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EXPLORING THE CAUSAL RELATIONSHIP AMONG SOCIAL, REAL, MONETARY AND INFRASTRUCTURE DEVELOPMENT IN PAKISTAN

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Abstract. This paper examines the causal relationship among composite indicators for real, monetary/financial, social and infrastructure development in Pakistan. This is an effort to provide evidence on the two highly debatable issues, *i.e.* money-real causality and social-economic causality in a single multivariate framework. We use a large number of variables to construct the composite indicators of development in four major sectors of the economy: social development, real economic development, monetary and financial growth and infrastructure development. The data are collected from 1971-72 to 2003-04 on annual basis. The technique of factor analysis using principal component is employed to construct these indicators. The computed values of these indicators over the aforementioned time span constitute time series data. Using these time series data the paper assesses that a long-run relationship exists among social, real, monetary and infrastructure activities. The paper has applied Granger Causality test in a Vector Error Correction model and concludes that social development is caused by real economic development but not *vice versa*, which is indicative of 'trickle-down' development policies. It also concludes that in the context of Pakistan, no causal relationship exists between real economic development and monetary growth; meaning that monetary development has no impact on the economic growth of the country. However, both real development and monetary indicators appear to be exogenous in the system which implies that these can be used as instrument in developing social and physical infrastructure to boost investment and improving the quality of life of the people.

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I. INTRODUCTION

Theoretically, causation can be studied for any group of variables that are associated in a long-run relationship over time. But for both the modern economists and that of the past, the questions of social and economic causality and real and monetary causality have always been an issue of much argument. The interpretation of the term 'causality' has itself been debatable. For instance, Colambatto (1991) argues that causality is some thing different from 'precedence'. He states that causality tests do not actually deal with causality but what with Leamer (1985) defined as 'precedence', which is neither a necessary, nor a sufficient condition for causality. According to a text book definition of causality, one set of variables is usually said to be 'caused' by another set of variables if the information contained in the past and present values of the later improves the prediction of the former (Judge *et al.*, 1985). Econometricians usually refer to Granger Causality (Granger, 1969), which is defined as follows:

X is said to be a Granger cause of Y if present Y can be predicted with greater accuracy by using past values of X rather than not using such past values, all other information being identical.

However, Newman and Thompson (1991) cite that no one has monopoly rights in defining 'causality'. The term is in common parlance and the only meaningful change is that of providing a meaningful explication of it. They also seem to be inclined towards meaning the term causality as interdependence among the variables, rather confining it to predictability only. Maliaris and Urrutial (1991), Darrat and Dickens (1999), Jamal (1998) and this paper interpret the term causality in the same sense as in Newman and Thompson (1991).

Causality between social development and real economic growth stems in the idea that society matters for growth which is almost as old as economics itself (Temple *et al.*, 1998). Modern social arrangements have some times been placed among the preconditions for economic development, as advocated in the United Nations and the first mission reports of the World Bank. This suggests the significance of a 'trickle-up effect', whereby social development would lead to economic growth. The other view is that social development is a byproduct of economic development, *i.e.* 'trickle-down effect'. This is based on the Rostovian model, where the economic growth is the impetus of passage through the various stages of development to fully modernized society. Jamal (1998) cites that researchers still suggest social development in general and basic needs in particular flow from economic development. They argue that increase in per capita income improves the

level of basic needs fulfillment. Further, casual models recommend that basic needs indicators weakly affect the economic indicators, if at all (Goldstein, 1985). Colambatto (1991) is also of the same view while Newman and Thompson (1991) claim that economic growth depends on social development but not vice versa. However, in case of Pakistan, Jamal (1998) have found that social development is a byproduct of economic growth. This finding will be assessed later.

Turning to the subject of real economic and monetary causality, numerous researchers have examined the relationship among, real, monetary and financial variables. Examples include Fama (1981, 1990), Chen *et al.* (1986), Campbell (1987), Darrat and Dickens (1999) and Maliaris and Urrutial (1991). Conventional wisdom in this regard is that stock market returns are a significant leading indicator of both monetary policy and real economic activity. Darrat and Dickens (1999), unlike Maliaris and Urrutial (1991), have found strong statistical evidence (in case of USA) consistent with the conventional wisdom. They also establish that monetary policy has no impact upon industrial production (real activity) thereby favoring real business cycle models in which real economic activity is determined without reference to monetary changes (King and Plosser, 1984; Hoover, 1988). Luintel (2002) studies the issue of exogeneity of money for four South Asian countries including Pakistan. He concludes that money in a system of price and GDP is found to be endogenous for these countries which make it difficult to use it as an instrument for output growth and controlling inflation. This work is an attempt to study this issue in the context of Pakistan with an improved methodology.

