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Subsidizing Agricultural Production on Imperfect Markets

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I. INTRODUCTION

Economic growth, and the distribution of wealth and income, are two of the major, dimensions of economic policy in all countries. If one follows the data published by the World Bank, one can see, that even the relative income distribution in the developed and some of the developing countries are very similar; it is only, that the level of income is much lower in the latter countries, and therefore, that low income is more visible and striking.

Therefore, raising the level of income of the very poor has been a major task of all governments. There has been a very controversial discussion, however, as to how the incomes of the poor can be raised easily, whether by economic growth, redistribution of wealth, i.e. the means of production, or of income. This discussion has been inconclusive so far, and the present paper sets out to examine some of these aspects. Pakistan may serve as a perfect example, considering the fact, that the country first suffered from an overemphasis on economic growth and a neglect of distribution and then tried distribution with no growth.

Among the many possible strategies at the disposal of the government, one has been and still is, to enhance the incomes of the very poor by regulating the prices of the basic consumer commodities, i.e. food items, which almost all stem from agricultural production. Consumer policy and agricultural production, therefore, are affected by the same measures and instruments.

Some work has been done on these aspects so far, with regard to the general aspects (right from the economic classics) as well as with regard to Pakistan (Zingel 1986). Therefore, the present paper will concentrate on one aspect, i.e., that government market intervention neither at the farm nor at the consumer level is possible for obvious technical reasons, and that the government has to interfere at the bottleneck', which is usually either trade, preferably foreign trade, or processing. This

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will only work if the relations between production, trade, processing, and retail sale are known in their structure and quantities.

Agriculture still is the major economic sector in Pakistan, regardless of the fact, that already two decades ago the tertiary sector has surpassed agriculture in gross value added, which means, that the "non-productive" activities, especially the transaction activities like trade, may not be neglected in economic analysis. Trade margins, indeed, are thus a matter of intensive debate. Despite considerable work having been done (like on wheat trade), information on trade margins and their determinants leaves much to be desired (Naqvi and Cornelisse 1986).

A second aspect is processing. Even in low-income economies most food items undergo some kind of processing outside the farm or the consumer household, like the milling of grain or oilseeds. And where no processing is being done, at least some grading is done by the trading sectors (potatoes are sometimes graded by size or appearance).

The purpose of the present paper is, to present a framework which will allow us to analyse the monitoring of key variables, in a comprehensive and consistent way, which are of special interest to the policy-makers.

In order to estimate the likely effects of policy changes, the *partial equilibrium* analysis has its obvious practical advantages and is thus the standard approach, but it is unsatisfactory in view of the close interaction between the markets. An economic policy measure which is implemented in a market closely related to several other markets, can be reinforced or weakened in its impact through induced supply and demand effects on the other markets. That is why markets which are both horizontally and vertically interlinked with the market in question need to be taken into account.

A *general equilibrium* approach should be considered to be more appropriate but, unfortunately, has proven to be cumbersome to handle and expensive to set up in terms of data (and manpower) requirements (Shoven and Whalley 1984, p. 1014).

A *flexible multi-market approach* would be another possibility. It has the additional advantage of concentrating on key links and including income distribution. The underlying methodologies were elaborated by Quizon and Binswanger (1983) and Marggraf (1985).

2. THE APPROACH

General Outline of the Approach

As it is known, general equilibrium models either suffer from a lack of (sectoral, personal, regional) disaggregation or easily become unmanageable. The present approach tries to overcome these shortcomings besides including product and factor-specific interventions. This is done in the model by the inclusion of product-specific value taxes.

The approach is flexible in the sense that it can be expanded subjectwise and spatially, without certain parameters (as is the case with (linear) input-output models) resp. market structures (as is the case for general equilibrium models) having to be kept constant. In the present model, processing and marketing are incorporated.

Contrary to other, computable general equilibrium models recently developed and applied, the present approach only requires local knowledge of prevailing preferences and technologies, in other words, no specific, under certain circumstances, maybe quite restrictive, functional forms and structures are assumed.

The model is formulated in relative changes of the variables (indicated by primes) The computations of the model are, thus, comparatively simple they are only based on a matrix inversion. This not only saves time and money, but also makes the testing of different assumptions (for example on supply reactions) easy, and thus makes it possible, to test the sensitivity of certain important variables in dependence of economic policy decisions.

In the model equations, the exogenous terms in the supply and demand functions symbolize the effects of government activities. These are for example, (i) the effects of land reclamation and amelioration and irrigation projects are reflected by exogenous changes of the agricultural supply equations; (ii) food subsidies via exogenous changes of the food demand; (iii) transmigration programmes via exogenous changes of the labour supply equation, and (iv) the effects of population policy via the shares of the socio-economic groups in total population. These examples may suffice to demonstrate, that in the model the effects of the different state activities with programme character can be analysed without much difficulty. Of course, only the quantitative effects of government activities can be taken into account in the model. The effects of the order (qualitative) policy cannot be determined on the basis of the model (Tinbergen 1955).

