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Substitutability of Pakistan's Monetary Assets under Alternative Monetary Aggregates

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This paper's main objective is to empirically investigate whether or not the use of the simple-sum aggregate is justified in the context of Pakistan's economy and also to determine the degree of substitutability of monetary assets.

INTRODUCTION

The monetary aggregates, M_1 or M_2, are important and essential to policy-makers and researchers. The need for such aggregates to the policy-makers may arise in designing policies to control inflation, output and employment while the researcher may use those aggregates in estimating a simple money demand equation or a complex macro model of the economy. Traditionally, these monetary aggregates are basically the simple-sum aggregates and they are computed by adding the currency and other financial assets linearly and by assigning equal weights to each of them.

It has been argued in recent literature on monetary aggregates [e.g., Barnett (1980, 1987) and Barnett, Offenbacher and Spindt (1984)] that the use of the simple-sum procedure in defining monetary aggregates is questionable. Such a procedure imposes restrictions of perfect substitutability on the component assets of monetary aggregates. These restrictions have been tested by many researchers in developed countries and they have shown that, in many cases, the assumption of perfect substitutability is violated. It has also been shown that the alternative aggregation procedures [such as Divisia index or functional aggregates as suggested by Barnett (1980)] produce a relatively stable monetary aggregate.

In Pakistan, a number of money demand functions have been estimated using a simple-sum monetary aggregate [Mangla (1979); Khan (1980) and Hasan (1987a)]. No attempt has been made, so far, to test the implicit perfect substitutability restrictions imposed by such an aggregation procedure. Motivated by these considerations, we use, in this paper, an alternative model suggested by Clements and Nguyen

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(1980) [we name this model as the C-N approach hereafter] to test such substitutability restrictions of various liquid assets. This model is essentially a hybrid of Barnett's (1980) two approaches, namely, functional aggregators (BFA hereafter) and economic index numbers (EIN hereafter) and it is based on an *ad hoc* single equation money demand specification and does not rely on any optimization behaviour. In addition, we use the C-N approach to generate a time series for the new monetary aggregate and we then compare it with the series computed from the simple-sum procedure.

In Section 2, we will first briefly discuss Barnett's (1980) two approaches and the C-N method and then a detailed derivation of the latter approach will be presented. Section 3 deals with data and estimation techniques applied to the model. The estimates of alternative monetary aggregates and their comparison are reported in Section 4. Concluding remarks are made in Section 5.

THE MODEL

Since the monetary aggregation procedure used in the paper is a combination of Barnett's (1980) two approaches, it would be useful to briefly discuss these two approaches before discussing the model.

The two approaches suggested by Barnett (1980) deal with the problems arising from the use of the simple-sum procedure to aggregate various monetary assets. The first approach suggested by him known as the functional approach uses the consumers optimization theory to investigate the substitution possibilities among various financial assets. In this framework, economic agents are assumed to treat a monetary aggregate as a single meaningful good while making decisions about alternative choices. Indeed, a simple-sum aggregate would be meaningful in this context if the variation in relative quantities of assets, while holding the value of the aggregate constant, does not affect the taste of the consumer. The motive behind this sort of exercise is, therefore, to find an aggregate of money which is treated by the agents as a single good and which is also stable. This objective of formulating a monetary aggregate is accomplished by estimating the parameters of a flexible utility function such as the CES which possesses certain special desirable properties.

The second approach is based on the theory of statistical index numbers and it is used to construct alternative indices of money aggregates. The usefulness of this approach was well explained by Barnett *et al.* in their paper (1984, p. 105). They pointed out:

> ". . . if one wished to obtain an aggregate of transportation vehicles, one would never aggregate by simple summation over the physical units, of say, subway trains and roller skates. Instead, one could construct a quantity index using weights based upon the values of the different modes of transportations."