The paper makes several contributions to the literature. Firstly, unlike other studies which investigate the money-real and economic-social causality separately this study leads the way in that we have provided the empirical evidence in a single multivariate framework which improves efficiency of the tests. Lutkepohl (1982) points out that the results from bivariate causality tests are subject to omitted variable bias. Secondly, many studies rely usually on a single or a few variables to capture social, economic and monetary dimension. As each of these aspects of the economy encompasses several related dimensions we have constructed composite indicators which combine the information from many different variables each of which captures a unique aspect of development. Thirdly, the cross country studies involve uncontrollable noise in the causal relationship owing to economic, geographic, institutional and legal condition of the countries under consideration. This paper provides time series evidence in context of a developing country thus avoids such noise.

Following this introduction the paper is organized as follows: Section II describes the composite indicators to be constructed, choice of variables and the methodology of Factor Analysis using Principal Component Analysis to construct these composite indicators. In section III, the long-term economic relationship among the aforementioned activities is examined to apply the Granger Causality test. Finally, Section IV is reserved for the interpretation of the findings. Section V concludes with some policy issues.

II. CONSTRUCTION OF THE COMPOSITE INDICATORS

The composite indicators to be constructed are Social Development composite Indicator, Infrastructure Indicator, Monetary Variable Indicator and Real or Economic Development Indicator. The choice of variables for the construction of these indicators largely depends on both the scope of the study and the availability of statistics. As far as scope is concerned it has been intentionally tried to include all the economically relevant as well as rather rarely used variables from both social and economic sectors. The list of these variables is included in the appendix A. The data have been collected on annual basis from 1971-72 to 2003-04 from several sources such as various publications of the Federal Bureau of Statistics of different years and various issues of the International Financial Statistics.

To construct the above mentioned composite indicators the technique of Factor Analysis (FA) is to be used. FA is the most powerful multivariate technique for reducing the dimensions of multivariate data (Adelman and Dalton, 1971). This technique groups together all those variables which are most highly correlated with each other into a lesser number of uncorrelated factors or components. Factor analysis can be carried out by using several methods (Manly, 1996) and Principal Component Analysis (PCA) is one such methods which this paper has employed.

The main idea behind FA is that it may be possible to describe a set of p variables X_1, X_2, \dots, X_p in terms of a smaller number of indices or factors and hence explicate the relationship between these variables. The FA model is described as follows

$$X_i = a_{i1} F_1 + a_{i2} F_2 + \dots + a_{im} F_m + e_i \quad (1)$$

where,

$$e_i = a_{i(m+1)} F_{m+1} + a_{i(m+2)} F_{m+2} + \dots + a_{ip} F_p \quad (2)$$

and

X_i is the i^{th} variable ($i = j = 1, 2, \dots, p$).

F_j is the j^{th} common factor or component which is uncorrelated to each other factor and has mean zero and unit variance.

a_{ij} is called the factor loadings and its square represents the proportion of variance of X_i which is accounted for by the j^{th} factor.

$\sum a_{im}^2$ is called the *communality* and is equivalent to the multiple regression coefficient in regression analysis.

e_i is a factor specific to the i^{th} variable which is uncorrelated to the common factors and has mean zero, and

$\text{Var}(e_i)$ is called the *specificity* of X_i which is the part of the variance unrelated to the common factors.

Manly (1996) has discussed the method of constructing the model given by (1) using PCA. All that needs to be done is that the first m principal components are retained depending upon how much variation they account for in the original variables. Normally, they should explain a high amount of the total variation. The remaining small proportion of variance, *i.e.* $\text{Var}(e_i)$, can be attributed to noise factors. These retained components are then used to give FA model as stated in (1). The common factors F_j can be represented exactly as the linear combinations of the X variables using the factor loading a_{ij} to give the following relationship to compute factor scores

$$F_j = \gamma_{j1} X_1 + \gamma_{j2} X_2 + \dots + \gamma_{jp} X_p \quad (3)$$

where γ_{ji} are called the factor score coefficients.

