CHAPTER III

ASSET SEPARABILITY: SOME NONPARAMETRIC EVIDENCE

3.0. INTRODUCTION

As noted earlier, the first step of Barnett's (1982) three stage procedure for selection of optimal monetary aggregates is to identify weakly separable groups of monetary assets for possible aggregation to form economic monetary aggregates. Weak separability ensures the existence of an economic monetary aggregate, and hence testing weak separability among different assets becomes a basic requisite towards obtaining a meaningful monetary aggregate. In the literature both parametric and non-parametric approaches are employed to test weak separability. A few studies in the Indian context (Ramachandran and Kamaiah (1994), Subrahmanyan and Swaroop (1994)) have already tested separability of assets for monetary aggregates M1, M2, M3 and M4 as given in the Second Working Group of the RBI using parametric tests. It has been observed that the parametric tests are sensitive to use of particular functional forms approximating the underlying utility functions. The non-parametric tests, however circumvent this problem as the results of these tests are independent of any functional form and parameter estimates. The tests can also handle a relatively large number of goods. It may be noted that to date, there are no studies relating to India examining separability of assets using the non-parametric approach. Hence an attempt is made in this chapter to re-examine the issue of separable monetary asset blocks in the Indian context using the non-parametric tests suggested by Varan (1982, 1983).
3.1. WEAK SEPARABILITY

The first and foremost task in the process of identifying a monetary aggregate is to confirm weakly separable monetary asset groupings. That is to say, a monetary aggregate can be formed only with financial assets that are weakly separable from other available financial assets as well as real goods and services, in the representative agent's preferences.

Following Blackorby et al (1978), weak separability may be defined as follows. Let \((P, R)\) and \((Q, M)\) be two vectors of prices and goods where \(R\) and \(M\) represent some arbitrary bundles of real goods and monetary assets respectively. \(P\) and \(Q\) represent the prices of the real goods and monetary assets respectively. Then, we say the agent's utility function \(U(R, M)\) is said to be weakly separable in \(M\), if it is possible to find a "subutility function" say \(V(M)\) and a macro utility function \(U(R, V)\) which is strictly increasing in \(V\), such that

\[
U(R, M) = \overline{U}(R, V(M))
\]  

A necessary and sufficient condition of weak separability is that the marginal rate of substitution between any two pairs of assets in \(V(M)\) is independent of the amount of consumption of any good outside \(V(M)\). A detailed discussion on weak separability may be found in Deaton and Muellbauer (1980).

The criterion of weak separability may be illustrated with the following utility maximaization problem involving a two-stage budgeting procedure.

Let \(U_t\) be the consumer's utility function in period \(t\) expressed as a function of real goods \((R_t)\), leisure \((L_t)\) and monetary assets \((M_t)\). Let \(Y_t\) be total expenditure or full income in period \(t\). \(P_r\), commodity prices, \(P_L\), price of leisure and \(P_m\), monetary asset rental prices. Now, the utility maximaization problem may be formulated as follows:

Maximize: \(U_t = U_t(R_t, L_t, M_t)\)  

\[3.2\]
subject to: \[ P^*_t R_t + P^*_1 L_t + P^*_m M_t = Y_t \] \hspace{1cm} (3.3)

where * refers to equilibrium values.

Let us assume that the total expenditure is predetermined within the framework of an intertemporal model of consumer demand in which it is assumed that the utility function is intertemporally separable. If utility is weakly separable in consumption, leisure and monetary services, then it may be rewritten as,

\[ U = U[V_1 (R), V_2 (L), V_3 (M)] \] \hspace{1cm} (3.4)

Equation (3.4), then, implies the following three demand functions

\[ R_d = f(P_r, Y_r), \hspace{0.5cm} Y_r = P^*_r R \hspace{1cm} F(P_r, P_m, P_l, Y) \] \hspace{1cm} (3.5)

\[ L_d = g(P_l, Y_1), \hspace{0.5cm} Y_1 = P^*_1 L \hspace{1cm} G(P_r, P_m P_l, Y) \] \hspace{1cm} (3.6)

\[ M_d = h(P_m, Y_m), \hspace{0.5cm} Y_m = P^*_m M \hspace{1cm} H(P_r, P_m, P_l, Y) \] \hspace{1cm} (3.7)