Barnett has used both the Divisia index and Fisher ideal index to form alternative aggregates of money. A third alternative, proposed by Clements and Nguyen (1980) is basically a combination of the two approaches discussed above. In this approach, information about the characteristics of the monetary aggregates is obtained by empirically estimating the parameters of a monetary aggregate function consisting of various monetary assets. Clements and Nguyen (1980) have named it a "liquidity production function". As pointed out by Clements and Nguyen (1980, p. 49), although this approach is not based on rigourous consumers optimization theory, it is nevertheless, more pragmatic and intuitive. Since we adopt the C-N approach in this paper, a brief discussion on the methodology of such an approach and the "liquidity production function" is given in the next section.

C-N Monetary Aggregates

In this section, we first derive the model to be estimated. The derivation of this model is based on the money market clearing condition and a specification of an alternative monetary aggregate function (termed as liquidity production function). Subsequently we use the parameter estimates of this model to generate an alternative monetary aggregate and then compare it with the simple-sum aggregate.

Following Clements and Nguyen (1980), we begin with the following equilibrium condition in the money market:

$$L(y, r) = M/P, \quad \ldots \quad \ldots \quad (1)$$

where y is the real income, r is the nominal rate of interest, M and P are the nominal quantity of money and price level, respectively. Taking a total differential of the logarithmic version of Equation (1), we get

$$d[ln(P)] = d[ln(M)] - \alpha\, d[ln(y)] - \beta\, d[ln(r)],$$

$$\alpha > 0; \quad \beta < 0; \quad \ldots \quad (2)$$

where α and β are the income and interest elasticities of money demand. So far, we have not yet provided the definition of money supply M. To define the monetary aggregate (M) in Equation (2), one may either use the conventional simple-sum aggregate of M_3 which assigns equal weights to the individual components or an alternative aggregate where these weights may not be necessarily equal. However, as noted earlier, simple-sum is a special aggregation procedure which is justified only if all the assets in M_3 are perfect substitutes. If the assets in the monetary aggregate are not perfect substitutes then a new monetary aggregate, as proposed by Clements and Nguyen (1980) can be defined by the following linear function:

$$d[ln(M)] = \lambda_1 d[ln(C)] + \lambda_2 d[ln(S)] + \lambda_3 d[ln(F_1)] + \lambda_4 d[ln(F_2)], \quad \ldots \quad (3)$$

where C is the currency and demand deposits, F_1 and F_2 are the short-term and medium-term fixed deposits,[1] respectively, and S is the savings deposits. The above definition of the monetary aggregate represented by Equation (3) is interpreted by Clements and Nguyen (1980) as the "liquidity production function". New substituting Equations (3) into (2), we get

$$d[ln(P)] = \lambda_1 d[ln(C)] + \lambda_2 d[ln(S)] + \lambda_3 d[ln(F_1)] + \lambda_4 d[ln(F_2)] - \alpha d[ln(y)] - \beta d[ln(r)] \quad \ldots \quad (4)$$

In the above equation the moneyness or liquidity of each individual asset is measured by the λ's. Therefore, those components that have a higher effect on the prices have larger weights in the measurement of liquidity of $d[ln(M)]$. It is interesting to note that, if we define the shares of each deposit as

$$w_1 = C/M_3, \quad w_2 = S/M_3, \quad w_3 = F_1/M_3, \quad w_4 = F_2/M_3, \quad \ldots \quad \ldots \quad (5)$$

then the simple-sum procedure, $M_3 = C + S + F_1 + F_2$, implies that $\lambda_1 = w_i$, and the liquidity variable M and the simple-sum aggregate M_3 are one and same.

For an empirical estimation of Equation (4), the continuous changes are replaced by their discrete changes and a lagged dependent variable is added on the right hand side to allow for the partial adjustments of prices.[2] Hence, the model can now be written as:

$$\Delta[ln(P)]_t = \lambda_1' \Delta[ln(C)]_t + \lambda_2' \Delta[ln(S)]_t + \lambda_3' \Delta[ln(F_1)]_t + \lambda_4' \Delta[ln(F_2)]_t - \alpha' \Delta[ln(y)]_t - \beta' \Delta[ln(r)]_t + \delta[\Delta ln(P)]_{t-1} + \mu_t. \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

[1] The classification of the fixed deposits are not arbitrary. In fact, the State Bank of Pakistan publishes fixed deposits into six assets categories ranging from sixty months to over five years. In this paper we have taken the first two categories (in terms of their maturities) as short-term deposits (F_1) while the second two are termed as medium term deposits (F_2).

