A Multilevel Economic Analysis of the Wheat Market in Pakistan

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Government price policy in Pakistan affects both the supply and demand of wheat. The wheat market has been established in a particular idiosyncratic manner in Pakistan, and a thorough appraisal of policy needs to take this into account. Hence, to analyse various policy interventions, this study develops a multi-level wheat market model. After considering the real world aspects of the wheat marketing chain, a conceptual framework is developed involving five market levels. This is then translated into a multi-equation econometric model. The model is based on secondary time series data from 1971 to 1996. It consists of equations representing supply, demand, stock holding, importing and price formation. The model is used to estimate changes in consumer surplus, producer surplus and government expenditures, resulting from proposed policy changes.
(I) Introduction

Agriculture is the largest sector of Pakistan’s economy. In many ways it sets the trend for economic performance. It contributed 24 per cent to GDP and employed 47 per cent of the labour force during 1995-96. It is also responsible for 80 per cent of export earnings (Government of Pakistan 1997, Malik et al. 1994).

Wheat is the staple food of Pakistan and occupies a central position in farm policy. It is a winter-season crop which is planted during November-December and is harvested during April-May. Its share in total cropped area is around 35 per cent (Agricultural Statistics of Pakistan 1997). It is grown in both irrigated and unirrigated areas in all four provinces. It is the most important commodity in the consumption of low-income consumers being the main source of carbohydrate and protein, accounting for 53 per cent of calories and 59 percent of daily protein intake (Goletti et al. 1994). In 1995-96, per capita availability of wheat was 127 kg per annum as compared to 16 kg per annum in the case of rice. In 1992-93 the monthly consumption of wheat per household was 10 kg as compared to 1 kg of rice (Agricultural Statistics of Pakistan 1997).

The population of Pakistan is estimated to be 135 million and it is increasing at an annual rate of about 2.8 per cent (Government of Pakistan 1997). To meet the food needs of this burgeoning population, wheat availability will have to be increased. Despite increases in yield and production, Pakistan has not achieved self-sufficiency in wheat and significant quantities are imported (Table 1). One of the main goals of the agricultural strategy recommended by the National Commission on Agriculture (NCA) is that of food self-sufficiency: ‘a key element in the entire strategy, would be the achievement and maintenance of food self-sufficiency through increases in yield and productivity’ (Government of Pakistan 1988, pp. xxvii). Optimism is expressed by the Commission in reporting that Pakistan has the potential for yield and productivity improvement for food grains. It is thought that new technologies, gradual development of irrigation and drainage facilities, reclamation of water-logged and saline soils, and institutional
services such as credit and extension, will bring about substantial increases in output in the future. In the short-term, however, price policy is being relied upon to provide incentives to farmers to expand wheat production.

Table 1: Production and Imports of Wheat in Pakistan, 1971-96

<table>
<thead>
<tr>
<th>Years</th>
<th>Production (000 tonnes)</th>
<th>Imports (000 tonnes)</th>
<th>Consumption (000 tonnes)</th>
<th>Imports as % of consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-72</td>
<td>6890</td>
<td>690</td>
<td>7580</td>
<td>9.1</td>
</tr>
<tr>
<td>1975-76</td>
<td>8691</td>
<td>1186</td>
<td>9877</td>
<td>12.0</td>
</tr>
<tr>
<td>1980-81</td>
<td>11475</td>
<td>305</td>
<td>11780</td>
<td>2.6</td>
</tr>
<tr>
<td>1985-86</td>
<td>13923</td>
<td>1909</td>
<td>15832</td>
<td>12.1</td>
</tr>
<tr>
<td>1986-87</td>
<td>12016</td>
<td>378</td>
<td>12394</td>
<td>3.1</td>
</tr>
<tr>
<td>1987-88</td>
<td>12675</td>
<td>601</td>
<td>13276</td>
<td>4.5</td>
</tr>
<tr>
<td>1988-89</td>
<td>14419</td>
<td>2171</td>
<td>16590</td>
<td>13.1</td>
</tr>
<tr>
<td>1989-90</td>
<td>14316</td>
<td>2047</td>
<td>16363</td>
<td>12.5</td>
</tr>
<tr>
<td>1990-91</td>
<td>14565</td>
<td>972</td>
<td>15537</td>
<td>6.3</td>
</tr>
<tr>
<td>1991-92</td>
<td>15684</td>
<td>2018</td>
<td>17702</td>
<td>11.4</td>
</tr>
<tr>
<td>1992-93</td>
<td>16157</td>
<td>2868</td>
<td>19025</td>
<td>15.1</td>
</tr>
<tr>
<td>1993-94</td>
<td>15213</td>
<td>1902</td>
<td>17115</td>
<td>11.1</td>
</tr>
<tr>
<td>1994-95</td>
<td>17002</td>
<td>2248</td>
<td>19250</td>
<td>11.7</td>
</tr>
<tr>
<td>1995-96</td>
<td>16907</td>
<td>1968</td>
<td>18875</td>
<td>10.4</td>
</tr>
</tbody>
</table>

