

Structural Change in Demand for Cereals in Sri Lanka

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ABSTRACT. *The purpose of this paper is to assess the factors affecting the demand for rice and wheat in Sri Lanka. The analysis was done using the AIDS model. Time series data collected for the period 1970-2000 from Food Balance Sheets and Central Bank Annual Reports were used for the analysis. Results show that there is a structural change in cereal consumption and it is biased towards wheat. Results also show that own price elasticity and expenditure elasticity for rice are significant after 1977 period. Those elasticity values are significant for wheat before and after the structural change. However, cross price elasticities for rice and wheat are not significant after 1977 period, implying that rice demand is not significantly affected by the price of wheat. Therefore, it is concluded that taxing wheat so as to increase the demand for rice is an ineffective strategy to increase the income of paddy producers.*

INTRODUCTION

Since political independence, successive governments in Sri Lanka have considered the achievement of food self-sufficiency, especially in rice, as one of their major objectives. A variety of strategies have been implemented to achieve this objective and they include large scale investments in infrastructure, provision of support services, input subsidies, consumption subsidies on rice and floor prices to farmers (Ranaweera, 1998). As a result, paddy cultivation productivity and the extent under paddy cultivation increased significantly over the past five decades and, at present, Sri Lanka is nearly self sufficient in rice.

Despite the increase in domestic production of rice, a significant increase in consumption of wheat during the past few years was observed in Sri Lanka along with rice consumption. This situation is considered as a threat to the paddy market as it can lower the price of paddy, due to a decline in demand for rice. The increase in consumption of wheat is due to a number of factors. The first factor is the lower price of wheat based products due to the subsidy on wheat. Wheat has been subsidized through various measures. Until 1994, wheat prices were normally set to cover the full cost. However, the government lowered prices of wheat flour and bread in 1994 and the cost of subsidy was Rs. 5-6 billion a year in 1995 and 1996 (World Bank, 2003). Wheat imports are subject to a 5% tariff, while a 25% tariff plus a surcharge was imposed on direct imports of wheat flour in 2002 (World Bank, 2003).

The second factor affecting the demand for cereals is the changes in the economy after the implementation of open economic policies in 1977. Lifestyles of the Sri Lankan population have changed due to urbanization, working mothers, and demand

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for convenience food *etc.* As a result, among the cereals, consumers may now have a higher preference towards wheat and wheat based products, as they are easy to prepare when compared with rice. The third factor is the change in income levels and the fourth is the change in own prices that tend to be highly inelastic. These factors lead to structural change in cereal demand.

Given this context, the purpose of this study is to assess the factors affecting demand for cereals in Sri Lanka. It estimates demand for rice and wheat using the Almost Ideal Demand System (AIDS) model and assesses the importance of structural change in explaining the demand for cereals.

The paper is organized as follows. The next section provides the trends in consumption of rice and wheat in Sri Lanka. Which is followed by review of the past studies is presented next. The next two sections provide the model and data. Results are presented next and the paper ends with conclusions and policy implications.

TRENDS IN CONSUMPTION OF RICE AND WHEAT

Rice still remains as the staple food and the major calorie and protein source for both rich and poor in Sri Lanka. Consumption of rice was influenced by successive governments since independence through various policies. The universal rice-rationing scheme was initiated in 1942 to ensure equitable distribution of available food resources. The amount of rice ration and the nominal price of a unit of rationed rice were changed alternatively during its implementation. The income tax payers were excluded from the ration scheme in 1972 due to the high fiscal burden to the government. In late 1979 a food stamp scheme was introduced. The scheme provided food stamps with a fixed nominal value. The food stamp scheme was replaced by the *Janasaviya* program in 1989 where beneficiaries were provided food along with the assistance to improve their skills. In 1994 the *Samurdhi* program was initiated with some modifications to the existing program (Ratnayake, 1998).

Consumption needs of rice in Sri Lanka were met through local production as well as through imports. Figure 1 shows the trends in per capita availability of rice and wheat during 1970-2000 period a gradual reduction in rice imports. However, there was a gradual reductions in rice imports over the same period (Figure 2).