By retaining one principal component in each respective activity the resulting factors or composite indicators are reported below. First, the social development composite indicator is given as follows

$$\begin{aligned} SDI_t = & + 0.04 X_{1t} + 0.035 X_{2t} + 0.042 X_{4t} + 0.042 X_{5t} + 0.042 X_{6t} \\ & + 0.042 X_{7t} + 0.042 X_{8t} + 0.042 X_{9t} + 0.114 X_{10t} + 0.012 X_{11t} \\ & + 0.042 X_{12t} - 0.024 X_{13t} + 0.035 X_{14t} + 0.036 X_{15t} + 0.034 X_{16t} \\ & + 0.042 X_{17t} + 0.041 X_{18t} - 0.038 X_{19t} + 0.042 X_{20t} + 0.042 X_{21t} \\ & + 0.04 X_{22t} + 0.042 X_{23t} + 0.042 X_{24t} + 0.042 X_{25t} - 0.033 X_{26t} \\ & + 0.011 X_{27t} + 0.041 X_{28t} \end{aligned} \quad (4)$$

where t stands for a particular point in time. The infrastructure development composite indicator is given as

$$\begin{aligned} NDI_t = & 0.062 X_{1t} + 0.074 X_{2t} - 0.061 X_{3t} - 0.055 X_{4t} - 0.072 X_{5t} \\ & - 0.068 X_{6t} - 0.069 X_{7t} + 0.059 X_{8t} + 0.047 X_{9t} + 0.053 X_{10t} \\ & + 0.074 X_{11t} + 0.072 X_{12t} + 0.058 X_{13t} + 0.069 X_{14t} \\ & + 0.073 X_{15t} + 0.073 X_{16t} + 0.0731 X_{17t} \end{aligned} \quad (5)$$

where N stands for 'infrastructure'. Equation for the composite indicator of monetary activity is

$$\begin{aligned}
 MI_t = & +0.137 X_{1t} + 0.151 X_{2t} + 0.149 X_{3t} + 0.037 X_{4t} \\
 & + 0.115 X_{5t} + 0.128 X_{6t} + 0.091 X_{7t} + 0.151 X_{8t} \\
 & + 0.083 X_{9t} + 0.144 X_{10t}
 \end{aligned} \quad (6)$$

The real economic development composite indicator is given by the following equation

$$RDI_t = 0.209 X_{1t} + 0.196 X_{2t} + 0.204 X_{3t} + 0.21 X_{4t} + 0.21 X_{5t} \quad (7)$$

The composite indicators given above have been constructed by using annual data from 1971-72 to 2003-04. See appendix A for definition of the variables. These four composite indices explain 84%, 80%, 65% and 94% of the total variation in their respective data sets and can, therefore, be satisfactorily used as the representative indicators of the respective activities. The computed values of these indicators from 1971 to 2003 are given in the appendix B. These values constitute a time series for each activity.

III. APPLYING THE GRANGER CAUSALITY TEST

Granger-causality tests require the time series of the respective activities to be cointegrated. A time series is said to be integrated of order d , written as $I(d)$, if, after being differenced d times, it becomes stationary. Two or more time series are said to be cointegrated if (a) all the time series are $I(d_1)$, that is, become stationary after being differenced d_1 times, and (b) there is some linear combination of these which is $I(d_2)$, $d_2 < d_1$. When this is the case, we can say that a long-run relationship between these time series exists and we can be certain that any correlation between any of these time series over time is not spurious, that may be the case when only relying on the ordinary least square regression models.

Testing for Stationarity

To test the hypothesis H_0 : time series has a unit root, *i.e.* non-stationary vs. H_1 : Time series is stationary; the test statistic generally used is the Augmented Dickey-Fuller (ADF) statistic. Using this test it is found at level that all the four time series are non-stationary at level and in fact MI_t is even not stationary at the first difference. Table 1 summarizes the values of the DF test statistic at first difference except for MI_t which is tested for stationarity at second difference. The DF test statistics show real, infrastructure and social activities are all stationary at first difference while monetary activity is stationary at second difference.