The subscript "d" in equations (3.5) to (3.7) refers to the demand function for the respective commodity vector and *s in the equations refer to equilibrium values. \( Y_r, Y_1, \) and \( Y_m \) refer to expenditure on real goods, leisure and monetary goods respectively. Weak separability implies a two-stage model for consumer behaviour. First the consumer allocates expenditures among the various broad categories of goods determining \( Y_r, Y_1, \) and \( Y_m \) where equations 3.5, 3.6 and 3.7 are obtained. In the second stage the consumer allocates expenditures among the goods within each broad category based only on the relative prices of the goods in that category. This is referred to as the concept of a utility tree in Deaton and Muellbauer (1980). Therefore the two-stage budgeting procedure is not an accurate description of consumer behaviour if weak separability conditions are not satisfied.
3.2. TESTING WEAK SEPARABILITY

There are two ways of testing separability viz., (i) parametric tests and (ii) non-parametric tests. Parametric tests involve estimation of parameters by way of estimating a particular functional form assumed for the indirect monetary services utility function. Non-parametric tests, on the other hand, are directly applicable to the data for checking whether the data set rationalises a well behaved utility function.

3.2.1. Parametric Tests

Parametric tests require a functional form for the optimizing agent's preferences estimate a model and perform hypothesis tests for different structures of separability. This may be illustrated with the help of a representative consumer's allocation problem which is as follows

Maximize \( U(X_{1t}, X_{2t}, \ldots, X_{nt}) \) \hspace{1cm} (3.8)

Subject to

\[
\sum_{i=1}^{n} P_{it} X_{it} = M_t \hspace{1cm} (3) \\
1 \hspace{0.5cm} 2 \hspace{0.5cm} \ldots \hspace{0.5cm} n
\]

where \( X_{it} \) is the \( i \)-th monetary asset in period \( t \), \( P_{it} \) is the user cost associated with the \( i \)-th asset in period \( t \) and \( M_t \) is expenditures on monetary assets in period \( t \). The user cost is the one period foregone interest opportunity cost expressed as

\[ P_{it} = (R_t - r_{it}) (1 + R_t) \]

where \( R_t \) is the yield on a benchmark asset and \( r_{it} \) is the yield on the \( i \)-th asset in period \( t \).

This problem may be analyzed via its dual problem, i.e., budget constrained maximization of the indirect utility function. The indirect function expresses monetary...
services as a function of the monetary asset prices and the budget allocation to monetary services, $M_t$. Accordingly, this problem may be rewritten as

Maximize

$$ G = G(P_{1t}, P_{2t}, \ldots, P_{nt}, M_t). \quad (3.10) $$

Subject to

$$ M_t = \sum_{i=1}^{n} P_{it}X_{it} \quad (3.11) $$

where $G$ is the indirect monetary services utility function.

The use of this indirect function has one advantage viz. demand equations are functions of prices which are obtained directly from the first order conditions by applying Roy's identity.

A particular functional form may be assumed for the above indirect utility function (eqn (3.10)) and demand equations derived and subsequently estimated. Then by imposing the restriction of equality among Allen elasticities of substitution, an approximate weak separability test is conducted. The hypothesis implies equality within each set of Allen partial elasticities of substitution $\sigma_{ij}$s that is constructed by pairing all the assets in the separable subgroup with a given asset not in the separable group. For instance if assets $i'$ and $j'$ are separable from asset $k$ then the hypothesis implies that $\sigma_{ik} = \sigma_{jk}$. That is to say, if the marginal rate of substitution of asset $i$ for asset $j$ is not influenced by the holdings of asset $k$, then assets $i'$ and $j'$ are equally substitutable with $k$.

Functional forms that have been used in the past include Generalized Leontief (Donovan 1978), Translog (Ewis and Fisher 1984), Fourier Flexible form (Ewis & Fisher 1985) etc.
However, the basic limitation of the parametric approach is that the results are conditional on a particular functional form specified for the utility function. Moreover, a joint hypothesis is always tested under this approach viz., testing derived restrictions along with the maintained hypothesis of functional form. This amounts to confusion in case of violations of axioms of neoclassical consumer theory. It becomes very difficult to confirm whether it is particular functional form or data or the consumer theory that is being rejected. A quick review of the results obtained from parametric approaches to testing weak separability of monetary assets reveals that they(results) are not robust. Most of the studies assumed separability of real goods from monetary assets and proceeded testing separability among various proposed subgroups of monetary assets. Since the focus of the present chapter is on the non-parametric approach to separability, a review of studies which have employed the parametric approach is not attempted here.