As illustrated in figure 3 the real price of rice has decreased over the years with an increase in the level of production during the same period. Similarly, the real price of wheat also has decreased over the period of 1974-2000

The fact, provided by these figures does not provide any causality between changes of prices of rice and wheat on changes in consumption of rice and wheat over the period of 1977-2000. Therefore an econometric analysis is necessary to find out the extent to which rice and wheat consumption is affected by prices, income levels and structural change. The following section presents some studies, which were conducted in the past on this issue.

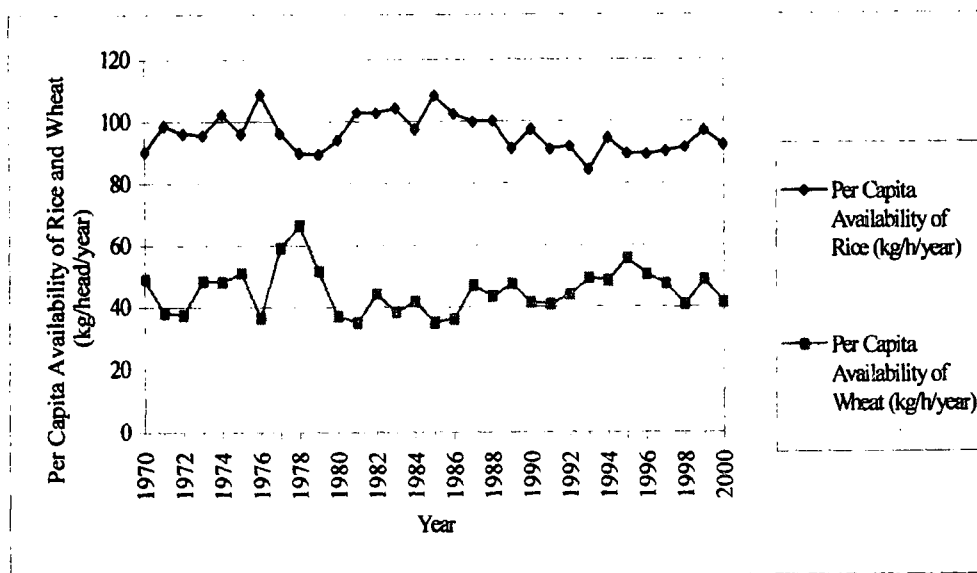


Fig. 1. Trends in per capita availability of rice and wheat
 Source: Food Balance Sheets, Various years.

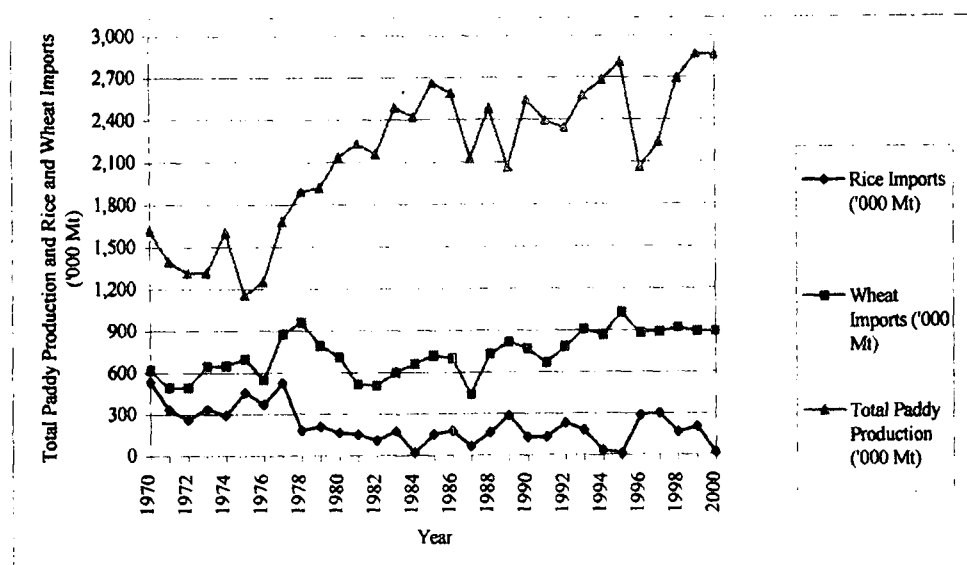


Fig. 2. Trends in total paddy production and rice and wheat imports.
 Source: FAO, Food Balance Sheets, Various years.