Source: Government of Pakistan 1997

Since independence, the wheat market has been subject to government intervention. The government has tried to keep the price of wheat below international levels to subsidise domestic consumers, thus involving a substantial subsidy (Hamid et al. 1991). National and international organisations are expressing the need for re-examination of the price policy and for appropriate input and output pricing policies for wheat.
It is thought that substantial increases in wheat yield and food self-sufficiency might be achieved through the appropriate output and input price policies, particularly for fertiliser, and by the development of appropriate wheat varieties for different ecological zones and better targeted extension programs.

The objectives of this study are to develop a conceptual model of the wheat economy of Pakistan and determine the welfare effects of current government policies. This study follows the earlier work of Bale and Lutz (1981), Mohammad and Tahir (1988), and Barkley (1992) for welfare analysis and Ali (1988), Bogahawatte (1990) and Ghani (1995) for econometric modelling of this type of policy situation in the developing countries.

The theoretical framework for the study is in the second part of the paper. This is followed by a description of the empirical procedures in part III. Methods of analysis are discussed in part IV. Results and discussions are presented in part V and conclusions are drawn in the final part of the paper.

(II) Theoretical Framework

A multi-level model of the wheat market in Pakistan is represented in Figure 1. The figure shows the market for retail product in panel (a), milling and marketing services in panel (b), wholesale product in panel (c), storage and transportation in panel (d) and farm product in panel (e). The domestic supply curve in panel (e) reflects the current government’s agricultural policies like subsidies on irrigation water, credit and electricity. There also were subsidies on fertilisers, pesticides, seed and tube wells, but with the passage of time the government has withdrawn all those subsidies.

The final product is made by a unique proportion of various inputs. Therefore, a fixed proportion has been assumed between factors as is discussed by Friedman (1976) and is further illustrated by Alston (1991) for the production of the intermediate product, wheat, and the final product, flour. The farm product, and storage and transportation are
Figure 1: Wheat Market in Pakistan

(a) Retail Market

(b) Milling and Marketing Services Market

(c) Wholesale Market

(d) Storage and Transportation Market

(e) Farm Product Market

Quantities
combined in a fixed proportion to produce wheat in the wholesale market. Similarly, the wholesale market product, wheat, and milling and marketing services are combined in a fixed proportion to produce the retail product i.e. flour.

In panel (e) of Figure 1, the total supply at farm level is given by $S_S/S'$. The domestic supply is represented by the curve $S_S/S'$. The international supply of wheat is represented by the curve $S'S'$ and is assumed to be perfectly elastic. The supply curve of storage and transportation is represented by curve $S_st$ and is shown in panel (d). The demand curve in the wholesale market is represented by curve $D_{ws}D_{ws}$ and is shown in panel (c). As the factors are used in fixed proportion, one can derive the wholesale supply curve and demand curves for storage and transportation and farm product market. The wholesale supply curve, $S_{ws}S'_{ws}S'_{ws}$, is derived by vertically summing the supply curves at storage and transportation market and farm product market levels. The derived demand curve for storage and transportation, $D_{st}D_{st}D_{st}$, is given by the vertical difference between the wholesale demand curve and farm supply curve. The derived demand for the farm product, $D_fD_f$, is given by the vertical difference between the wholesale demand curve and supply of storage and transportation curve.

The demand curve for the retail product is given by curve $D_rD_r$ and is shown in panel (a). The supply curve of milling and marketing services is given by curve $S_m$ as shown in panel (b) and is assumed to be perfectly elastic because considerable excess capacity existed in the wheat milling units (Cornelisse and Naqvi 1987) and flour mills are working at an average of 30-40 per cent of their capacity (Rayan and Khan 1992). The supply at the wholesale market is represented by curve, $S_{ws}S'_{ws}S'_{ws}$, and is shown in panel (c). One can derive the retail supply curve, $S_rS_{r1}S_{r1}$, by vertically summing the supply curves at milling and market services and wholesale market levels. The derived demand curve for milling and the marketing services, $D_mD_mD_m$, is given by the vertical difference between the retail demand and the supply function of the wholesale market product. The derived demand curve in the wholesale, $D_{ws}D_{ws}$, market can be derived as well by vertical difference between the retail demand and the supply of milling and marketing services.