TABLE 1
Augmented Dickey Fuller Test Statistic

Variable	Level	First Difference
Real (RDI_t)	-2.91811	-2.13570**
Monetary Growth (ΔMI_t)	-1.76108	-7.30485*
Infrastructure (NDI_t)	-2.22535	-1.94052***
Social (SDI_t)	-1.61561	-3.42750**

*, ** and *** stand for significance at 1%, 5% and 10% level of significance respectively.

This in fact shows that it is growth in monetary activity that is stationary at first difference and not the level of monetary activity itself.

Granger Causality Test in VECM

The vector error correction model (VECM) is used to identify the direction of causality. The existence of cointegration cannot alone detect direction of causality. However, one can determine the direction of causality through VECM. Furthermore, the VECM can assist us in that course by discerning the econometric causality, the econometric exogeneity or endogeneity of a variable. The following sequential procedure will be adopted to identify the direction of causality.

Step 1. Johansen's multivariate cointegration test will be performed to test for the cointegration of the variables which is an efficient method as compared to applying this test for pair wise cointegration.

Step 2. The vector error correction model (VECM) will then be estimated to establish direction of causation and exogeneity or endogeneity of the variables.

Using the parametric notations of Johansen and Juselius (1990) a vector auto regression model is specified as

$$Y_t = \mu + \pi_1 y_{t-1} + \dots + \pi_k y_{t-k} + \phi X_t + \varepsilon_t \quad t = 1, 2, \dots, T \quad (8)$$

Where Y_t is a P dimensional vector of endogenous variables, X_t is a vector of exogenous variables, ε_t is the usual error term such that it is distributed normally and independently with zero mean and covariance matrix Σ ; $\pi_1, \pi_2, \dots, \pi_k$ are matrices of the parameters that contain the coefficients of the endogenous variable and μ is a vector of constants. In our case Y_t is given as

$$Y_t = [RDI_t, \Delta MI_t, NDI_t, SDI_t]' \quad (9)$$

Due to non-stationarity of all the time series considered, the VAR in (8) is expressed in first difference form. If the variables are cointegrated then the valid vector error correction models (VECMs) can be specified as

$$\Delta y_t = \mu + r_1 \Delta y_{t-1} + \dots + r_{k-1} \Delta y_{t-k+1} + \pi y_{t-k} + \phi X_t + \varepsilon_t \quad (10)$$

where

$$r_1 = -(1 - \pi_1 \dots \pi_k), \quad (i = 1, \dots, k-1)$$

$$r_1 = -(1 - \pi_1 - \pi_2 \dots \pi_k)$$

Johansen's cointegration methodology necessitates testing the rank of π to establish the number of cointegrating vectors. The following three possible cases may arise.

1. Rank (π) = 0, *i.e.* π is a null matrix; in this case, the traditional methods of regression of first difference VAR are appropriate.
2. Rank (π) = P, *i.e.* $-\pi$ is a full rank matrix; in this case, a VAR in level form is suitable.
3. Rank (π) = $r < P$, *i.e.* π is not a null matrix and the coefficients matrix can be written as $\pi = \alpha\beta$, where α and β are matrices of dimension $P \times r$ each.

The eigenvalues λ_i , ($i = 1, 2 \dots P$) of the matrix π are computed. Trace statistic is used to identify the number of cointegrating vector(s), as developed by Johansen (1988). This statistic is used in testing the hypothesis that at most r cointegrating vectors exist against the alternative hypothesis the number is more than r vectors.

Another test statistic is called λ max, which is used to test the hypothesis that at most r cointegrating vectors exist against the alternative hypothesis the number is $r + 1$ vectors. Osterwald-Lenum (1992) provides critical values of these tests.

Both of these test statistics support the hypothesis of one cointegration vector. This vector is normalized for RDI_t , and the resulting cointegration equation is given as

$$RDI_t = 6.30175 \Delta MI_t - 6.187054 NDI_t + 5.4621048 SDI_t + 0.633436 \quad (11)$$

Hence there is strong statistical evidence signifying that there exists a long-term relationship among the social, real, monetary growth and infrastructure activities. After satisfying these pre-conditions the test for the Granger causality can now be applied.

Table 2 summarizes the F test statistics for zero restrictions on the coefficients of the variables where the optimal lag structures (shown in parentheses) in the VECMs are determined by of Akaike Information Criterion (AIC) using 'specific to general' approach. The significance of the lagged error correction term (ECT) in an equation implies causality from all right-hand side variables to the corresponding left-hand side variable.