3.2.2. Non-Parametric Tests

Vanran (1982) developed a systematic non-parametric approach to test different utility maximization hypotheses weak separability and homotheticity. This approach is based on the revealed preference theory of consumer behaviour. Varian (1982) reformulated Afnian’s (1967) theorem in terms of his Generalized Axiom of Revealed Preference (GARP) and Homothetic Axiom of Revealed of Preference (HARP).

Given a set of monetary asset quantities $X^l = (X^l_1, X^l_2, X^l_k)$ and its corresponding user costs $P^l = (P^l_1, P^l_2, P^l_k)$, Afnian’s (1967) theorem tries to answer the following question: Are these observed user costs and quantities consistent with the maximization of a well-behaved utility function?
Afriat's (1967) Theorem:

(a) There exists a non-satiated utility function that rationalizes the data.

(b) The data satisfy the axiom of transitivity, that is, \( P^r X^r \geq P^r X^s \), \( P^s X^s \geq P^s X^t \), \( P^q X^q \geq P^q X^r \) implies \( P^r X^r = P^r X^s \), \( P^s X^s = P^s X^t \), \( P^q X^q = P^q X^r \)

(c) There exists utility indexes \( U^1 \) and marginal utility indexes \( \lambda^i \geq 0 \), \( i = 1, 2, \ldots, n \) such that,

\[
U^1 \leq U^j + \lambda^j (X^j - X^i) \text{ for } i, j = 1, 2, \ldots, n
\]

(d) There exists a nonsatiated, continuous, monotonic, concave utility function that rationalizes the data.

Varian developed an equivalent formulation of the transitivity axiom (axiom (b)) as mentioned above and called it the Generalized Axiom of Revealed Preference (GARP).

The following definitions were given by Varian (1982). Given an observation \( X^i \) and a bundle \( X \),

Definition 1 - \( X^i \) is directly revealed preferred to \( X \) written \( X^i D X \) if \( P^i X^i \geq P^i X \)

Definition 2 - \( X^i \) is strictly directly revealed preferred to \( X \), written as \( X^i S X \), if \( P^i X^i > P^i X \)
Definition 3 - \( X^i \) is revealed preferred to \( X \), written as \( X^i \succeq X \), if \( P^i X^i \geq P^i X \), \( P^j X^i \geq P^j X \), and \( P^m X^m \geq P^m X \) for some sequence of observations \( (X^i, X^j, ..., X^m) \). In this case \( R \) is called the transitive closure of the relation \( D \).

In terms of the notations and definitions given above, GARP can be stated as follows. If \( X^i \succeq X^j \) then \( P^i X^i < P^j X^j \) for \( i, j = 1, 2, ..., n \) where \( P^j \) is a vector of \( m \) prices, \( X^i \) and \( X^j \) are vectors of \( m \) associated goods, \( n \) is the number of observations and \( R \) means revealed preferred. A violation of GARP occurs if for some \( X^i \succeq X^j \), the condition \( X^j \succeq X^i \) is true, that is, a violation of GARP occurs if \( X^i \) is shown to be revealed preferred to \( X^j \).

Vanian (1983) proved the following theorem which outlined the conditions required to satisfy weak separability:

(a) There exists a weakly separable, nonsatiated continuous concave, monotonic utility function that rationalizes the observed data.

(b) There exist utility indices \( U^i, V^i \) and marginal utility indices \( \lambda^i > 0, \mu^i > 0 (i = 1, 2, ..., n) \) that satisfy the Afriat (1967) inequalities \( U^i \leq U^j + \lambda^j P^j (X^i - X^j) + (\lambda^j - \mu^j) (V^i - V^j) \) and \( V^i \leq V^j + \mu^j q^j (Z^i - Z^j) \) for \( i, j = 1, 2, ..., n \).

(c) The data \((q^i, Z^i)\) and \((P^i, 1, \mu^i, X^i, V^i)\) satisfy GARP for some choice of \((V^i, \mu^i)\) that satisfies the Afriat (1967) inequalities.