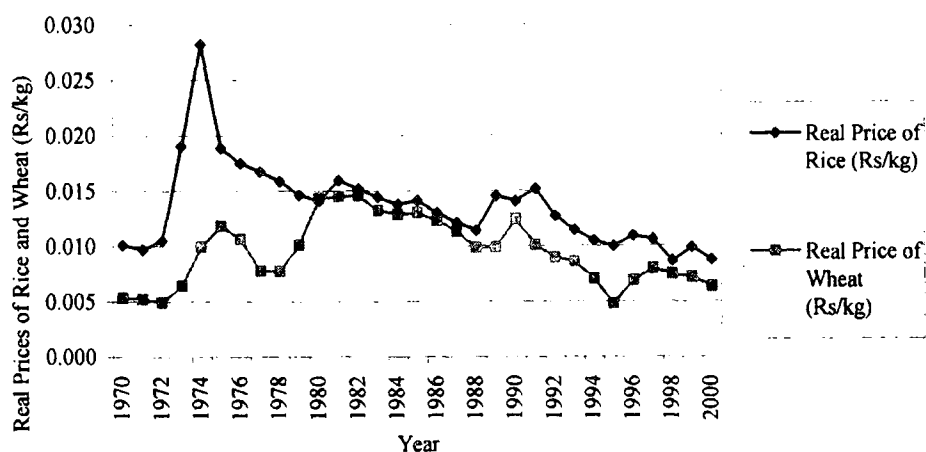


Fig. 3. Trends in real prices of rice and wheat.

Source: Central Bank, Various years.

PAST STUDIES

A number of authors attempted to econometrically estimate the demand for different food items including rice and wheat in Sri Lanka. Jogaratnam and Poleman (1969) estimated expenditure elasticities for twelve food categories using semi-log functional form. Data on expenditure and consumption obtained from Consumer Finance survey in 1963 were used for the analysis. Results revealed that the demand for non-starchy food increases with an increase in levels of income.

Alderman and Timmer (1980) estimated price and expenditure elasticities for eight major food commodities for three expenditure groups. The analysis was conducted using a double log quadratic functional form. Data on consumption and expenditure during 1969-1970 were used for the analysis. The results revealed that although expenditure elasticity for wheat is constant with a rise in income levels, it decreases for rice with an increase in income.

Bogahawatte and Kailasapathy (1986) estimated price and expenditure elasticities for protein and calorie sources using a quadratic form. They have used time series data on expenditure and consumption from 1965 to 1980. The results indicated that the consumers were more responsive to changes in the price of rice than that of wheat.

Nigel and Bogahawatte (1990) estimated a demand system for food types using cross sectional data from urban, rural and estate sectors in Badulla district during 1987/1988. They have used the linear version of the Almost Ideal Demand System (AIDS) to estimate price and expenditure elasticities. The results revealed that the consumers considered the cereals other than rice and wheat as inferior commodities.

Thudawe (2002) estimated food demand parameters using the linear version of the Almost Ideal Demand System (AIDS) for eleven food groups. In addition to prices and expenditure/income, household characteristics were also included in the model. In order to find out the trend in changes in elasticities between 1990/91 and 1995/96 periods, a two-sample *t* test was performed. Data used in this study was from the Household Income and Expenditure Surveys conducted in 1990/91 and 1995/96. The results revealed that the responses for changes in prices and income are different among high, middle and low-income groups and in urban and rural sectors for different food items. Further, a comparison of the coefficients for rice between each income group and each sector in the two study periods showed that, except for the high-income groups, for all the other categories the coefficients for 1990/91 were significantly different from these for 1995/96. Furthermore, the study showed that expenditure/income is more important in increasing rural consumption of rice whereas in the urban sector lower prices are more effective in enhancing household rice consumption.

