Pakistan J. Agric. Res. Vol 22 No1-2, 2009.

FOOD AUTARKY THROUGH SUBSTITUTION BETWEEN RICE AND WHEAT: AN ECONOMETRIC ANALYSIS

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ABSTRACT: Wheat autarky has been an elusive goal for Pakistan since independence. The shortage in domestic production is met through imports for which valuable foreign exchange has to be earmarked. On the other hand, Pakistan has been a sizeable net exporter of rice. An effort has been made in the present paper to probe the possibility of attaining food autarky through a partial substitution of wheat with rice in the consumption plan of consumers. The study reveals that rice is a substitute food commodity for wheat and may be promoted as such. Since level of significance is small, it may need sustained promotional efforts and appropriate policy measures on the part of the state. Moreover, wheat being a staple diet of people for centuries, switching over to rice may happen only over a long period of time.

Key Words: Rice; Wheat; Food Autarky; Substitution; Staple Diet; Nutrition Transition; Convenience Food; Bio-fuels; Economic Analysis; Pakistan.

INTRODUCTION

Pakistan is a minor producer of rice, accounting for only 1.2% of total world production, it has however emerged as a leading exporter of rice. Pakistan is the 5th largest exporter of rice after Thailand, Vietnam, India and the USA, accounting for 8.5% of total world exports. The earlier four account for 70% of total world exports. The curious paradox of being a small producer and a large exporter at the international level, may be explained by the fact that rice is not a staple diet for an overwhelming majority of Pakistanis. For most of the population, it is a secondary food item or a supplementary diet used mostly on week-ends. This is particularly true after the exit of East Pakistan. Rice was a staple diet for the population of East Pakistan who formed majority in the united Pakistan. The 'new' Pakistan has been importing wheat in substantial quantities barring some isolated years of surplus production. This obliged it to allocate valuable foreign exchange for wheat imports. The self sufficiency in food, therefore, remained an elusive goal for the country.

Aslam (1982) by using time series data (1968-1978) and computing price, cross and income elasticities of demand had found that at the level of Punjab at least rice was a substitute for wheat. Income level was the strongest determinant of per capita consumption of rice.

IIASA (2008) probes the possibility of the diet change, based on the present trends of economic growth in China and predicted that Chinese diet would become more diversified and may include more animal products and foods with high sugar content such as milk, beverages, ice cream and cakes. In case China confronts economic crises and reverts back to the old 'commune' system in agriculture, there is a high probability that there might be a change back to the staple diets of rice, wheat and tubers which were the hallmark of 1950s and 1960s. By estimating elasticity of meat consumption, it was predicted that consumption of meat would increase with growth in incomes and urbanization.

The climatic changes through pushing up food prices may induce changes in staple diets (Lavelle, 2008) who mentioned that apart from erratic weather resulting in floods, storms and droughts, sharp increase in oil price - a major input in production and transportation of food – land scarcity, as more and more land is being allocated to biofuels in developed countries, rising Chinese demand for food, are other

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important factors of pushing food prices upward.

Monteiro (2006) studied the so-called 'diet transition' in the developing world using time series data during 1961 - 2001. According to his findings, the contribution of staple diets to the total energy provided by food in the developing world as a whole, declined by 10.3 %. The greatest change took place in China where the contribution of staple foods declined 26.3 % points. In South Asia the decline was relatively modest- a decline of 9.3 % points. Staple diets were generally replaced by vegetable oils, sugar, meat, fruits and vegetables.

Malik and Ding (2008) reported traditional Chinese dietary patterns are being increasingly modified as more quantity of western products such as sugar sweetened beverages and fast food is being consumed particularly by people of high socioeconomic status. In 1840s under occupation of Britain, the majority of its population was forced to rely on one food source i.e. potato, that caused the death of one million people in the Great Famine of 1840s (Cheat House.com, 2002). The paper thus implicitly underlines the importance of diversity in dietary habits of people.

Among Central Americans and Mexicans, 'nutrition transition' that has taken place during the last few decades of the 20th century under impact of globalization and urbanization. Major change has been in the direction of increased use of animal products and processed food. (www.faqs.org 2008)

Cristina and Grace (2004) also refer to the 'nutrition transition' that has taken place in Asia under impact of economic growth and westernization. This has manifested in a 'shift away from traditional Asian diets to a more varied diet higher in sugar, fats and processed food.'