TABLE 2
Granger Causality Test in Error Correction Model

Dependent Variable	Lagged Difference Terms				ECTs
	F-statistic				
	ΔRDI_t	$\Delta^2 MI_t$	ΔNDI_t	ΔSDI_t	t-statistic
ΔRDI_t	–	2.4366(2)	4.1519(1)***	1.2551(2)	–0.7179
$\Delta^2 MI_t$	0.3038(1)	–	0.8589(2)	0.0162(1)	0.1771
ΔNDI_t	6.6971(1)**	5.2717(3)*	–	0.2973(1)	–2.5603**
ΔSDI_t	2.3290(1)	10.4752(2)*	0.0466(1)	–	–3.5422*

* stands for significance at 1% level.

** and *** show significance at 5% and 10% respectively.

Furthermore, the significance of ECT also implies economic endogeneity of the corresponding left-hand side variables in the given model and tells that the rest of the variables are exogenous and therefore not explained by the model. The significance of the F-statistic shows short-run causality flowing from the corresponding left hand side variable to the variables on the right hand side in the same row.

IV. EMPIRICAL RESULTS

The long-run relationships from the above tests can be summarized as follows:

1. Real development causes infrastructure and social development but it does not cause monetary growth.
2. Social development neither causes real economic development nor the monetary growth but it does cause infrastructure development.
3. Infrastructure development causes social development but it does not cause both real economic development and growth in monetary activity.

4. Growth in monetary activity causes social activity and also infrastructure development but not the real economic development.
5. Both real economic development and monetary growth appear to be weakly exogenous in the multivariate system. Thus they play their leading role in determining both social and physical infrastructure of the country.

In the short-run there is a bilateral causality between real economic development and infrastructure development and unilaterally monetary and financial development causes both social development and infrastructure.

These findings reveal that in the long-run the doctrine of trickle-down effect seems to be operational in the context of Pakistan as the results show that real economic development causes social development but not vice versa. This implies that social sector depends on economic development. Although increasing poverty in recent years make this conclusion weaker it must be mentioned that our composite social indicators contains many social variables which have been historically improved such as life expectancy, school enrollment rate, adult literacy, decreased infant mortality, greater access to mass communication. Thus, educational, health and mass communication sectors have improved as a result of economic development. Moreover, the cointegration rules out the possibility that the relationship is due to spurious time trend. Higher inflation resulting from increasing input and food prices and unemployment might have been the factors which hinder the full impact of economic development in enhancing the individual incomes and curtailing poverty as output grows. But the impacts are more visible when considered as providing shared public services such as education, health and mass communication.

These results indicate no casual relationship between real economic development and monetary growth which is in contrary to many other studies for developed and developing economies. For example, Luintel (2002) reports endogenously of money for the four South Asian countries including Pakistan. One of the reasons is that we have used a broad measure of monetary activity comprising several monetary and financial variables. In the long-run both real economic development and monetary and financial growth cause development in social and physical infrastructure of the country. The exogeneity of the output is reported elsewhere for example Masih and Masih (1996) in case of Indonesia reports this result. It is interesting to note that recent government's claimed economic successes are more on the monetary and financial side such as high level of foreign exchange reserves, Karachi Stock Exchange being the best performing capital market, all time high KSE-

100 index level and aggregate market capitalization, increasing number of local and foreign banks and branches, etc. The study concludes that these monetary/financial developments are unrelated to output growth and employment. However developments in both economic and monetary/financial sides have the potential to affect social sector growth and infrastructure development that are conducive to favorable investment climate and enhancement of output and employment.

V. CONCLUSION AND POLICY

The paper investigated the two most debated and controversial issues *i.e.* social-economic causality and monetary-real causality in a multivariate framework. The conclusion is that economic development leads social development. Thus the claims of the trickle-down policies of various political regimes are to some extent justified. However keeping in view increasing poverty it is probably the case that although individual incomes have not been much improved the shared services provided by the government such as education, health and mass communication have improved. Also both real economic development and monetary growth are found to be exogenous in the four sector system which makes them an instrument in improving the physical and social infrastructure for long term development. To boost individual incomes and reduce poverty greater emphasis by both government and the private sector are needed which provide employment opportunities. Policies to enhance investment climate by improving infrastructure may be one such avenue to follow. On the other hand, greater control on input and food prices by the government and anti-inflationary policies by the monetary authorities may result in the trickle down more visible to people.

