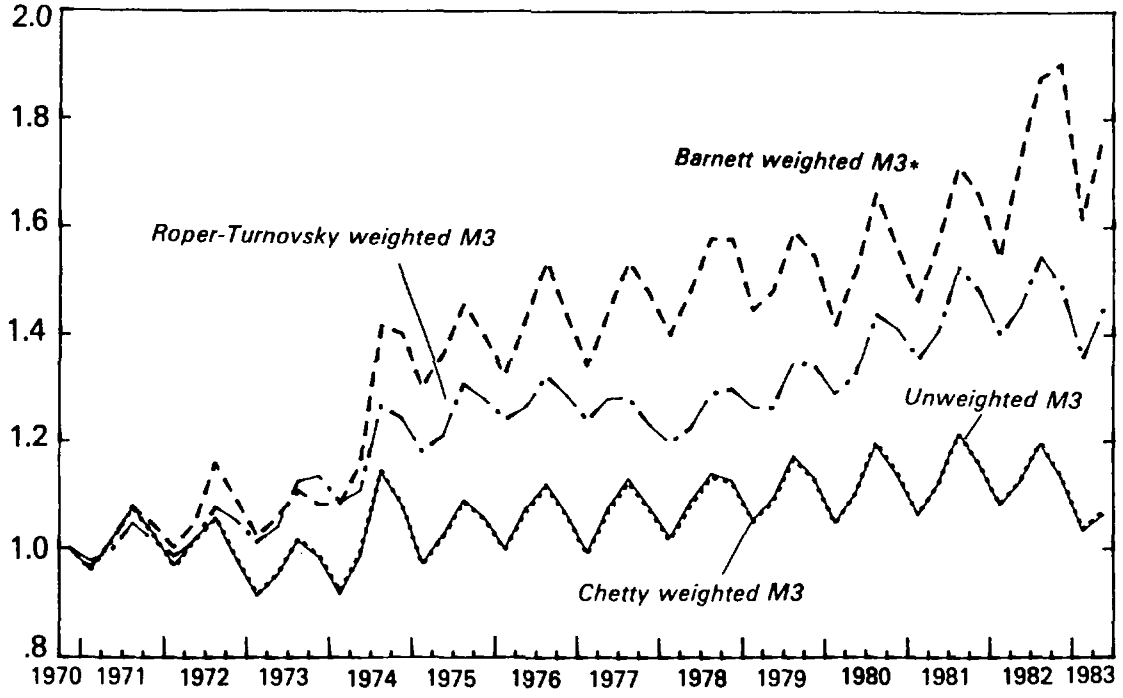


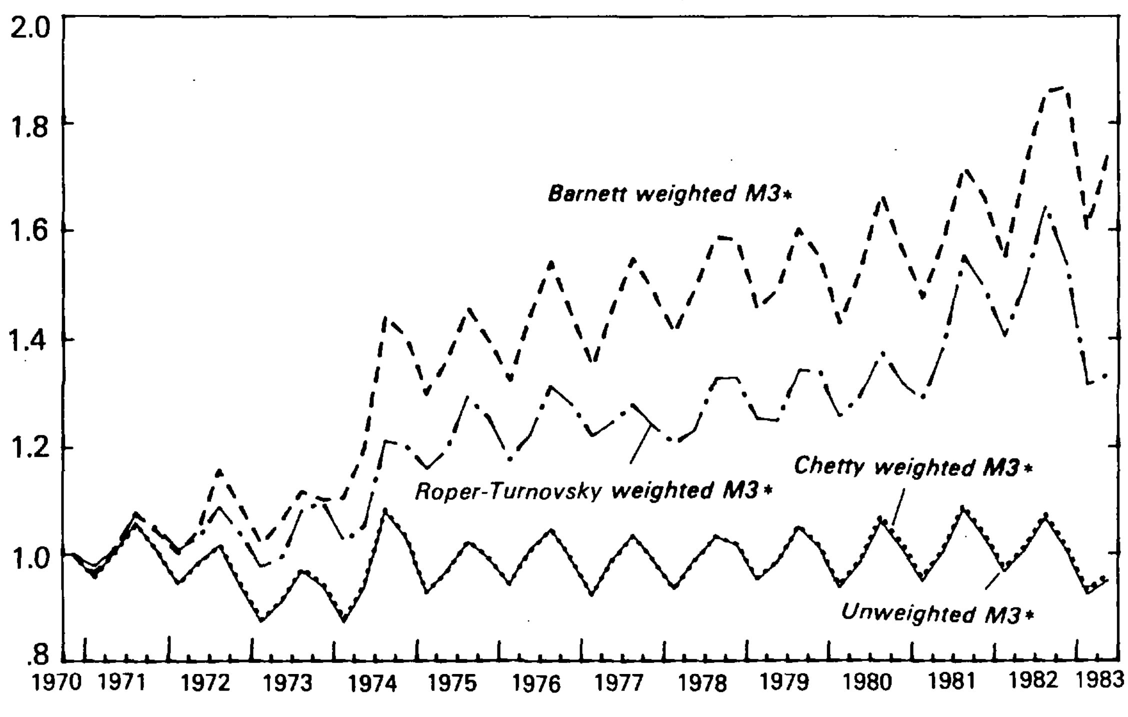
CHART 3

AUSTRALIA

VELOCITY OF WEIGHTED AND UNWEIGHTED MONETARY AGGREGATES, 1970(4)-1983(2)

(1970(4) = 1.0)





d. Controllability

The occurence of feedback from noncontrol variables to control variables reduces the controllability of the latter, and hence the controllability of the target variables. If the relative importance of these noncontrol variables can be diminished by using a weighted monetary aggregate, an improvement in the controllability of the target variable is also achieved. To test for feedback from the target variable to the control variable, the Granger test of causality is used. If the weighted monetary aggregate is more controllable, then "a priori" we expect the sum of the lags on nominal or real income in the weighted monetary aggregate equation to be relatively less statistically significant than in the equation with the unweighted monetary aggregate as the dependent variable.

The results of the Granger causality tests given in Table 4 demonstrate that both the weighted and unweighted monetary aggregates are exogenous in the Granger sense, and are therefore statistically controllable. However, the F-statistic on the lagged values of nominal income in the R-T weighted M3* equation is shown to be relatively more statistically significant than in the other equations, suggesting that this aggregate is marginally less controllable. 1/

Table 4. Granger Causality Test

	F-statistic			
	M3		M3*	
	nominal	real	nominal	real
Unweighted	0.6	0.6	0.2	0.7
Barnett	1.3	1.3	0.2	0.2
Roper-Turnovsky	0.8	n.a.	2.0	n.a.
Chetty	n.a.	0.6	n.a.	0.7

e. Stability of weights

In order to test the sensitivity of the weights to policy shifts, in particular deregulation, the Barnett and Chetty weights were re-estimated

1/ The computed F-statistic (F = 2.0) still falls below its critical value at a 5 percent significance level.