The conditions stated above (i.e., (a) to (c)) are equivalent and may lead to a three-step test procedure, which may be used to ascertain whether any proposed subgroup of financial assets form a separable group.
Step-1

In this step, the whole data set is checked for consistency with GARP (Generalized Axiom of Revealed Preference). If the data set is consistent with GARP, then it is consistent with utility maximization.

Step-2

Here, the task is to test for consistency with the necessary condition for weak separability. The necessary condition is that all goods in the macro utility function and the array of financial assets in the monetary subutility function are consistent with GARP.

Step-3

The last step warrants consistency with the sufficient conditions. One sufficient but not necessary condition for weak separability is consistency with what Varian (1983) called the Afriat Inequalities.

If the data pass the three steps mentioned above, then the assets in the monetary subutility function can constitute an economic monetary aggregate. If a hypothesized preference structure fails to meet the necessary condition for weak separability, then assets in the proposed subutility function cannot form a theoretically admissible group. If the hypothesized preference structure (or utility function in other words) meets the necessary condition for weak separability but fails to meet the Afriat sufficient condition, the proposed monetary subutility function may still be considered as a separable group so as to constitute an economic monetary aggregate. In the present study, the three-step procedure is implemented by using Varian's (1991) software routine NONPAR.
3.3. SOME PREVIOUS WORKS

The studies of Swofford and Whitney (1986, 1988, 1995), Belongia and Chalfant (1989), Belongia and Chrystral (1991) which have applied the non-parametric tests, to identify separable monetary asset blocks, merit attention in this context.

Using the U S quarterly real per capita data for the period 1969 I - 1979 IV on monetary assets and their associated user costs, Swofford and Whitney (1986a) found no violations of GARP for entire data set. But some subutility function revealed violations of GARP. In another attempt, the same authors (1986b) took consumption of durable goods, nondurable goods and services along with 27 monetary assets in the overall utility function for the period 1970 1 - 1985 2 in the U S context. The data were in real per capita terms. The data set met the necessary condition and could be rationalized by a well-behaved utility function. The utility function was found to be weakly separable in consumption goods and leisure. Relatively liquid monetary assets met the necessary conditions for weak separability from other goods, thereby favouring a narrow monetary aggregate.

In yet another attempt Swofford and Whitney (1988) performed non parametric tests on real per capita goods consumption, leisure and monetary assets for the period 1970-1985 using both annual and quarterly observations. Among the important results, annual real per capita data on consumption goods, leisure and monetary assets could be rationalized by a well-behaved utility function, whereas with quarterly data, utility maximization held good only with relatively liquid monetary assets upto and including small-time deposits. It was believed that the less liquid assets used in the study were not adjusted to optimal levels within a quarter. The results also indicated weak separability of the utility function in consumption goods and leisure and in monetary assets with annual data. Finally for no grouping the study could obtain homothetic preferences.
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The studies of Swofford and Whitney (1986, 1988, 1995), Belongia and Chalfant (1989), Belongia and Chrystal (1991) which have applied the non-parametric tests, to identify separable monetary asset blocks, merit attention in this context.

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Assuming real goods and services and leisure to be separable from monetary assets, Belongia and Chalfant (1989) searched for weak separable blocks over financial assets alone. The assets considered by them were currency, demand deposits, NOWs, Super NOWs, MMDAs, MMMfs, and Savings(SVGs). Several groups such as (C, DD), (C, DD, NOWs), (C, DD, NOWs, Super NOWs) and (C, DD, NOWs, Super NOWs, MMDAs, MMMFs) emerged as separable groupings.

Searching for an admissible monetary aggregate for the United Kingdom, Belongia and Chrystal (1991) applied Varian's non-parametric test to examine the separability conditions for five assets viz., currency, non-interest bearing sterling sight deposits, private sector interest-bearing retail deposits, wholesale deposits and interest bearing building society deposits. The results were indicative of the entire group as a weakly separable block and an additional asset group containing non-interest bearing sight deposits, interest bearing retail deposits and interest bearing building society sight deposits also formed a weakly separable block.