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APPENDIX A

The List of Variables

Social Development

1. Per capita GNP
2. Per capita Calories per day
3. Per capita Protein per day
4. Adult literacy rate
5. Adult literacy rate (male)
6. Adult literacy rate (female)
7. Primary enrollment rate
8. Primary enrollment rate (boys)
9. Primary enrollment rate (girls)
10. Secondary enrollment rate
11. Secondary enrollment rate (boys)
12. Secondary enrollment rate (girls)
13. Infant Mortality Rate
14. Life expectancy at birth
15. Life expectancy at birth (male)
16. Life expectancy at birth (female)
17. Number of doctors
18. Number of nurses
19. Population per Hospital bed
20. Electricity consumption in household sector (000 GWH)
21. Gas consumption in household sector (billion cub. ft.)
22. Number of telephone lines
23. Number of motorcycles
24. Number of cars
25. Number of TV sets

26. Number of Radio sets
27. Newspapers and Periodicals in circulation
28. Number of crimes reported

Real or Economic Development

1. Per capita GDP
2. Unemployment Rate
3. Real Investments
4. Quantum Index of Manufacturing and Production
5. Quantum Index of Agricultural Production

Monetary Activity

1. M1
2. M2
3. M3
4. Money Market Rate
5. Foreign Exchange Reserves
6. Number of Scheduled Banks
7. Number of Bank Branches
8. Rate of inflation (CPI)
9. KSE-100 index
10. Aggregate Market Capitalization

Infrastructure Development

1. Road length in kilometers
2. Number of registered motor vehicles
3. Railway rout in kilometer
4. Railway track in kilometer
5. Number of Locomotives owned by Pakistan Railways
6. Number of Coaching Vehicles owned by Pakistan Railways
7. Number of Freight wagons owned by Pakistan Railways

APPENDIX B

Computed Indicators

YEAR	RDI_t	MI_t	NDI_t	SDI_t
1972-73	-1.4722	-1.1401	-1.3442	-1.3356
1973-74	-1.4373	-1.0340	-1.2939	-1.2605
1974-75	-1.4415	-0.9555	-1.1804	-1.1475
1975-76	-1.3149	-1.0514	-1.1902	-1.0847
1976-77	-1.2183	-0.9866	-1.1279	-0.9059
1977-78	-1.0689	-0.8049	-0.9918	-0.9386
1978-79	-0.9899	-0.8765	-0.8234	-0.9915
1979-80	-0.8852	-0.7734	-0.7602	-0.8439
1980-81	-0.7910	-0.7193	-0.8097	-0.7757
1981-82	-0.6169	-0.7371	-0.7629	-0.7237
1982-83	-0.4829	-0.6700	-0.6539	-0.6362
1983-84	-0.4056	-0.5644	-0.5914	-0.6022
1984-85	-0.2775	-0.5332	-0.5030	-0.5329
1985-86	-0.1779	-0.5436	-0.3785	-0.4841
1986-87	-0.1340	-0.5525	-0.2237	-0.3690
1987-88	-0.0090	-0.4504	-0.1325	-0.3258
1988-89	0.0142	-0.2822	0.0112	-0.1077
1989-90	0.0931	-0.1967	0.0866	0.0545
1990-91	0.4916	-0.0732	0.1646	0.1360
1991-92	0.6337	0.0432	0.3956	0.2583
1992-93	0.6180	0.2799	0.4817	0.5019
1993-94	0.6796	0.4010	0.5474	0.6471
1994-95	0.8492	0.8226	0.6798	0.7772
1995-96	0.9288	0.8306	0.7543	0.8720
1996-97	0.9926	0.9711	1.1535	1.0405
1997-98	0.9644	1.1978	1.2468	1.2224
1998-99	1.0039	1.0936	1.1964	1.3542
1999-00	1.3057	1.2189	1.3662	1.4416
2000-01	1.2523	1.3886	1.4347	1.4994
2001-02	1.3900	1.5643	1.4938	1.4130
2002-03	1.5061	1.9169	1.6138	1.5884
2003-04	1.5103	2.3588	1.6324	1.6558