In the 19th century Western Europe, starchy staples figured prominently but with growth of per capita GNP and expansion of real wages, both the number of starchy staple calories consumed and their proportion of the total have declined (Grigg, 1996). The starchy staples were replaced by livestock products and the plant foods.

In South Africa and China, the demand for processed potatoes is on the increase (FAO, 2008). There is thus need for balanced diet that should include vegetables and whole grain foods.

Prior to early 20th century, sorghum was staple diet of black South Africans, but then gradually it was replaced with maize. This had a negative aspect too. The use of beer produced by fermenting maize is also held responsible for higher incidence of esophagus cancer in black males (Isaacson, 2004).

The changes in staple diets have taken place in the past; it is also an ongoing process due to many compulsive factors and the so-called 'nutrition transition' will continue in future as well.

The objective of this study is to explore the possibility of substituting rice, at least partially, for wheat in consumption plan of consumers to achieve the coveted goal of food autarky. There are many studies on production and export aspects of the rice economy of Pakistan but its consumption aspect largely remains unexplored. The present study is therefore expected to fill this gap.

The consumption demand for rice at present, forms more than half of the production of rice (between 2000-01 and 2004-05, rice consumption was on average 52% of the rice production). Can rice consumption be further promoted to partially replace wheat and to achieve combined food autarky of wheat and rice? This sounds a very interesting proposition. Of course it is not going to be an easy task. The weaning away of people from wheat and to persuade them to consume rice instead requires changing food habits of people formed over centuries. This possibility, however remote it may look, is worth probing, careful examination and study.

MATERIALS AND METHODS

To explore the possibility of substituting wheat with rice in Pakistan, a rice demand model has been used.

According to economic theory, indi-

vidual demand of a product is influenced by price of the product, prices of alternative products, income of consumers and their tastes and preferences. In case aggregate demand is being studied, then two additional variables namely size of population and income distribution may also be incorporated. The resultant demand function may then be written as follows:

$Q_d = f(P_p, P_1 \text{———} P_n, Y, N, T, G)$

Where

Q_d = quantity demanded

P_p = prices of the product

$P_{1-\ -}P_n$ = price of other commodities

Y = per capita income

N = number of people (population)

T = tastes and preferences

G = distribution of income

For consumption demand model for rice, the above generalized form of model may be adjusted as follows.

$Q_{drl} = f(P_r, P_w, P_r/P_w, Y, X, Prod, Pop,)$

where,

Q_{drl} = per capita consumption demand for rice

P_r = price of rice

P_w = price of wheat

P_r/P_w = ratio of rice and wheat prices

Y = per capita income

X = exports

Prod = production

Pop = population

The age, composition and income distribution of the population are also relevant explanatory variables but lack of data hindered their incorporation. The tastes and preferences of consumers, although a relevant predictor, were also ignored due to quantification problem. A trend variable (T) may however be substituted for variables which are either difficult to quantify or for which reliable data is not available.

The main objective of the study outlined above is realized through estimation of price and income elasticities of demand for rice and also cross price elasticity of demand between wheat and rice.

Data pertaining to variables incorporated in the models is collected from secondary sources. Main reliance is placed on government publications such as Agricultural Statistics of Pakistan, Pakistan Economic Surveys and Pakistan Statistical Yearbooks. The net availability of rice available for domestic consumption is estimated through indirect method i.e. by deducting exports and a 6% allowance for seed, feed and wastages from total yearly production of all types of rice (Planning and Development Division, Nutrition Cell). Per capita availability of rice was estimated by dividing total net availabilities with population of the respective years. The price of rice was taken as yearly average retail price of the basmati rice (broken). The price of wheat taken was yearly average retail price of average quality wheat flour. The prices taken were average of 12 centres across the country. The export quantities of rice has been incorporated as an explanatory variable as these showed sizable yearly fluctuations depending upon world demand for rice. As rice availability in the domestic market is a residual quantity after exports are deducted from production, inclusion of exports as a predictor seemed justified. Moreover, as agricultural production in general is highly vulnerable to weather conditions and domestic availability of rice is equal to the difference between production and exports, its inclusion as an explanatory variable seemed logical. The inclusion of population as an explanatory variable seems even more appropriate than price of rice itself. As rice is not staple diet and is generally consumed in measured quantity, price of rice may turn relatively of lesser importance. Under the circumstances, size of population becomes an explanatory variable of much greater impact.