The evidence on elasticities from these studies are mixed due to differences in methodologies and the data used, even though all of them addressed the impact of prices and level of income on the change in demand for rice and wheat. Studies reported above however, do not explicitly address the impact of structural change on demand for cereals in Sri Lanka, though similar studies have been conducted elsewhere.

Huang and Bouis (1996) assessed the importance of structural change on pattern of consumption in Taiwan and China using the linear version of the AIDS model and found that structural factors accounted for 73 percent of the decline in rice consumption between 1981 and 1991. Moschini and Meilke (1989) used the AIDS model with an additional structural change parameter to capture the variations in demand for meat before and after structural change. The present study uses a linear version of the AIDS following Moschini and Meilke (1989) to assess the structural change in cereal demand in Sri Lanka.

MODEL

In order to find out the factors affecting demand for cereals and to assess the importance of structural change, the analysis was performed using the linear version of the AIDS (Deaton and Muellbauer, 1980 and Moschini and Meilke, 1989). This model differs from the model used by Thudawe (2002), who also made an attempt to model structural change, as it incorporates an additional time path in order to find out changes in the parameters to be estimated before and after structural change. The model uses time series data and hence it can allow all the parameters of the model to change over time.

The linearity of the AIDS model is an attractive feature for the econometric analysis of structural change. The demand system includes only two commodities, rice and wheat to represent the two major cereals used in the Sri Lankan diets, as the consumption of other cereals such as maize and millet in Sri Lankan diets is negligible. Furthermore, data on prices and demand on other cereals is limited.

It was implicitly assumed that the utility of cereal consumption is weakly separable from the utility derived from other commodities. The algebraic form of AIDS

is presented below (Deaton and Muellbauer, 1980). The AIDS in budget form is expressed as:

$$w_i = a_i + c_i \cdot \ln(E/\bar{P}) + b_{1i} \cdot \ln P_{1i} + b_{2i} \cdot \ln P_{2i} + g_i \cdot t + \varepsilon_i \quad (1)$$

where w_i is the budget share of the i^{th} commodity, E is total consumption expenditure on rice and wheat, P_i is the price of i^{th} commodity, t is the trend variable, ε_i is the stochastic error term and \bar{P} is the price index defined by

$$\ln \bar{P} = a_0 + \sum_k a_k \cdot \ln P_k + 0.5 \sum_k \sum_j b_{jk} \cdot \ln P_k \cdot \ln P_j, \quad (2)$$

Deaton and Muellbauer (1980) suggest approximating the price index \bar{P} by the Stone geometric price index, as shown below.

$$\ln \bar{P} = \sum_i w_i \cdot \ln P_i \quad (2')$$

The adding up restrictions for the demand system requires,

$$\sum_i a_i = 1, \quad \sum_i c_i = 0, \quad \sum_i b_{ij} = 0, \quad \text{and} \quad \sum_i g_i = 0. \quad (3.1)$$

$$\text{The homogeneity restriction is } \sum_j b_{ij} = 0, \quad (3.2)$$

and the cross-equation symmetry restrictions can be imposed as

$$b_{ij} = b_{ji} \text{ for } i \neq j \quad (3.3)$$

Under the hypothesis of no structural change the set of parameters in equation (1) gives a full representation of underlying utility maximization process. In this analysis the time path d_t was used to represent the 1978-2000 period in order to capture the structural variations that occurred after introducing open economic policies to Sri Lanka. Structural change can be characterized by allowing those set of parameters to change over time. Given the cross equation restrictions in (3.1), (3.2) and (3.3) structural change is likely to affect all equations simultaneously, so that a common time path for all parameters can be assumed (Moschini and Meilke, 1989). If this path is given by d_t , equation (1) can be reparameterized as,

