MONEY, MEASUREMENT AND COMPUTATION

Edited by

Michael T. Belongia and Jane M. Binner

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and

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Introduction

Jane M. Binner and Thomas C. Elger

The present book is a collection of papers by leading applied and theoretical micro-economists, macro-economists and econometricians from a variety of institutions and universities. A common feature of the papers included in this book is that they all have better measurement or computation as their central theme. A majority of the contributions are based on a framework for monetary aggregation pioneered by Barnett (1978, 1980).

Several surveys of the theory of monetary aggregation exist. See, for example, Anderson *et al.* (1997a,b,c), Barnett *et al.* (1992) and Fisher *et al.* (1993). Some of the most important papers in this field can be found in Barnett and Serletis (eds), *The Theory of Monetary Aggregation*. Serletis (2001) provides a textbook treatment of the theory.

We begin exploring issues related to money, measurement and computation by introducing some of the more central concepts in monetary aggregation theory. Readers familiar with the topic may safely skip ahead. Readers desiring a more in-depth knowledge about the field should definitely consult the sources mentioned above.

Monetary aggregation theory

Monetary aggregation theory is founded on microeconomic aggregation theory and index number theory. Empirical studies are often based on data that has been aggregated across consumers.[1] Assume that there are $n+l=h$ arguments in a (representative) consumer's utility function u that can be partitioned into $\boldsymbol{x}_t=(\boldsymbol{m}_t,\boldsymbol{c}_t)$, where $\boldsymbol{m}_t=(m_{1t},\ldots,m_{nt})$ and $\boldsymbol{c}_t=(c_{1t},\ldots,c_{lt})$. The fundamental existence condition for an economic aggregate over the goods in $\boldsymbol{m}_t$ is that the consumer's preferences are weakly separable such that we can write u in this following weakly separable form:

$$u(\boldsymbol{x}_t)\equiv u_1(\mu(\boldsymbol{m}_t),\boldsymbol{c}_t) \tag{1}$$

where μ is a category sub-utility function. Weak separability implies that the marginal rates of substitution between goods inside μ are independent of changes in quantities in goods outside μ. Under weak separability, it is possible to consider the consumer's allocation problem over goods in μ alone, i.e. it is possible to only consider the problem: max $\mu(\boldsymbol{m}_t)$ subject to a budget constraint. We let $\boldsymbol{m}_t^*$ denote the quantities that solve the consumer's constrained maximization problem. If μ is homothetic, then $M_t^A = \mu(\boldsymbol{m}_t^*)$ is an economic quantity aggregate, which behaves as if it were the quantity of an elementary good. If μ is not homothetic, then the quantity aggregate is the distance function. In both cases, the correct dual price aggregate is given by the expenditure function.[2] One question that arises at this point is whether it is possible, assuming separability and homotheticity, to determine a value for M^A given only data on quantities and prices. The answer to this question is yes – in theory. The sub-utility (aggregator) function can indeed be tracked without error by the Divisia index. This index is defined (in log change form) as $d\ln(M_t^A) = \sum_n \varsigma_{it} d\ln(m_{it}^*)$, where ς_{it} is the expenditure share of good i at time t. Real world data is, however, only observed at discrete points in time. This means that the researcher observes Δm and not dm and, therefore, must choose some method to approximate M^A. Two main routes are available:

1. Specify a particular functional form for μ, derive demand functions, estimate and restore M^A. This route suffers from two main deficiencies. Firstly, the resulting M^A will depend on what functional form is used. Secondly, the choice of estimation method will affect M^A.
2. Approximate M^A using index numbers. Index numbers are parameter and estimation free in the sense that they only require knowledge about prices and quantities. Diewert (1976) denotes index numbers that are consistent with specific functional forms exact. A class of exact index numbers, termed superlative by Diewert, are exact for a flexible functional form. A flexible functional form provides a second-order approximation to any unknown functional form of μ.

Now consider the case when the m-goods are monetary assets optimally chosen by a consumer. Under the assumption that these assets form a homothetic weakly separable group, the stage is completely set for the construction of an aggregate monetary services good based on index numbers.

Barnett (1978) derives an expression for calculating discrete time user costs for monetary assets under the assumption that all interest rates paid on monetary asset holdings at the end of each period t are known with certainty at the beginning of each period, and Barnett (1980) demonstrates how aggregate monetary series indices (MSIs) can be constructed using superlative index numbers. More formally, let:

$$\pi_{it} = \frac{R_t - r_{it}}{1 + R_t} \tag{2}$$

be the period t discrete time real user cost associated with the nominal monetary asset i.[3] R_t is the period t nominal benchmark rate and r_{it} is the own rate of monetary asset i for period t. The benchmark rate is the rate of the return on an asset that provides no monetary services whatsoever. It is held solely for the purpose of transferring wealth intertemporally. The own-rate, assumed known at the *beginning* of period t, fully captures the investment services provided by a specific monetary asset.[4] The user cost may subsequently be viewed as the (discounted) opportunity cost for holding a pound's worth of a monetary asset. Diewert (2000) discusses user costs for monetary assets and how they relate to rental prices commonly calculated for other types of durable goods. He notes that statistical agencies generally are opposed to constructing rental prices/user costs for durable goods. The reason is that they are not objective or reproducible in the sense that the resulting prices will depend on choices of interest rates, etc. He notes, however, that common problems associated with calculating depreciation rates for durable goods, such as accounting for wear and tear, are not relevant for monetary assets.

Given user costs, we are ready to construct an aggregate nominal monetary services index. For this purpose, Barnett (1980) advocates using a chained Törnqvist Theil discrete time approximation of the Divisia index. This index is superlative and has a functional form that is easy to interpret. The latter becomes particularly evident when considering the index in log-change form. Define period t total expenditure on monetary services as $Y_t = \sum_n \pi_{it} m^*_{it}$ and define the period t expenditure share for monetary asset i as $\varsigma_{it} = \pi_{it} m^*_{it}/Y_t$. Average expenditure shares for monetary assets are given by $\varsigma a_{it} = [\varsigma_{it} + \varsigma_{it-1}]/2$. The Törnqvist Theil discrete time monetary services index (M_t^T) is, in log change form, defined as:

$$\Delta \ln(M_t^T) = \sum_n \varsigma a_{it} \Delta \ln(m^*_{it}) \tag{3}$$

As is evident in (3), the growth-rate of the index is simply a weighted sum of growth rates of the components of the index. Having obtained the aggregate nominal quantity index M_t^T, we can also calculate a real user cost index, P_t^D, that is dual to the quantity index in the sense that:

$$P_t^D = \frac{Y_t}{M_t^T} \tag{4}$$

Key findings and implications

Some of the chapters in this book address the problems associated with measuring money, and point, in particular, to the advantages of the Divisia index. The Divisia index is found to be more stable than the simple sum alternative and bears more ready economic interpretation. In the final chapter, for example, Belongia illustrates how Diewert's (1976, 1978) work on aggregation permits direct measurement of the own-price of