Again Swofford (1995) analyzed Friedman and Schwartz money using revealed preference approach. The study took the assets that Friedman and Schwartz (1970) considered in their study of U.S. monetary history, and tested for consistency with weak separability. The study reached the same conclusion as that of Friedman and Schwartz (1970) who found that currency, demand deposits, and time deposits issued by commercial banks met the criteria to form an aggregate. Additional evidence from the study supported Friedman and Schwartz’s notion that a broader monetary aggregate might have been appropriate after World War II.
3.4. EMPIRICAL ANALYSIS

The present study uses annual data for the period spanning over 1970 to 1996 and monthly data from 1985 04 1996 09. Four financial assets viz., currency with the public (CU), net demand deposits of the public held by banks (DD), net time deposits of the public held by banks (TD) and saving deposits with post office savings banks (PD) are considered for the separability test. The assets are measured in real per capita terms.

Here Vanan's nonparametric tests are conducted with a two-fold objective. First, to discover certain theoretically admissible groups for further analysis of economic monetary aggregates. Secondly, to examine the consistency of official definitions of money as given by the Second Working Group (SWG) of the RBI, with economic theory of aggregation i.e., to see whether the components of M1, M2, M3 and M4 form weakly separable blocks. The study also attempts to include a new asset namely certificate of deposit (CD) for the period 1994 04 1996 07 and searches for some separable combinations with this new asset. The number of observations are constrained due to the availability of data on this asset for a longer period of time. It is to be noted that this asset is introduced only after June 1989, and RBI started publishing the data from 1994 onwards.

It is to be noted here that the hypothesization of utility structures for weak separability tests follows Barnett's (1982) recursiveness condition which states that the components of each utility structure must include currency (legal tender) and must not include any good or asset that is not a monetary asset. Economic aggregation theory does not dictate use of this condition. However, violation of this condition results in a large number of weak separable groups in practice and therefore it could be difficult to choose from among such a large class of weak separable groups. Applying conventional views from monetary theory, this condition restricts the number of theoretically admissible
component groups. More specifically this condition, "restricts the domain of possible components to "monetary assets" and requires the collection of admissible component groups to be nested about "hard core money", defined here by its legal tender property" (Barnett 1982, p. 697)

As Varian's (1983) revealed preference test required data on both prices and quantities of the financial assets, Barnett's (1978) user cost formula is used to generate prices for these assets. The formula for the user cost of say ith monetary asset takes the form

\[ \Pi_i = \frac{(R - r_i)}{(1 + R)} \]

where \( \Pi_i \) is the user cost of the ith asset, \( R \) is the benchmark rate and \( r_i \) is rate of return of the ith asset. The above formula denotes the discounted interest foregone by holding a rupee's worth of the ith asset.

Regarding rate of return on individual assets, currency being the most liquid amongst all assets, the rate of return on it is assumed to be zero. For demand deposits an implicit competitive rate is constructed using Klein's (1974) methodology. The formula employed for constructing this rate is

\[ r_{DD} = r_T \left[ 1 - \left( \frac{BR}{DD} \right) \right] \]

where \( r_T \) is 91 day treasuring bill rate and \( BR \) is bank reserve held against demand deposits, 12 month deposit rate is used as a proxy for time deposit rate. In case of postal savings deposits, the rate of interest per annum on post office savings bank accounts with limits of investment lying between a minimum of Rs 20/- and a maximum of Rs 50,000, is
used In the absence of such a rate commercial bank 3 months savings deposit rate is used For certificate of deposit, its own rate of return is used

Theoretically R, the benchmark rate should be the rate on a particular asset which is completely illiquid and does not provide any monetary service. The rate on human capital may serve the purpose since it does not render any monetary service in a world where there is no slavery system. However, due to difficulties associated with such a measurement, the present study proxies R by taking the rate of return on the highest yielding asset in period t and calculates user costs for each asset in that particular time period. In the absence of any direct measurement of a benchmark rate, one can only construct proxy measures, which need not be rate of return on only one asset. Thus, rates of return like long term government bond yield rate, company deposit rate, yield on private debentures and UTI dividend rates have served this purpose for different time periods in the study. The highest available rate from among these rates in a particular year is considered the benchmark for that year.

3.4.1. Evidence from Annual Data

The non-parametric test results for the annual sample 1970-1996 are summarized in the following table (table 3.1).
Table 3.1
Non Parametric Test Results

<table>
<thead>
<tr>
<th>Hypothesized Utility Structure (1)</th>
<th>Necessary Condition (GARP) (2)</th>
<th>Sufficient Condition (Afriat Inequalities) (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1=U[PD, TD, V(CU, DD)]</td>
<td>V</td>
<td>----</td>
</tr>
<tr>
<td>U2=U[PD, DD, V(CU, TD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U3=U[DD, TD, V(CU, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U4=U[PD, V(CU, DD, TD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U5=U[TD, V(CU, DD, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U6=U[DD, V(CU, TD, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U7=U[CU, DD, TD, PD]</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

Foot Note In columns (2) and (3) above S indicates that the specified utility function satisfies the particular condition and V indicates violation of the same.