[2] It should be noted that there are other adjustment processes that can be used for the price variable, such as the rational expectations approach, adaptive expectation etc. [e.g., see Hasan (1987) and Khan (1982)]. For the sake of convenience, we have used the partial adjustment process in this paper.

The primed coefficients in Equation (5) are the short-run elasticities and μ_t is the error term assumed to be white noise. We know that in the long-run

$$\Delta[ln(P)]_t = \Delta[ln(P)]_{t-1} = \Delta[ln(P)]_{t-2} \quad \ldots \quad (7)$$

Therefore, the long-run elasticities are the multiples of $[1/(1-\delta)]$ where $(1-\delta)$ is the coefficient for speed of adjustment $[0 < \delta < 1]$. Equation (6) will be used to estimate both the short-run and long-run elasticities.

In addition, we also test the equality of the simple-sum aggregate and our alternative aggregate in the long-run. The testing of this hypothesis is carried out in two stages. In the first stage we test whether Equation (6) exhibits constant returns to scale (CRS). Equation (6) exhibits CRS in the long-run if

$$\Sigma\lambda'/(1-\delta) = 1,$$

or

$$\delta = (1 - \Sigma\lambda'). \quad \ldots \quad \ldots \quad (8)$$

If the above restriction is not accepted then the equality hypothesis of the two monetary aggregates is rejected and we do not proceed any further. Otherwise we test the following restrictions in the second stage:

$$\lambda_i'/(1-\delta) = w_i, \quad \ldots \quad \ldots \quad (9)$$

where w_i's are the shares of individual deposits in the aggregate M_3. Note that the sum of the asset share weights should add up to unity ($\Sigma w_i = 1$), therefore, Equation (9) is a special case of the restrictions in Equation (8).[3]

DATA AND RESULTS

The quarterly data set used in this study spans over the period 1972–1 to 1981–4. The quarterly real income (GDP) variable is obtained from the recent data bank of the Applied Economics Research Centre developed for the Macroeconometric Model. All other variables were collected from the various issues of Annual and Monthly Bulletins of the State Bank of Pakistan.

We estimated three versions of our model, represented by Equation (6), by a maximum likelihood method using the TSP programme. The results are reported in

[3] Restriction in Equation (8) is only a necessary condition for the equality of the two aggregates, while the restrictions in Equation (9) are sufficient conditions because

$$\Sigma\lambda_i/(1-\delta) = \Sigma w_i = 1.$$

Table 1. The first version of the model was estimated with no restrictions while the estimation of the second version was carried out by imposing a constant returns to scale restriction [as given in Equation (8)]. The third version of the model assumes that each of the long-run money elasticities are equal to their respective shares [see Equation (9)].

In columns (1), (2) and (3) of Table 1, we report the parameter estimates of the three versions of Equation (6). It is important to note that the acceptance of the restrictions on parameters in column (3) amounts to the equivalence of the simple-sum aggregate to the alternative C-N aggregate in the long-run. We make use of a log-likelihood ratio to test the restrictions in columns (2) and (3).[4]

The restrictions in column (2) cannot be rejected at the 0.01 level of significance. We, therefore, focus our discussion of results on the restricted estimates in column (3).