**Equilibrium in the Multilevel Wheat Market without Government**
**Intervention**

When there is no intervention by the government, the quantity of domestic wheat supplied is $Q_{fs}$ and the total quantity demanded is $Q_{fo}$ at price $P_w$. The difference between the quantity supplied and quantity demanded ($Q_{fs} - Q_{fo}$) is imported at price $P_w$. The quantity of wheat $Q_{fo}$ in panel (e) is combined in fixed proportion with a quantity of storage and transportation $Q_{so}$ in panel (d) at price $P_{st}$ to produce the quantity of wheat at wholesale $Q_{ho}$ in panel (c) at price $P_{wh}$. Similarly, the quantity of wheat $Q_{ho}$ in panel (c) is combined with the quantity $Q_{mo}$ of milling and marketing services at price $P_m$ in panel (b) to produce the quantity of flour $Q_{ro}$ at the retail level at price $P_{wf}$ in panel (a).

**Equilibrium in the Multilevel Wheat Market with Government Intervention**

Now, with government intervention, the equilibrium with respect to prices and quantities is changed at all market levels. The government imports $Q_{fs} - Q_{fo}$ to keep the wheat price at $P_d$ in the farm product market. Now the new supply curve at this level is $S_{fs}/S_{fs}/S_{fs}$ as shown in panel (e). The supply curve of storage and transportation is given by $S_{st}$ and is shown in panel (d). The demand for wheat at the wholesale market level is still $D_{ws}D_{ws}$ in panel (c). The new wholesale supply curve $S_{ws}/S_{ws}/S_{ws}$ is derived by vertically summing the supply curve at storage and transportation $S_{st}$ and the new supply curve, $S_{fs}/S_{fs}/S_{fs}$, at farm product market level as shown in panel (e). The new derived demand curve for storage and transportation is given by the vertical difference between the wholesale demand curve $D_{ws}D_{ws}$ and supply at farm product market $S_{fs}/S_{fs}/S_{fs}$ and is represented by $D_{st}D_{st}D_{st}$ and is shown in panel (d). The derived demand curve for wheat at the farm product market level $D_{fs}D_{fs}$ is unchanged. The supply of retail product $S_{fs}/S_{fs}/S_{fs}$ is derived by vertical summation of supply curve at milling and marketing service market $S_{m}$ and new supply curve at the wholesale level market $S_{ws}/S_{ws}/S_{ws}$ and is shown in panel (a). The derived demand curve for milling and marketing services is given by vertically subtracting the supply function for wholesale market $S_{ws}/S_{ws}/S_{ws}$ from the retail demand.
function $D_dD_r$ and is given by $D_mD'_mD''_mD_m$ as shown in panel (b). The derived demand curve for wheat at the wholesale level $D_{ws}D_{ws}$ is unchanged.

The new equilibrium quantity supplied by domestic producers is $Q_{fs}$ and the quantity demanded is $Q_{f1}$ with $Q_{fs}Q_{f1}$ imported at price level $P_d$ in the farm product market as shown in panel (e). The new equilibrium quantity $Q_{f1}$ is combined with the quantity of storage and transportation $Q_{st}$ in panel (d) at price $P'_{st}$ to produce the quantity of wheat at wholesale $Q_{h1}$ at price $P_{ws}$ as shown in panel (c). Similarly, this quantity of wheat at wholesale level is combined with the quantity of milling and marketing services $Q_{m1}$ at price $P_m$ in panel (b) to produce quantity of flour $Q_{r1}$ at the retail level at price $P_r$.

**The Welfare Effects of the Government Intervention**

The net social benefit of the government intervention, measured in terms of the total change in the surpluses i.e. the sum of consumer surplus, producer surplus and government costs is equal in every market to area $-B/-F/ (as shown in the farm product market). The total economic surplus measured in any market will give the same answer. However, interpretations of the surplus areas will be different for different markets. For example in the retail market in panel (a), the consumer surplus will accrue to the buyers of the retail product (i.e. flour) and the producer surplus will include the surpluses accruing to all the suppliers of all the inputs used to produce flour.