The present model version is to be extended (i) with respect to the peculiarities of the Pakistani agricultural sector and (ii) in the area of intersectoral relations.

THE STRUCTURE OF THE MODEL

Product Supply and Factor Demand

The model deals with the agricultural sector, which produces five products ($i = 1, \ldots, 5$) i.e. wheat (F_1) rice (F_2) sugar (F_3), cotton (F_4) and other products (F_5). For agricultural production two variable factors, i.e. labour (A) and other inputs (K) such as fertilizer, plant protection, irrigation water, and one fixed factor, i.e. land (B) are utilized. The agricultural units are multi-product enterprises. They produce under conditions of perfect competition. Their production depends on the (producer) prices of the outputs and variable inputs (q_i) and the amount of fixed

production factors (B). There are no stocks. We start with the domestic supply functions (β_{ij} = elasticity of supply/demand of i (i = 1, . . ., 5, A, K) with respect to j = price of i B)

$$F_i = \beta_{i1} q_1 + \beta_{i2} q'_2 + \beta_{i3} q'_3 + \beta_{i4} q'_4 + \beta_{i5} q'_5 + \beta_{iA} q'_A + \beta_{iK} q'_K + \beta_{iB} B' \quad (1)\text{-}(5)$$

and the factor demand functions

$$A' = \beta_{A1} q'_1 + \beta_{A2} q'_2 + \beta_{A3} q'_3 + \beta_{A4} q'_4 + \beta_{A5} q'_5 + \beta_{AA} q'_A + \beta_{AK} q'_K + \beta_{AB} B' \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

and

$$(7) \quad K' = \beta_{K1} q'_1 + \beta_{K2} q'_2 + \beta_{K3} q'_3 + \beta_{K4} q'_4 + \beta_{K5} q'_5 + \beta_{KA} q'_A + \beta_{KK} q'_K + \beta_{KB} B'. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

We have substantial imports only for one product, i.e. wheat. Thus, we have to take into account the domestic (F_1), the import (F_{M1}), and the total (F_{T1}) supply (m = share of imports in the total supply)

$$F'_{T1} = mF'_{M1} + (1 - m)F'_1. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

Demand for Products

Households are divided into rural – landless and land owning – and urban – with a lower and with a higher income (k = 1 . . . , 4).

The total demand for wheat, sugar or for other agricultural products' is equal to the aggregate demand of the four household groups:

$$F'_{T1} = \sum_k c_{1k} F'_{1k} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

and

$$F'_i = \sum_k c_{ik} F'ik \quad \ldots \quad \ldots \quad (i = 3, 5). \quad \ldots \quad \ldots \quad (10)\text{-}(11)$$

on the rice market, private households (F_{21} , . . . , (F_{24}) as well as the government (F_{2S}) appear as buyers. Thus the total demand for rice is

$$F'_2 = c_{21} F'_{22} + c_{22} F'_{22} + c_{23} F'_{23} + c_{24} F'_{24} + c_{2S} F'_{2S} \quad \ldots \quad (12)$$

For cotton, only government (F_{4S}) and manufacturing industries (F_{4G}) appear as buyers:

$$F'_4 = c_{4S} F'_{4S} + c_{4G} F'_{4G} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

(c_{ik} = proportion of agricultural output i consumed by socio-economic group k, by manufacturing industry ($k = G$) or by the state ($k = S$)).

Manufacturing and government demands are model exogenous. The demand of the household group k for agricultural products i ($i = 1, 2, 3, 5$) is the product of the population of this group V_k and the per capita demand of this group, which is a function of (consumer) prices P_{H2} and the real per capita income of this household group y_k

$$F'_{iK} = \epsilon_{i1k}\rho'_{H1} + \epsilon_{i2k}\rho'_{H2} + \epsilon_{i3k}\rho'_{H3} + \epsilon_{i5k}\rho'_{H5} + \epsilon_{iyk}y'_k + V'_k \quad (14)\text{-}(29)$$

(ϵ_{ijk} = elasticity of demand of socio-economic group k of output i with respect to output prices, ϵ_{iyk} = income elasticity of demand of socio-economic group k of output i).

One Price Equations

For each agricultural output we distinguish between three prices: (i) the price, which the agricultural producers get for their produce, the farm gate or producer's price q (ii) the wholesale price p, and (iii) the final price, which the (private or public) consumers have to pay, p_H. Between the farm gate price q and the wholesale price p we have the trade and processing margins vp and the wholesale price p and the consumer price p_H differ by the (ad valorem) tax rate t_p.

$$\rho'_i = q'_i - z'_i \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (30)\text{-}(34)$$

(zi = $(1 - V_i)$ = trade (margin) coefficient for output i).

$$\rho'_{Hi} = \rho'_i + k'_i \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (35)\text{-}(39)$$

($k_i = (1 + t_i)$ = tax coefficient for output i).