The short-run money elasticities (λ_i') are 0.05, 0.03, 0.01 and 0.01 for cash and demand deposits, savings deposits, short-term and medium term fixed time deposits, respectively. The numbers indicate that, in the short-run, more liquid assets have a greater impact on the inflation rate. The corresponding long-run money elasticities [$\lambda_i'/(1-\delta)$] are 0.56, 0.34, 0.069 and 0.069 which are equal to the mean share values. For example, these results would indicate that an increase of 10 percent in cash and demand deposits may lead to an increase in the prices by 0.5 percent in the short-run and by 5.6 percent in the long-run. The other elasticities can also be interpreted in a similar fashion and they seem to be consistent. That is, more liquid assets have a larger impact on the prices both in the short-run as well as in the long-run.

The income and interest elasticities can also be deduced directly from the parameter estimates. The short-run and long-run income elasticities of the demand for money are 0.09 and 1.05, respectively. The magnitude of our long-run estimate of income elasticity of money demand is close to the ones obtained by others on Pakistan's economy [e.g. Khan (1980, 1982)].[5]

[4] Likelihood ratio statistic is defined as: LRS = $-2(Lr - Lu)$, where Lr denotes the maximal value of the log likelihood function under restriction and Lu is its log value when restrictions are not imposed. The proposed null hypothesis is that the restrictions are correct and, of course, LRS is assymptotically distributed as Chi Square with q degrees of freedom (df), where q is the number of restrictions imposed.

[5] It is important to note that the earlier estimates of income elasticities of money demand on Pakistan's economy are based on the simple-sum monetary aggregates. The magnitudes of earlier estimates of these elasticities may well coincide with ours in the long-run as we have already argued that in the long-run both aggregates are equivalent.

Table 1

Estimates of the Liquidity Production Function

	Unrestricted	Restricted	
		$\Sigma\lambda_i'/(1-\delta) = 1$	$\lambda_i'/(1-\delta)$ = Mean w_i
	(1)	(2)	(3)
λ'_1	0.0808 (0.060)	0.0804 (0.060)	0.0486
λ'_2	–0.1426 (0 118)	–0.1592 (0.119)	0.0297
λ'_3	0.0450 (0.056)	0.0595 (0.055)	0.0060
λ'_4	0.1876 (0.069)	0.1875 (0.070)	0.0060
α'	0.0711 (0.033)	0.0875 (0.031)	0.0910 (0.032)
β'	0.0028 (0.003)	0.0030 (0.003)	0.0043 (0.003)
δ	0.6953 (0.128)	0.8330	0.9135 (0.062)
$\lambda'_1/(1-\delta)$	0.2649	0.4814	0.5618
$\lambda'_2/(1-\delta)$	–0.4675	–0.9533	0.3433
$\lambda'_3/(1-\delta)$	0.1475	0.3563	0.0694
$\lambda'_4/(1-\delta)$	0.6151	1.1227	0.0694
$\alpha'/(1-\delta)$	0.2328	0.5239	1.0520
$\beta'/(1-\delta)$	0.0092	0.0179	0.0497
R^2	0.248	0.516	0.875
D.W.	1.973	2.028	2.360
L (# of free parameters)	89.579 7	88.603 6	84.516 5

Notes: 1. Asymptotic standard errors are reported in parentheses.
2. Standard errors of the derived parameters are not reported.
3. L stands for log-likelihood value.

It is important to note that the interest rate variable in Table 1 is insignificant and has the wrong positive sign in all three cases.[6] The statistical insignificance of the interest rate variable may not be very surprising in the context of developing countries, such as Pakistan, where there is very little year to year movements observed in the interest rates. In the past fifteen years, interest rates have changed only on five occasions.[7] Although our results indicate that in the long-run the simple-sum aggregate M_3' and the liquidity variable M coincide with each other, a comparison of $\Delta ln(M)_t$ and $\Delta ln(M_3)_t$ nevertheless, reveals that the former aggregate fluctuates significantly less than the latter (as shown in Figure 1).[8] Consequently, $\Delta ln(M_3)_t$ cannot be considered as a good predictor relative to $\Delta ln(M)_t$ and the results of this paper are quite consistent with other studies [e.g. Barnett (1980) and Clements and Nguyen (1980)].