for the two sample periods, 1975(1)-1980(3), and 1975(1)-1983(2). 1/ The first sample period includes the deregulation of returns on certificates of deposit, and the regulation of all other interest rates on bank liabilities. The second sample period includes observations following the deregulation in 1980(4) of all interest rates on bank liabilities. The results are shown in Table 5.

The results given in Table 5 show that as the sample size is extended to allow for the deregulation of returns on bank liabilities in 1980(4), the weight attached to the nonbank liability, building society deposits rises. 2/ This finding supports the a priori argument that deregulation tends to increase the degree of substitutability between bank and nonbank liabilities. The weights on all assets other than currency and current deposits also rise or remain stable in the post-deregulation period as wealth-holders shifted from non-interest-bearing assets to interest-bearing liquid assets. Offsetting these changes, the weights attached to currency and current deposits are shown to have fallen.

IV. Usefulness to Monetary Policy

This section discusses some of the main implications of the preceding analysis for three issues of particular relevance for monetary policy; monetary targeting, financial innovation, and the benefits and costs to the monetary authorities of using weighted monetary aggregates.

a. Monetary targets

During the 1970s, the dominant trend in central bank thought was the belief that publicly announced monetary aggregate growth rates were the key to the control of inflation. Instability in money demand, related in particular to financial innovation and institutional shifts have considerably shaken this faith in the desirability of intermediate targeting.

1/ The R-T weights could not be estimated for smaller sample sets owing to insufficient degrees of freedom. However, in Horne and Martin (1985), R-T weights are estimated in a four-asset model (comprising M3) for a longer sample set, 1962(2)-1983(2), and re-estimated for the subsample 1962(2)-1980(3). In the earlier subsample period, savings deposits (ordinary savings deposits and saving-investment accounts) have a heavier weight, reflecting to some extent the distortions induced by regulation.