The entire data, when tested, reveal no violations of GARP and thus meet the necessary condition for weak separability. The data also satisfy Afriat inequalities, the sufficient condition of weak separability. Hence, it may be concluded that the data can be rationalized by a well-behaved utility function. In other words the data is consistent with the utility maximization hypothesis.

Next, as shown in the above table, seven different utility functions have been hypothesized containing the four assets viz., CU, DD, TD and PD. The hypothesization follows Barnett's recursiveness condition and therefore includes currency as a common element in all the preference structures. All the preference structures except U1,
consistently pass the necessary and sufficient conditions of weak separability and form theoretically admissible groups.

The first preference structure, where currency and demand deposits enter the subutility function fails to meet GARP, the necessary condition. It can, therefore be inferred that components of simple sum M1 as defined by the RBI SWG(1977) and published by RBI do not form a weakly separable block. The validity of this asset group to constitute an economic monetary aggregate is questioned by economic aggregation theory.

The components of M3 as defined by the RBI SWG(1977) are the same as those in the subutility function of the macro function U4 which consistently pass GARP without revealing any violations and also satisfy the Afriat Inequalities. The preference structure is consistent with separability and hence (CU, DD, TD) forms a weakly separable block.

The utility structure U5 contains CU, DD, and PD and consistently pass the necessary and sufficient conditions of weak separability. This combination closely correspond to the official M2 as defined by the RBI SWG(1977).

The data used in this study confine to monetary assets only. Assuming that monetary assets are weakly separable from real goods, it can be said that M4 components as defined by the SWG(1977) form a weakly separable block as the entire data set consistently pass both GARP and Afriat Inequalities, the necessary and sufficient conditions respectively.

In addition to the separable blocks identified above, some more weakly separable groups which consistently pass Vanan's (1983) three step test and meet both the necessary and sufficient conditions are discovered. They are preference structures, U2, U3, and U6.
with (CU,TD), (CU,PD), and (CU,TD,PD) as respective weakly separable monetary asset groups. The viability of these newly obtained admissible groups is examined in Chapter IV by testing their performance as suitable economic monetary aggregates.

Investigation with an annual sub-sample from 1980 to 1996 yielded the following results which are summarized in Table 3.2.

Table 3.2
Non Parametric Test Results
Annual Data (1980-1996)

<table>
<thead>
<tr>
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<td>S</td>
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<tr>
<td>U3 = U[D,D, T,D, V(CU, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
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</tr>
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<td>S</td>
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</tr>
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<td>U6 = U[D,D, V(CU, TD, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U7 = U[CU,DD, T,D, PD]</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

Foot Note Same as in Table 3.1

Preference structures hypothesized in Table 3.2 were the same as in Table 3.1. In addition to separable groupings found in Table 3.1 (CU, DD) was found to form a weakly separable block in this sub sample.
3.4.2. Evidence From Monthly Data

Separability tests for the monthly data from 1985 04 1996 09 were carried out in two phases, breaking the sample at 1990 12. This would facilitate having 1991 01-1996 09 as a period which coincides with the period of economic liberalization in India. Accordingly, the results of the tests for samples 1985 04-1990 12 and 1991 01-1996 09 are presented in tables 3 3 and 3 4 respectively.

<table>
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<td>S</td>
<td>V</td>
</tr>
<tr>
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<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U5 = U[TD, V(CU, DD, PD)]</td>
<td>S</td>
<td>V</td>
</tr>
<tr>
<td>U6 = U[DD, V(CU, TD, PD)]</td>
<td>S</td>
<td>V</td>
</tr>
<tr>
<td>U7 = U[CU, DD, TD, PD]</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

Foot Note Same as in table 3 1

As shown in the above table, groupings (CU, DD, TD) and (CU, DD, TD, PD) pass both the conditions of separability viz., GARP and Afrati inequalities and form theoretically admissible groups. Preference structures U3, U5, and U6 satisfy the necessary condition only. Combinations (CU, DD) and (CU, TD) violate GARP.
Table 3.4
Non Parametric Test Results