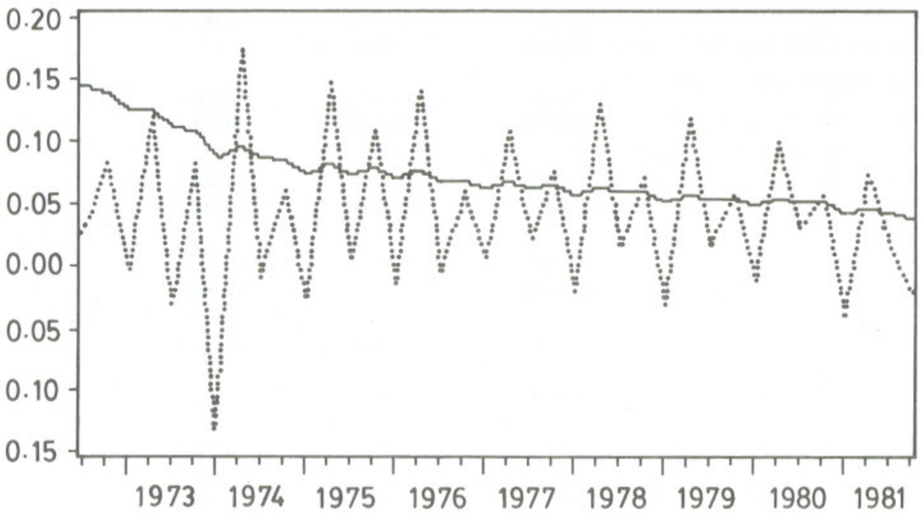

Fig. 1. A Comparison of Δ[ln(M)] t and Δ[ln(M_3)] t

Notes: Δ[ln(M)] t represented by dark lines (____) is the time series plot generated using alternative monetary aggregate, while Δ[ln(M_3)] t, represented by dotted lines (. . .) is the one generated from simple sum aggregate.

[6] A similar result was also found by Hasan (1987a, 1987b) for the rational expectations money demand function. These results may well reflect the imperfections in the financial markets in Pakistan.

[7] Since the coefficient of the interest rate is insignificant a meaningful interpretation for such a result may not be possible.

[8] Following Clements and Nguyen (1980), we also constructed $\Delta[ln(M)]_t$ as $\lambda_1' \Delta[ln(C)]_t + \lambda_2' \Delta[ln(S)]_t + \lambda_3' \Delta[ln(F_1)]_t + \lambda_4' \Delta[ln(F_2)]_t + \delta \Delta[ln(M)]_{t-1}$ with the estimates given in column (3) of Table 1 and with $\Delta[ln(M)o = D[ln(M_3)]$ o.

CONCLUSIONS

In this paper our main objective was to empirically investigate whether or not the use of the simple-sum aggregate is justified in the context of Pakistan's economy and also determine the degree of substitutability of the monetary assets. We have estimated a liquidity production function, as suggested by Clements and Nguyen (1980), to test the validity of the simple-sum aggregate in the short-run as well as in the long-run.

Our results indicate that the alternative monetary aggregate proposed in this paper is not statistically different from the traditional simple-sum aggregate in the long-run. However, the two aggregates are different in the short-run. In the short-run, our alternative monetary aggregate is far more stable than the simple-sum in the sense that the fluctuations in the latter series are far greater than the former. We realize that this smoothness in the alternative monetary aggregate $\Delta ln(M)_t$ is due to the presence of the lagged dependent variable $\Delta ln(M)_{t-1}$ in the model, but, nevertheless, it is still a good predictor and therefore, this finding may have some practical importance to the policy-makers in forecasting monetary aggregates in Pakistan.

Our results on the estimated short-run and long-run elasticities are also interesting and they provide better insight on the substitution possibilities among different monetary assets in Pakistan. A comparison of these elasticities shows that assets are not perfect substitutes in the short-run.

The interesting results of this paper is a testimony that more thorough work is needed on similar lines. For instance, possible extensions of this research would be to generate monetary aggregates using alternative models as discussed earlier in Section 2 of this paper.

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