Conversely, the consumer surplus in the farm product market includes the consumer surplus of the markets directly above the production process at the farm level and producer surplus accruing to the suppliers of farm product.

The distribution of welfare due to government intervention is summarised in Table 2. The entries in the table are based on the areas in Figure 1.

**Table 2: Change in the Distribution of Welfare as a Result of Government Intervention**
<table>
<thead>
<tr>
<th>Market Level</th>
<th>Govt. Cost</th>
<th>Change in Producer Surplus</th>
<th>Change in Consumer Surplus</th>
<th>Change in Total Surplus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>-B′-C′-D′-E′-F′</td>
<td>-A-B-C+G+H+I</td>
<td>+A+B+C+D+E</td>
<td>-B′-F′</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As G+H+I+D+E = C′+D′+E′</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>H′+I′+J′ = C′+D′+E′</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-B′-F′</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-B′-C′-D′-E′-F′</td>
<td>-J-K-L+P+Q+R</td>
<td>J+K+L+M+N</td>
<td>-B′-F′</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As P+Q+R+M+N = C′+D′+E′</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-B′-C′-D′-E′-F′</td>
<td>+S+T+U+V+W</td>
<td>X+Y+Z-S-T-U</td>
<td>-B′-F′</td>
</tr>
<tr>
<td></td>
<td></td>
<td>As X+Y+Z+V+W = C′+D′+E′</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage and Transportation</td>
<td>-B′-C′-D′-E′-F′</td>
<td>-A′-B′</td>
<td>A′+B′+C′+D′+E′</td>
<td>-B′-F′</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm Product</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note: The entries refer to areas in Figure 1

(III) Empirical Procedure

Model Specification

Due to the annual nature of wheat production and the characteristics of the data available on variables included in the model, an annual model was constructed. The specification of Pakistan’s wheat economy and brief variable definitions are given in Appendix 1. In this Appendix and in the description, expected signs for the parameters are indicated on top of the relevant symbols. The subscript of each variable refers to the year of interest. For example, St-1 is the stock of wheat held by government in year t-1. The variables included in the equations are chosen on the basis of relevant theory, a priori information and the experience of other researchers. A brief description of various components of the model is provided below.
The model currently consists of ten equations and three identities. The supply component has three estimated equations and an identity. The equations are an area equation (1), a yield equation (2) in which the quantity of fertiliser demanded is treated endogenously in equation (4). In equation (3) total supply is equal to area times yield. The demand component of the model also has three equations and an identity. The equations are, the quantity demanded of wheat in the wholesale market (5), quantity of wheat demanded for feed (6) and quantity of wheat demanded for seeds. In equation (8) total quantity of wheat demanded is equal to quantity of wheat demanded for these three components. The prices component has two equations, namely procurement price (9) and retail price (10). The import and stock component has an import equation (11) and a stock equation (12). Equation (13) is a market clearing equation in which total quantity supplied plus imports of wheat are equal to total quantity demanded plus change in stocks plus exports of wheat (if any). This identity generates the market clearing and wholesale price of wheat. The model is shown in Appendix 1.

The Supply Component

The area equation has included various variables which were considered important for area response. The lagged area \((A_{t-1})\) of wheat was included in the equation. Previous research (Lal and Katar 1981, Krishna 1963, Sabur 1984 and Salassi 1995) on area response showed a positive response by farmers to lagged area of the crop. The positive response might be due to the reason that producers follow a partial adjustment process (Doran and Guise 1984) in the wheat industry due to changing economic conditions. The partial adjustment hypothesis depends on the cost, capital, labour or other constraints which prevent the farmer from completely adjusting his enterprise in response to a change in the price. While the lagged area \((A_{t-1})\) was expected to have a positive sign, the coefficient of lagged cotton price \((PC_{t-1})\) was expected to have a negative sign. The important thing to note here is that although wheat is a winter crop (sown in Oct-Dec) while cotton is a summer crop (harvested in Oct-mid Dec), there is some potential overlap between them. The argument is that higher cotton prices induce farmers to leave
the cotton crop for a longer time period in the field. The price of fertiliser (Pf) is an important variable that affects the use of fertiliser and ultimately the area under wheat. The coefficient was expected to have a negative sign due to its inverse relationship with area. According to Ahmad et al. (1994) fertiliser typically constitutes over 30 per cent of the total variable cost of production of wheat. It is argued that a higher price of fertiliser has a negative impact on wheat area.