$$w_i = a_i + \gamma_i d_{1t} + (c_i + \delta_i d_{1t}) \cdot \ln(E/\bar{P}) + (b_{1i} + \delta_{1i} d_{1t}) \cdot \ln P_{1i} \\ + (b_{2i} + \delta_{2i} d_{1t}) \cdot \ln P_{2i} + (g_i + \delta_{it} d_{1t}) \cdot t + \varepsilon_i \quad (1)$$

with the properties of homogeneity, adding up, and symmetry requiring the following additional parametric restrictions:

$$\sum_i \gamma_i = 0, \quad \sum_i \delta_i = 0, \quad \sum_i \delta_{ij} = 0, \quad \text{and} \quad \sum_i \delta_{ii} = 0 \quad (3.1')$$

$$\sum_j \delta_{ij} = 0 \quad (3.2')$$

$$\delta_{ij} = \delta_{ji} \quad (3.3')$$

and $a_i, c_i, b_{ij}, g_i, \gamma_i, \delta_i, \delta_j$, and δ_{ii} are the parameters to be estimated.

This system has two equations to be estimated. However, due to theoretical restrictions it is sufficient to estimate only one equation and other parameters can be calculated using theoretical restrictions. In this study expenditure share for rice was estimated and parameters of the wheat equation were calculated using theoretical restrictions given in (3.1'), (3.2') and (3.3').

In this study, bias in terms of the expenditure share on rice and wheat was measured in order to illustrate effects of structural change on quantity demanded of rice and wheat while prices and expenditure were held constant. The measure of bias is

$$B_i = w_i^a - w_i^b \quad (4)$$

where, w_i^a is the i^{th} commodity share after structural change and w_i^b is the same commodity share before structural change. When the expenditure shares are evaluated at the sample mean of the exogenous variables (such that $P_i = 0$, $(E/P) = 0$ and $t=1$) this measure can be reduced to

$$B_i = \gamma_i + \delta_{it}(d_i) \quad (4')$$

Structural change will be biased against the i^{th} commodity if it resulted in a lower demand for this good, which would be implied by $B_i < 0$. Conversely, $B_i > 0$ implies that structural change is biased in favour of the i^{th} commodity.

The expenditure (η_{ix}), own price (η_{ii}), and cross price (η_{ij}) elasticity values are derived as follows.

$$\eta_{ii} = (b_{ii} + \delta_{ij})/w_i - (c_i + \delta_i) - 1 \quad (5.1)$$

$$\eta_{ij} = (b_{ij} + \delta_{ij})/w_i - (c_i + \delta_i) * (w_j/w_i) \quad (5.2)$$

$$\eta_{ix} = (c_i + \delta_i)/w_i + 1 \quad (5.3)$$

If d_i equals to zero, γ and δ too become zero and it gives the demand elasticity values for 1970-1977 period or before structural change, and hence two sets of demand elasticities were calculated, i.e. before and after 1977 period. The parameters were estimated using the two stage Least Square Estimation procedures in TSP version 4.4 (TSP International, 1997).

DATA

Time series data on per capita availability and prices of rice and wheat, GNP and population were gathered for the period 1970-2000. In addition, data on the rice ration including the amount of ration per person and nominal price of rationed rice were also gathered (Annex). Per capita availability of rice and wheat was obtained from the Food Balance Sheets published by the Food and Agricultural Organization of the United Nations. Retail prices of rice and wheat were obtained from Statistical Abstracts published by the Central Bank of Sri Lanka. Data on population, GNP and consumer price index were obtained from the annual reports published by the Central Bank of Sri Lanka. Nominal per capita GNP and nominal prices were deflated using the consumer price index in order to obtain the real income and prices. Estimation of the equation (1') for rice was performed using weighted prices of rice for the 1970-1977 period in order to incorporate the effects of the rice ration scheme on the price of rice that prevailed during this period². Furthermore, it was assumed that per capita availability of rice and wheat was equal to per capita consumption of rice and wheat.