Regression technique was used for estimation of the model. The 'Minitab' statistical computer package was pressed into service for estimation of the model equations. The model was estimated in linear form. The data pertains to the period 1990-91 to 2004-05 (Table 1).

RESULTS AND DISCUSSION

Model 1

In this model, predictor variables of price of rice, price of wheat, population, exports, and production were regressed

against dependent variable of per capita net availability of rice and obtained the following equation:

Q_{drl} = 4.08 - 0.40 P_r + 0.09 P_w –0.01Pop
(0.76) (-2.06) (0.46) (-0.20)
-0.008 X + 0.008 Prod
(-20.35) (23.40) **R^2= 99.2 %**

The predictive value of the model is very strong as 99.2 % of the changes in the dependent variable (Qdrl) are explained by predictor variables included in the model. The coefficient of price of rice carries a negative sign which is according to the economic theory but is not statistically very significant. The coefficient of wheat carries a positive sign which makes it a substitute commodity of rice but is insignificant. The coefficient of population does carry the desired negative sign establishing inverse relation between the population and per capita consumption (availability) of rice. It is however highly insignificant. The coefficient of exports carries the desired negative sign and is also highly significant. The same is true of the production variable which carries a desired positive sign and is also highly significant.

Model 2

The second model was estimated without population variable that was found to be highly insignificant.

Q_{drl} = 3.01 – 0.42 P_r + 0.08 P_w – 0.007X
(4.59) (-3.46) (0.45) (-21.42)
+ 0.007 Prod
(27.59) **R^2 = 99.2 %**

Quite obviously, discarding the population variable did not at all influence the predictive power of the remaining explanatory variables which is still very strong at 99.2 %. The significance level of the coefficient of price of rice variable has improved. It also carries the desired negative sign. The coefficient of price of wheat variable carries positive sign alluding to its substitutability although its significance level is almost negligible. The coefficients of both exports and production in addition to having desirable signs in accord with the economic theory continue to remain highly significant.

Model 3

In the third model, instead of using price of rice and price of wheat as separate variables, price ratio of rice and wheat was used as an explanatory variable. This gave us the following equation.

Q_{drl} = 17.1 – 1.5 P_r/P_w-0.11 Pop
(7.23) (-1.39) (-8.63)
- 0.008 X + 0.007 Prod
(-18.41) (25.57) **R^2 = 99.0 %**

Table 1. Data used for estimation of rice demand models (1990/91-2004/05)

Qdr	Qdrl	Pr	Pw	PrPw	Y	Pop	X	Prd
1860	16.35	6.10	3.66	1.67	4003	112.61	1205	3261
1536	13.09	6.97	4.20	1.66	4137	115.54	1512	3243
1897	15.70	8.06	4.44	1.81	4273	118.50	1032	3116
2771	22.26	8.77	4.93	1.78	4328	121.48	984	3995
1388	11.49	9.09	5.78	1.57	4458	124.49	1852	3447
2043	15.52	11.27	5.90	1.91	4588	127.51	1685	3966
2280	16.85	12.85	7.37	1.74	4535	130.56	1767	4305
1982	15.07	13.40	8.64	1.55	4575	133.48	2091	4325
2663	19.80	14.50	8.35	1.74	4662	136.69	1789	4674
2857	20.78	15.71	8.92	1.76	4719	139.76	1990	5156
2227	15.85	15.35	9.80	1.57	4719	142.86	2294	4810
2004	13.97	15.49	9.67	1.60	4866	145.96	1645	3882
2560	17.24	18.07	10.14	1.78	5162	149.03	1684	4479
2585	17.38	19.04	11.71	1.62	5317	150.47	1972	4848
2532	16.50	20.19	13.28	1.52	5615	153.96	2168	5000

Source: 1) Pakistan Economic Survey (1995, 2000, 2005).
2) Pakistan Statistical Yearbook (1996, 2001, 2006).

The predictive power of the explanatory variables included in the model remains very strong at 99 %. The coefficient of rice-wheat price ratio variable carries negative sign confirming again an indirect and negative relationship between rice price and per capita consumption of rice and direct and positive relation between price of wheat and per capita consumption of rice. The price ratio variable is however not very significant. The variables of exports and production in addition to having theoretically desirable signs remain highly significant. The population variable carries the required negative sign and unlike the first model, also emerges as highly significant.