In the model, yield response was specified as a function of the quantity of fertiliser used in wheat production in year t (QFDt) and total rainfall during the sowing and growing period in year t (Wt). The quantity of fertiliser used for wheat production (QFDt) was also estimated separately as a input demand equation. The coefficient of this variable was expected to have positive sign because yield will respond positively to further applications of fertiliser within the range of fertiliser that is typically applied. Total rainfall (Wt) during the sowing and growing period will have a positive impact on the dependent variable and was expected to have a positive sign. Rainfall plays a very important role in increasing the yield, particularly in rainfed areas.

A now traditional way of estimating supply response is to go for area and yield equations and then multiply the results (Pinckney 1989 and Ashiq 1992). The second alternative is to estimate the total supply. Neither alternative worked particularly well, and the supply component had to be estimated indirectly as an extension of the first alternative in which it was hypothesised that the yield of wheat is affected by change in quantities of fertilisers applied per hectare because of wheat price. Then, incorporating this extension, the total quantity of wheat produced in Pakistan was specified as the product of the area under wheat crop in year t and the yield of wheat in year t.

The quantity of fertiliser demanded for wheat production in year t (QFDt) was estimated as an input demand equation. A positive relationship was expected between the procurement price (P_{proc}) and quantity of fertiliser used for wheat production. A higher wheat price will encourage the farmers to use more fertiliser. The coefficients of area under higher yielding varieties (AHYVt) and numbers of tractors (TRt) were expected to
have positive signs. The high yielding varieties give good response to fertiliser and better tillage preparation. Including number of tractors as an independent variable is in accord with Khan and Mohammad (1981), who observed that fertiliser use increases with the use of tube wells and tractors.

**The Demand Component**

The domestic demand for wheat is divided into three parts, viz. the demand for wheat for human consumption, the demand for wheat for feed and the demand for wheat for seed. In the specification of demand equations, this study follows the work of Myers (1982), Chaudhary et al. (1987), Bogahawatte (1990) and Ghani (1995).

The wholesale quantity of wheat demanded for human consumption \( (Q_{DHS_t}) \) was specified as a function of price ratio of wheat to substitute grains \( (PR_{ww_t}) \) in year \( t \), gross national product in year \( t \) \( (GNP_t) \) and the release price of wheat to millers \( (RP_t) \) in year \( t \) as a policy variable.

There is an inverse relationship between quantity demanded of a commodity and its price, and a direct relationship between quantity demanded and price of substitutes. So the expected sign of the coefficient of the price ratio of wheat to other grains \( (PR_{ww_t}) \) is negative. The coefficient of GNP was expected to have positive sign because with an increase in income the demand for wheat should increase. The expected sign of the coefficient of the policy variable (i.e. release price of wheat to millers) was negative.

The quantity of wheat demanded for feed in year \( t \) \( (Q_{DF_t}) \) is directly influenced by total livestock units \( (LS_t) \) in year \( t \). The total animal units were first determined by using conversion factors given in Ahmad et al. (1994). The quantity of wheat demanded for feed \( (Q_{DF_t}) \) and the wholesale price of wheat \( (P_{ww_t}) \) have the usual inverse relationship. An increase in wholesale price of wheat would be expected to lead to a decrease in consumption of wheat for feeding livestock.
The quantity of wheat demanded for seed in year t (QDSₜ) is determined by the area under wheat crop in year t (Aₜ). The coefficient of the area under wheat crop (Aₜ) was expected to have a positive sign because a greater area under wheat will require more wheat for seed.

The total demand for wheat is the sum of the quantities demanded for human consumption, feed and seed.

**Prices Component**

Two price equations viz., procurement price and retail price were specified in the present model of the wheat economy of Pakistan. The wholesale price is determined by the market clearing equation. Some items of data were not available. For example, the prices of storage and transportation and milling and marketing services were not available and consequently these prices were assumed as the difference between market prices in the market levels above and below them. The price in the storage and transportation market was assumed as the margin between the wholesale price and the price at the farm level.

In the procurement price of wheat equation, the variable of cost of production (CPₜ) was included in the equation because it is stated to be an important factor in determining the procurement price (Government of Pakistan 1988). The variable was expected to have a positive sign. Data on the cost of production were not available for the years 1971-81. After its establishment in 1981, it became the responsibility of the Agricultural Prices Commission to estimate the cost of production of the major crops each year. In order to obtain a consistent data series, the labour cost is used as a proxy for this variable.