RESULTS AND DISCUSSION

The analysis was performed using the AIDS model in order to find out the factors affecting the demand for rice and wheat. In order to illustrate the effect of structural change on consumption patterns of rice and wheat, a bias parameter was estimated using

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the parameters obtained from the AIDS model (Table 1). The bias parameter provides the effects of structural change on quantity demand of rice and wheat while prices and expenditure remained constant. As indicated earlier, the difference between the expenditure shares of rice and wheat before and after structural change provides the bias and if it is greater than zero it can be concluded that structural change is biased in favour of rice or wheat. If the bias is less than zero, it implies that structural change is biased against the commodity considered. According to the calculations, the bias for rice and wheat are negative and positive respectively. This shows that structural change is biased against rice and in favour of wheat.

Although the own price elasticity for rice before structural change (evaluated at 1974) is not significant, it is negative and significant after the structural change (evaluated at 1989) at 5% significant level (Table 2). These results indicate that rice consumption became price sensitive only after the structural change. However, own price elasticities for wheat before and after structural change are significant at 5% significant level and show the expected negative signs. These results show that when own price of wheat increases the reduction in demand for wheat is significant during both periods. Furthermore, the own price elasticity values for rice and wheat after the structural change show that wheat is more price responsive.

Table 1. Parameters estimated in the AIDS model.

Independent Variable		Rice	Wheat
Intercept	$d_t = 0$	6.5945*	-5.5945*
	$d_t = 1$	(2.8231)	(2.8231)
Price of rice	$d_t = 0$	-4.3999	4.3999
	$d_t = 1$	(2.9961)	(2.9961)
Price of wheat	$d_t = 0$	0.1353*	-0.1353*
	$d_t = 1$	(0.0728)	(0.0728)
Price of wheat	$d_t = 0$	-0.0554	0.0554
	$d_t = 1$	(0.0913)	(0.0913)
Expenditure	$d_t = 0$	-0.1353*	0.1353*
	$d_t = 1$	(0.0000)	(0.0000)
Expenditure	$d_t = 0$	0.0554	-0.0554
	$d_t = 1$	(0.0000)	(0.0000)
Trend	$d_t = 0$	-1.2055	1.2055
	$d_t = 1$	(0.5769)	(0.5769)
Trend	$d_t = 0$	0.9025*	-0.9025*
	$d_t = 1$	(0.6111)	(0.6111)
Trend	$d_t = 0$	0.0168	-0.0168
	$d_t = 1$	(0.0106)	(0.0106)
Trend	$d_t = 0$	-0.0164	0.0164
	$d_t = 1$	(0.0108)	(0.0108)

Standard errors are in parenthesis *Significant at 10% level

Table 2. Elasticities estimated in the AIDS model evaluated before (evaluated in 1974) and after (evaluated in 1989) the structural change.

Elasticity	Period	Rice	Wheat
Own price	Before	0.3700 (0.5592)	-2.9695** (0.6098)
	After	-0.5888** (0.2165)	-1.6091** (0.2955)
Cross price	Before	-0.1645* (0.0885)	-0.7639* (0.4113)
	After	-0.1081 (0.0745)	-0.3061 (0.2111)
Expenditure	Before	-0.4651 (0.7012)	2.7103* (1.1362)
	After	0.5898** (0.2724)	2.1610** (0.7713)

Standard errors are in parenthesis **Significant at 5% level *Significant at 10% level

The cross price elasticities for rice and wheat before the structural change are negative and statistically significant at 10% significant level. However this result is not consistent with previous findings (Bogahawatte and Kailasapathy, 1986). However, those values are not significant after the structural change. These results show that there is no effect of price of wheat on the demand for rice and vice versa after the structural change.

Though the expenditure elasticity estimated for rice before structural change is not statistically significant, it is positive and significant at 5% significant level after the structural change. Those elasticities estimated for wheat are positive and significant before and after the structural change implying that both rice and wheat are normal goods.

CONCLUSIONS AND POLICY IMPLICATIONS

According to the results of the AIDS model, the demand for rice has declined while the demand for wheat has increased after the structural change, *i.e.* during 1978-2000 period. These imply that the consumers are moving away from rice towards wheat after the structural change.