2/ The usual tests of statistical stability cannot be applied to the Barnett weights since they are not estimated by regression methods. Horne, Martin, and Bonetti (1986) show that the Chetty parameters are unstable for the two subsamples compared to the sample period (1969(4) to 1983(2)).

Table 5. Stability of Weights and of Share and Substitution Parameters

	1975(1)-1980(3)				1975(1)-1983(2)			
	M3*	Chetty share para-meters	Chetty substitu-tion para-meters	Barnett weights	M3*	Chetty share para-meters	Chetty substitu-tion para-meters	Barnett weights
Cash	0.08	1.0	-1.0	0.17	0.07	1.0	-1.0	0.16
Current deposits	0.18	1.0	-1.0	0.41	0.17	1.0	-1.0	0.38
Trading bank fixed deposits	0.20	1.06	-0.93	0.03	0.21	0.73	-0.97	0.05
Certificates of deposit	0.03	1.02	-0.92	0.001	0.03	0.58	-0.95	0.001
Savings deposits	0.27	1.01	-0.97	0.30	0.26	0.95	-0.98	0.29
Saving-investment accounts	0.10	1.04	-0.91	0.04	0.11	0.68	-0.95	0.05
Building society deposits	0.15	1.01	-0.87	0.04	0.15	0.76	-0.96	0.08

weighted monetary aggregates, either as an alternative or supplement to simple-sum aggregates, is essentially a cost/benefit exercise for the monetary authorities.

The above analysis has emphasized the potential benefits to policy-makers of adopting weighted monetary aggregates. However, in contrast to simple-sum monetary aggregates, weighted monetary aggregates entail extra costs that stem largely from their additional information requirements. On practical grounds, a case could be argued in favor of Barnett-weighted aggregates since they do not require the large sample size and statistical properties of weights estimated by regression methods. However, even the construction of Barnett monetary aggregates entails considerably greater informational costs than simple sum aggregates. These costs include collecting data on interest rates of each asset included within the aggregate, and the imputation of implicit rates of return on currency and demand deposits. 1/ A further problem arises if a Barnett-weighted monetary aggregate were used for targeting or projection purposes since, in addition to quantity projections, forecasts of interest rates are required.

V. Conclusions

The preceding discussion has identified five desired properties of a weighted monetary aggregate; economic interpretation, predictability, controllability, practicality, and flexibility. It was suggested that weighting methods based on the functions of money, such as Chetty and Barnett, have a clearer economic interpretation than those based on policy criteria such as Roper-Turnovsky. While the ability to interpret the behavior of the monetary aggregates is a useful property, the monetary authorities are more likely to place primary emphasis on the degree to which the monetary aggregates increase the predictability of income. In this respect, the above empirical results, based on Australian monetary data, show the Roper-Turnovsky weighted aggregates to be superior to both unweighted and alternatively weighted monetary aggregates.

In addition to predictability, the monetary authorities are also concerned with the controllability of the monetary aggregates. However, on the basis of the limited tests conducted in this analysis, no strong case can be made for weighted monetary aggregates. The two remaining properties, practicability and flexibility, offer somewhat conflicting choices for policymakers. One advantage of the Barnett weighting scheme is that the flexible weights can incorporate changes in liquidity of

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1/ This list is by no means exhaustive. The additional informational requirements and assumptions associated with the Barnett aggregates are discussed in Batten and Thornton (1985), and Farr and Johnson (1985).

various financial assets. This advantage needs to be balanced against the relatively smaller gain in income predictability compared with a Roper-Turnovsky aggregate. While it can be argued that both Chetty and Roper-Turnovsky weighting methods can also incorporate financial innovations, the problems associated with unstable weights derived from regression methods limit their practical usefulness. All the above attributes of weighted monetary aggregates are offset, in part, by the additional informational costs involved in their construction.

In summary, the results of this study appear more favorable to the potential usefulness of weighted monetary aggregates than some recent surveys noted earlier. The Roper-Turnovsky aggregate, in particular, presents a clear gain in income predictability, but more practical considerations may lead the authorities to choose a Barnett aggregate. The challenge for research in this area is to proceed further in the direction of developing suitable weights that capture the essential functions of money and that are of direct usefulness for the conduct of monetary policy.

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