The international price of wheat (Pwi) was included in the equation because it is also considered an important factor in fixing the product price. The variable was expected to have a positive sign. Barkley (1992) also used this variable in his analysis of the procurement price of wheat and found it to be positive.
The government stock situation at the beginning of the year (S_{t-1}) also could have an impact in the determination of the procurement price. For example if the government holds a reasonable stock in any year, the procurement price announced for next year would be expected to have no increase or only a small increase. Thus the coefficient was expected to have a negative sign.

The retail price of wheat was specified as a function of wholesale price of wheat (P_{wwt}), and the quantity demanded at the wholesale level (QDHS_t). The wholesale price of wheat (P_{wwt}) and retail price of wheat (P_{w_t}) have a direct relationship with each other. Therefore, the variable (P_{wwt}) was expected to have a positive sign. The coefficient of the quantity demanded at the wholesale market level was expected to have a negative sign. All prices were specified in real terms.

**Imports and Stocks**

The factors which were considered to influence the total imports of wheat in year t (M_t) included lagged imports (M_{t-1}), international price of wheat in year t (P_{wi_t}) and stock of wheat held by government in year t (S_t). The coefficient of lagged imports (M_{t-1}) was expected to have a positive sign. The international price of wheat (P_{wi_t}) and total imports of wheat (M_t) have an inverse relationship. The coefficient of the stock of wheat held by government in year t (S_t) was expected to have a negative sign because imports will be increased when stocks are lower. Bogahawatte (1990) also used international price and stock of rice in his model for Sri Lankan rice.

In the government stock equation, the coefficient of lagged storage (S_{t-1}) was expected to have a positive sign, because lagged stocks will increase the current stocks. The procurement price of wheat (P_{proc_t}) was expected to have a negative sign. At a higher procurement price, the government storage agencies will have an incentive to purchase less and hence store less.
In the identity equation there are three sources of supply and three sources of demand (Pinckney 1989). The total domestic quantity of wheat supplied in year $t$ ($TQS_t$), stock of wheat held by government at the beginning of the year ($S_{t-1}$) and total imports of wheat in year $t$ ($M_t$) are equal to total quantity of wheat demanded in year $t$ ($TQD_t$), stock of wheat held by the government at the end of the year ($S_t$) and total exports of wheat (if any) in year $t$ ($X_t$).

Time series data from 1971-1996 on the variables included in the model were collected from the Central Bureau of Statistics, Ministry of Food, Agriculture and Cooperatives (MINFAC), Agricultural Prices Commission, Provincial Departments of Agriculture and from the files and publications of other departments. Only time series data on an annual basis are available (with some missing values). Time series data at some market levels and seasons are not available. The data on farmer’s home consumption, seed and feed are only available as percentages. The data on cost of production of wheat and storage cost were also not available for all years. The various variables which are included in the model, and their definitions are given in Appendix 1.

(IV) Methods of Analysis

A linear functional form was chosen and the model was estimated simultaneously using Three Stage Least Squares (3SLS). The TSP package was used to estimate the model. Two equations, the quantity of fertiliser demanded for wheat and the procurement price, were corrected for autocorrelation. All prices were expressed in real terms.

The supply and demand equations of the estimated model were used to measure consumer surpluses, producer surpluses and government expenditure at the farm level. The computed equilibrium prices and quantities were used in the measurement of the welfare effects. The present situation, in which the government is intervening in the wheat market, was compared with a free market situation. The welfare areas measured are those contained in panel (e) of Figure 1.
(V) Results and Discussion

The results of the estimated model were used to measure consumer surpluses, producer surpluses and government expenditures. The estimated equations in the model are shown in Table 3. Summary statistics provided for each equation are the ‘t’ values of the parameter estimates, the coefficients of determination ($R^2$) and Durbin-Watson statistics (DW). The estimated results seem quite reasonable in spite of the poor quality of the data. Signs of all the parameter estimates are consistent with a priori expectations.

Most of the parameter estimates obtained are significant at a 5 per cent level using a one-tailed ‘t’ test. The coefficients of determination ($R^2$) in the case of supply and demand equations are quite high, however there are questions mark in the price, imports and stocks components of the model. The values of each DW statistic indicates either acceptance of the null hypothesis (i.e. there is no first-order autocorrelation) or an inconclusive result at a 5 per cent level of significance. Durbin-h statistics are also calculated for those equations where lagged dependent variables were used. The values of Durbin-h for those equations lie between -1.96 and 1.96, therefore, the null hypothesis (i.e. there is no first-order autocorrelation) is not rejected.