The elasticity estimates show that the cross price elasticities for rice and wheat are not statistically significant after the structural change indicating that there is no effect of price of wheat on demand of rice and *vice versa* after 1977 period. The own price elasticities of both rice and wheat are statistically significant after 1977. Hence it can be concluded that the changes in demand levels in rice and wheat are not due to the cross price effects but either due to the structural change or own price effects specially after 1977 period. Therefore taxation or removal of subsidy on wheat may not help to

increase the demand for rice. Since, rice is a normal good an increase in income through income transfer programs may help to increase the demand for rice in Sri Lanka.

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ANNEX

Table 1.1. Time series data used for the analysis.

Year	Per Capita Availability of Rice* (kg/h/year)	Per Capita Availability of Wheat* (kg/h/year)	Retail Price of Rice** (Rs./kg)	Retail Price of Wheat** (Rs./kg)	Per Capita GNP** (Rs.)	Population** (Million)	CCPI** (1952=100)
1970	90.21	48.96	1.38	0.73	1,018	10,168	136.6
1971	98.56	38.06	1.35	0.73	1,008	10,443	139.1
1972	96.11	37.45	1.55	0.73	1,091	10,582	147.5
1973	95.65	48.36	3.16	1.07	1,282	10,903	166.2
1974	102.21	48.10	5.35	1.89	1,617	11,164	189.7
1975	96.00	51.00	3.85	2.42	1,750	11,439	204.3
1976	108.78	36.43	3.53	2.15	1,888	11,703	202.1
1977	96.14	59.10	3.40	1.58	2,242	11,992	203.3
1978	89.74	66.51	3.76	1.84	2,752	12,252	237.5
1979	89.32	51.55	3.84	2.66	3,613	12,514	263.3
1980	94.01	36.89	4.78	4.85	4,559	12,690	339.7
1981	102.89	34.96	6.35	5.77	5,694	12,861	399.6
1982	102.53	44.13	6.80	6.53	6,598	13,091	450.4
1983	104.31	38.33	7.28	6.68	7,847	13,284	506.3
1984	97.42	41.67	8.21	7.67	9,572	13,496	598.0
1985	108.24	34.99	8.42	7.77	10,207	13,717	598.4
1986	102.48	36.04	8.32	7.88	11,082	13,942	641.6
1987	99.86	46.94	8.43	7.88	11,964	14,190	697.0
1988	100.25	43.35	9.12	7.88	13,340	14,472	802.0
1989	91.22	47.37	12.82	8.72	14,862	14,747	884.6
1990	97.43	41.36	15.28	13.48	18,772	14,847	1,090.9
1991	91.03	40.74	18.49	12.31	21,385	15,196	1,220.3
1992	91.83	43.85	17.31	12.21	24,349	15,417	1,366.0
1993	84.36	49.26	17.38	13.00	28,314	15,603	1,519.4
1994	94.59	48.50	17.29	11.60	32,169	15,842	1,654.1
1995	89.54	55.62	17.66	8.50	36,339	16,127	1,768.1
1996	89.34	50.49	22.93	14.53	41,301	16,373	2,107.6
1997	90.21	47.29	24.73	18.63	47,433	16,599	2,336.9
1998	91.59	40.64	22.39	19.34	53,038	16,825	2,592.1
1999	96.89	48.88	26.60	19.35	56,827	17,015	2,695.4
2000	92.30	41.30	24.61	17.80	63,748	17,767	2,815.8

Source: *FAO, Various years and **Central Bank, Various years.

Table 1.2. Nominal Price and the amount of rice ration: 1970-1979 period.

Year	Amount of rice ration (Measures ^a)	Nominal Price of rationed rice (Rs./ Measure)
1970	2	0.75
1971	2	1
1972	2	1
1973	1.75	1.5
1974	1	2.25
1975	1	2.1
1976	1	2
1977	2	2
1978	2	2
1979	2	2

^a 1 Measure = 2 lbs

Source: Sanderatne, 2002.