<table>
<thead>
<tr>
<th>Hypothesized Utility Structure (1)</th>
<th>Necessary Condition(GARP) (2)</th>
<th>Sufficient Condition(Afriat Inequalities) (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1=U[PD, TD, V(CU, DD)]</td>
<td>S</td>
<td>V</td>
</tr>
<tr>
<td>U2=U[PD, DD, V(CU, TD)]</td>
<td>V</td>
<td>----</td>
</tr>
<tr>
<td>U3=U[DD, TD, V(CU, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U4=U[PD, V(CU, DD, TD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U5=U[TD, V(CU, DD, PD)]</td>
<td>V</td>
<td>----</td>
</tr>
<tr>
<td>U6=U[DD, V(CU, TD, PD)]</td>
<td>V</td>
<td>----</td>
</tr>
<tr>
<td>U7=U[CU,DD, TD, PD]</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

Foot Note: Same as in table 3.1

It is clear from this table that for the sample 1991:01-1996:09 groupings (CU, DD, TD) and (CU, DD, TD, PD) form weakly separable groups as they satisfy both the necessary and sufficient conditions of separability. Grouping (CU, DD), the official M1 satisfy the necessary condition only. Utility structures U2, U5, and U6 violate GARP, the necessary condition of weak separability.


In this sub-section we are presenting the non-parametric evidence for separable groups, in which a new asset namely certificate of deposit is added. Since data on this
new asset could be obtained only from 1994 04, the sample range is confined to 1994.04 to 1996 07. The test results are summarized in the following table (Table 3.5).

<table>
<thead>
<tr>
<th>Hypothesized Utility Structure (1)</th>
<th>Necessary Condition (GARP) (2)</th>
<th>Sufficient Condition (Afriat Inequalities) (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1=U[PD, CD, V(CU, DD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U2=U[DD, CD, V(CU, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U3=U[DD, PD, V(CU, CD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U4=U[CD, V(CU, DD, PD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U5=U[PD, V(CU, DD, CD)]</td>
<td>S</td>
<td>S</td>
</tr>
<tr>
<td>U6=U[DD, V(CU, PD, CD)]</td>
<td>S</td>
<td>V</td>
</tr>
</tbody>
</table>

Foot Note Same as in Table 3.1

As shown in the above table, the data set as a whole satisfies both GARP and the Afriat sufficient condition. Two new weakly separable groups viz., (CU, CD), and (CU, DD, CD) are obtained for the sample 1994 04-1996 07 as the utility structures U3 and U5 satisfy both necessary and sufficient conditions for weak separability. The combination (CU, PD, CD) satisfies the necessary condition but fails to satisfy the sufficient condition.

3.5. CONCLUDING REMARKS

The search for separable groups employing Vanan's (1983) non-parametric procedure among different financial assets yielded the following results. The study identified components of M2, M3 and M4 as defined by the Second Working Group(1977) as weakly separable groups for annual data 1970-1996. Some new
separable groups were also obtained in the process for this period suggesting construction of alternative monetary aggregates against the existing practice at the central monetary authority level. Interestingly, all the official money supply measures viz., M1, M2, M3, and M4 were found to be theoretically admissible groups for the sub-sample 1980-1996 as the groupings satisfied both the necessary and sufficient conditions for weak separability. However, the test results of monthly observations yielded only M3 and M4 as weakly separable groups. The monthly evidence therefore seemed to be in favour of broader aggregates. Results from the extended monthly data with the new asset Certificate of deposit (CD) indicated (CU, CD) and (CU, DD, CD) as two new separable groups.

The entire data set satisfied all the required conditions and therefore could be rationalized by a well-behaved utility function. This implies that the failure of specific functional forms in satisfying different axioms of neoclassical consumer behavior as has occurred in some past studies, indicates either a rejection of the particular specification or of a particular grouping and not a rejection of utility based money demand analysis.

Homothetic preferences could not be obtained either for the entire data set or for any of the tested groupings as the test revealed maximum number of violations. This was tested using Varan's (1983) Homothetic Axiom of Revealed Preferences (HARP). The implication of this finding is that studies relying on homothetic functional forms such as a constant elasticity-of-substitution function are misspecified.