Model 4

In this fourth model, population variable was replaced with per capita real GNP variable with the following results.

$$Q_{drl} = 16.5 - 1.19\ P_r/P_w - 0.0027\ Y$$
$$(6.28)\quad (-0.99)\qquad (-7.53)$$
$$- 0.0082\ X + 0.0069\ Prod$$
$$(-16.87)\quad (23.63)\qquad \mathbf{R^2 = 98.7\ \%}$$

The income variable carries a negative sign showing an inverse relationship between income and per capita consumption of rice. This is an interesting derivation. If rice is an inferior substitute or if consumers think it so, compared to staple diet wheat, then an increase in income may result in substitution of rice with wheat. The coefficient of income variable is also statistically significant. The exports and production variables are statistically significant and have the desired signs too i.e. within the framework of economic theory. The price ratio variable carries negative sign as before but is not significant as in previous model. The predictive power of the model is very strong at 98.7%.

Model 5

In this model, both population and per capita income were incorporated as explanatory variables in addition to price ratio, exports and production with the following results.

$$Q_{drl} = 17.6 - 1.51\ P_r/P_w - 0.0013\ Y$$
$$(8.85)\quad (1.68)\qquad (-2.31)$$
$$- 0.066\ Pop - 0.008\ X + 0.007\ Prod$$
$$(-3.02)\qquad (-22.15)\quad (30.19)$$
$$\mathbf{R^2 = 99.4\ \%}$$

The predictive power of the model enhances to 99.4 %. The coefficient of the price ratio variable carries, as before, a negative sign but its significance level remained low. The income variable carries negative sign as previously. This means per capita consumption of rice decreases as income rises. This once again points out substitution of rice with perhaps wheat which is a staple diet and an indispensable component of daily food of the people. The population variable is negatively linked to per capita consumption of rice. This also implies that rate of increase in total availability of rice is outpaced by more rapidly increasing population. The coefficient of population variable is also statistically significant. The production and export variables carry desirable signs and are also statistically significant.

Price elasticity of rice and cross price elasticity between wheat and rice were measured from model 3 equation with the following results.

Rice (own) Price Elasticity of Demand = 0.73
Cross Price Elasticity of Demand between Wheat and Rice = 0.45

Income elasticity of demand for rice was estimated from model 4 equation with the following result.

Income Elasticity of Demand for Rice = 0.02

Rice price elasticity of demand at 0.73 is less than one or unity. It means that a unit change in the price of rice brings 0.73 change in per capita consumption demand of rice. It shows that rice demand does respond to changes in the price of rice.

Cross price elasticity of demand between wheat and rice is estimated at 0.45. This implies that a unit change in the price of rice brings 0.45 change in the demand for wheat. Though wheat has emerged as a substitute commodity for rice but the extent or the degree of substitution is small.

Income elasticity of demand at 0.02 is quite small but still it shows that per capita

consumption of rice is positively related to per capita income and that consumption of rice will slowly but surely increase with the increase in per capita GDP.

The conclusions of the study are as follows:

The predictor variables incorporated into the rice demand models such as price of rice ($P_{r)}$, price of wheat ($P_{w)}$, exports (X), production (Prod), population (Pop) and income (Y) proved their justification for selection as these together adequately explained variations in per capita consumption demand for rice.

Rice price does influence the per capita consumption of rice in line with economic theory. The policy implication is that price of rice may be manipulated, to some extent, to increase rice consumption.

The wheat price coefficient carries a positive sign which makes it a substitute commodity of rice, opening way for substitution of wheat with rice in the consumption plan of consumers. The level of significance was however low. The cross price elasticity of demand between rice and wheat was also positive.

The relation between income and per capita consumption demand is also positive. The demand for rice does respond positively to changes in per capita income. The policy implication is that the increase in per capita incomes or living standards of people will only slowly but surely influence rice consumption.

Per capita availability of rice which has been substituted for per capita consumption of rice may be influenced by expanding production or alternatively by reducing exports. There is a great scope for the first as per acre yield of rice is only 32 maunds per acre whereas there is potential to increase it to 70 maunds per acre i.e. there is scope for doubling of the yield and output (Ahmad, (2007). There is also scope for extensive cultivation through reclamation of water-logged and saline lands and bringing new areas under cultivation of rice through improved irrigation facilities. Discovery of new high yielding varieties of rice as happened in the 1960s may also be given high priority by the policy makers. The increase in local availability through reduction in exports is another option that merits serious attention.

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