The elasticities associated with demand and supply equations were computed at the mean points. The price elasticity of supply was calculated as 0.13. A similar inelastic supply relationship was reported by Cumming (1975), Bale and Lutz (1981), Tweeten (1986) and

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<thead>
<tr>
<th>Table 3: The Estimated Wheat Model of Pakistan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter estimates (‘t’ values in parentheses)</td>
</tr>
<tr>
<td>Supply</td>
</tr>
<tr>
<td>$Y_t = 1.11 + 0.00076 \text{QFD}_t + 0.000499 \text{W}_t$</td>
</tr>
<tr>
<td>(11.9)</td>
</tr>
<tr>
<td>(1.83)</td>
</tr>
<tr>
<td>$R^2$</td>
</tr>
<tr>
<td>0.85</td>
</tr>
<tr>
<td>$D.W.$</td>
</tr>
<tr>
<td>2.32</td>
</tr>
<tr>
<td>$D.H.$</td>
</tr>
</tbody>
</table>
\[ A_t = 202.83 + 0.805 A_{t-1} - 0.136 PC_{t-1} - 0.447 P_{t-1} \]
\[ (15.09) \quad (3.97) \quad (2.23) \]
\[ QFD_t = -464.86 + 0.246 P_{proc} + 0.143 AHYV_t + 0.83 TR_t \]
\[ (1.45) \quad (13.49) \quad (8.29) \]

**Demand**

\[ QDHSt = 6230.64 - 7351.05 PR_{wwt} + 0.028 GNP_t - 2.14 R_{Pt} \]
\[ (1.80) \quad (5.4) \quad (4.8) \]
\[ 0.61 \quad 2.08 \]
\[ QDF_t = -29.61 + 5.51 L_{St} - 0.028 P_{wwt} \]
\[ (25.34) \quad (.78) \]
\[ QDS_t = -1009.65 + 0.248 A_t \]
\[ (23.28) \]

**Prices**

\[ P_{proc,t} = 395.78 - 0.011 S_{t-1} + 0.071 P_{wi} \]
\[ (1.12) \quad (1.60) \]
\[ P_{wt} = 430.61 + 0.36 P_{wwt} - 0.0045 QDHSt \]
\[ (3.77) \quad (1.56) \]

**Imports and Stocks**

\[ M_t = 1517.92 + 0.24 M_{t-1} - 0.63 P_{wi} - 0.133 S_t \]
\[ (1.49) \quad (0.71) \quad (.62) \]
\[ S_t = 4219.41 + 0.28 S_{t-1} - 8.96 P_{proc,t} \]
\[ (2.00) \quad (3.14) \]

Mubarak (1988). The price elasticity of demand was calculated as -0.53. This result is consistent with other studies like Alderman (1988), Deaton and Grimard (1991) and Riaz (1994). The cross-price elasticity with respect to cotton price was found to be -0.085. Tweeten (1986) calculated this elasticity as -0.02. The income elasticity of demand was calculated as 0.7. The elasticity seems a little bit high. The high income elasticity might
be due to the high proportion of income spend on wheat i.e. 19 per cent of total expenditure of households (Cornelisse and Naqvi 1987, p.73).

**Welfare Analysis**

Using the computed equilibrium values of prices and quantities, the welfare effects of current price policies compared with a free market situation were assessed. The movement to a free market involved an increase in output price from Rs 439.1 per tonne to the mean C.I.F. price of Rs 638.08 per tonne. In a similar manner the values of price and quantity variables were re-estimated. The differences in the values of current and policy simulations were compared and were used in measuring changes in producer surpluses, consumer surpluses and the government cost. The results are presented in Table 4.

**Table 4: Changes in Welfare Effects of Wheat Price Policies (Million 1971-72 Rs)**

<table>
<thead>
<tr>
<th>Loss in Producer Surpluses</th>
<th>Gains in Consumer Surpluses</th>
<th>Government Costs</th>
<th>Net Welfare Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1004.194</td>
<td>963.187</td>
<td>258.97</td>
<td>299.976</td>
</tr>
</tbody>
</table>

The results show that due to current government price policies, wheat producers are incurring an average loss of about Rs 1004.194 millions per year over the period of study. Consumers are gaining an average of Rs 963.187 million per year. The government cost of subsidising wheat imports was Rs 258.97 millions per year. The overall net welfare loss during the period of study was an average Rs 299.98 millions per year. As the welfare effects have been measured at the farm level, producer surpluses are accruing to the suppliers of farm product. The consumer surplus in the farm product market include the surplus to final consumers and any producer surpluses of supplies to the markets above the production process (storage, milling etc).
(VI) Conclusions

Wheat is the staple food in Pakistan. In addition to long-term policy measures like research and extension, land reclamation, and infrastructure development, short-run policies such as input and output price policies were operational in the country for many years. The present study evaluated the government wheat price policy. The results of the study indicated that due to the current wheat price policy, producers are producing less wheat as compared to a situation where they would receive a price equivalent to the international price. Consumers are gaining transfers from producers and taxpayers. Under the current weak financial situation of the country, the government is bearing a substantial loss. There is also a question about whether the ultimate consumers of wheat are gaining the benefits of present policies or whether it is the middleman like processors who are gaining the real benefits of the policy. In the paper, the welfare measures at other market levels and sensitivity analysis have not been included. They will form the basis of subsequent analysis.
Appendix 1: Model of Pakistan’s Wheat Economy

Supply

\[ A_t = f (A_{t-1}, PC_{t-1}, Pf_t, e_{t1}) \]

\[ Y_t = f (QFD_t, W_t, e_{t2}) \]

\[ TQS_t = A_t \cdot Y_t \]

\[ QFD_t = f (P_{proc}, AHYV_t, TR_t, e_{t4}) \]

Demand

\[ QDHSt = f (PRwwt, GNP_t, RPt, e_{t5}) \]

\[ QDF_t = f (LS_t, Pwwt, e_{t6}) \]

\[ QDS_t = f (A_t, e_{t7}) \]

\[ TQDt = QDHSt + QDF_t + QDS_t \]

Prices

\[ P_{proc,t} = f (S_{t-1}, CP_t, Pwi_t, e_{t9}) \]

\[ Pwt = f (Pwwt, QDHSt, e_{t10}) \]

Import and stock

\[ M_t = f (M_{t-1}, Pwi_t, St, e_{t11}) \]

\[ St = f (S_{t-1}, P_{proc}, e_{t12}) \]

Market Clearing Equation

\[ TQS_t + M_t = TQDt + (St - S_{t-1}) + Xi \]
Definitions of Variables.

**Endogenous Variables**

\(A_t = \text{Area under wheat crop in year } t\)
\(Y_t = \text{Yield of wheat in year } t\)
\(TQS_t = \text{Total quantity supplied of wheat in year } t\)
\(QFD_t = \text{Quantity of fertiliser demanded for wheat in year } t\)
\(QDHS_t = \text{Quantity of wheat demanded at wholesale level for human consumption in year } t\)
\(QDF_t = \text{Quantity of wheat demanded for feed in year } t\)
\(QDS_t = \text{Quantity of wheat demanded for seed in year } t\)
\(TQD_t = \text{Total quantity demanded of wheat in year } t\)
\(P_{\text{proc.}} = \text{Procurement price of wheat in year } t\)
\(P_{w_t} = \text{Retail price of wheat in year } t\)
\(P_{\text{wwt}} = \text{Wholesale price of wheat in year } t\)
\(M_t = \text{Total import of wheat in year } t\)
\(S_t = \text{Stock of wheat held by government in year } t\)

**Pre-determined Variables**

\(A_{t-1} = \text{Area under wheat crop in year } t-1\)
\(PC_{t-1} = \text{Price of cotton in year } t-1\)
\(P_f = \text{Price of fertiliser in year } t\)
\(W_t = \text{Total rainfall during the sowing and growing period in year } t\)
\(AHYV_t = \text{Area under high yielding varieties in year } t\)
\(TR_t = \text{No. of tractors in year } t\)
\(PR_{\text{wwt}} = \text{Price ratio of wheat to grains at wholesale level in year } t\)
\(GNP_t = \text{Gross national product in year } t\)
\(RP_t = \text{Release price of wheat to miller in year } t\)
\(LS_t = \text{Total Live stock units in year } t\)
\(S_{t-1} = \text{Stock of wheat held by government in year } t-1\)
\[ CP_t = \text{Cost of production of wheat on year } t \]
\[ Pwi_t = \text{International price of wheat} \]
\[ M_{t-1} = \text{Total import of wheat in year } t-1 \]
\[ X_t = \text{Export of wheat in year } t \]
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