The producer price of wheat is determined by the world market price q_{w1} and the currency exchange rate w.

$$q'_1 = q'_{1w} + w' \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (40)$$

Balance of Payments and State Budget Restrictions

The agricultural products wheat, rice and cotton are traded internationally. Wheat is imported (F_{M1}) and rice (F_{2S}) and cotton (F_{4S}) are exported by the government. Other net imports valued at world market prices are labeled N, and the world market prices q_w. With b as the share of wheat imports in total imports (value) and d as the share of rice exports in total export (value) the balance of payments restriction thus is

$$(1\text{-}b)N + b\,(q'_{1w} + F'_{M1}) = d\,(q'_{2w} + F'_{2S}) + (1 - d)\,(q'_{4w} + F'_{4S}). \quad (41)$$

On the input side of the government budget restriction stand tax revenues. Public (government) expenditure equals the difference of expenditure for state procurement of rice and cotton and the revenues from the sales of these export goods (converted into domestic currency, i.e. Rupees). R stands for other net expenditure, β_i for the share of tax revenue form good i in total tax revenue from agriculture, a_i for the share of government expenditure for good i (i = 2,4) in total government expenditure, and a_{iw} for the share of export revenue from state trade of i (1 = 2,4) in total government revenue (in domestic currency). Therefore,

$$s_1 (t'_1 + \rho'_1 + F'_{t1}) + s_2 (t'_2 + \rho'_2 + F'_2) + s_3 (t'_3 + \rho'_3 + F'_3) + s_4 (t'_4 + \rho'_4 + F'_4) + s_5 (t'_5 + \rho'_5 + F'_5) = a_2 (F'_{2S} + \rho'_2) - a_{2w} (F'_{2S} + \rho'_2 + w') + a_4 (F'_{4S} + \rho'_4) - a_{4w} (F'_{4S} + \rho'_w + w') + (1 - a_2 + a_{2w} - a_4 + a_{4w}) R' \quad (42)$$

Factor Supply and Migration

The variable production factor labour (A) is supplied by the landless (group 1). The total factor supply is the product of the population of the socio-economic group 1 (V_1) and the per capita labour supply which depends on the real wage rate. The real wage rate is the nominal wage rate (q_A) deflated by the consumer price level of group 1 (I_1), k_j being the factor supply elasticity of factor j (j=A, K).

$$A' = \pi_A (q'_A - l'_1) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (43)$$

The other variable production factor (K) is supplied by the landowners depending on the factor price

$$K' = \pi_K q'_K \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (44)$$

Migration is a function of the difference between rural and urban consumer price levels of groups 1 (landless) and 3 (lower urban). We endogenize the populations of these socio-economic groups (a = migration elasticity)

$$V'_1 = -V'_3 = a((l'_3 l_3/(l_3 - l_1)) - l'_1 l_1/(l_3 - l_1)). \quad \ldots \quad \ldots \quad (45)$$

Consumer Price Levels and Real per Capita Income

Changes of the consumer price level of household group $k(I_k)$ result from

$$l'_k = e_{1k} \rho'_{H1} + e_{2k} \rho'_{H2} + e_{3k} \rho'_{H3} + e_{5k} \rho'_{H5} + e_{0k} \rho'_0 \quad \ldots (46) - (49)$$

With p_0 we describe the consumer prices of industrial consumer goods, e_{ik} describes the share of total consumer expenditures spent on agricultural product i by

socio-economic group k and e_{0k} share of total consumer expenditures spent on industrial products by socio-economic group k.

The first socio-economic group only has labour income. The change of their real per capita income y_1 is determined by

$$y'_1 = A' + q'_A - l'_1 - V'_1. \quad \ldots \quad (50)$$

The second group has capital income and rent from the land (rB) from agriculture plus other income from industry (Y_{02}) (h_{j2} is the share of total income arising from capital ($i = K$) or land ($i = B$)).

$$y'_2 = h_{K2}(K' + q'_K) + h_{B2}(B' + r') + (1 - h_{K2} - h_{B2})Y'_{02} - l'_2 - V'_2 \quad (51)$$

The two urban groups receive (commercial/) industrial income

$$y'_3 = Y'_{03} - l'_3 - V'_3 \quad \ldots \quad (52)$$

$$y'_4 = Y'_{04} - l'_4 \quad \ldots \quad (53)$$

The Rental Value of Land

The change in the rental value of land (r) is derived residually from

$$r' = g_1 q'_1 + g_2 q'_2 + g_3 q'_3 + g_4 q'_4 + g_5 q'_5 + g_A q'_A + g_K q'_K \quad \ldots \quad (54)$$

(g_i = variable profit share, positive for outputs and negative for variable inputs).

3. FIRST RESULTS AND POLICY IMPLICATIONS

Despite its handiness the model needs more data than is readily available. First runs, therefore, were done with rough figures to test the model, using the SAS/IML package on an IBM 3090-180 mainframe under JES_2 MVS 3.8–SP1.3.6. Results turned out instantly. Since this programme is also available for personal computers, the model can be set up and run almost anywhere. Making it interactive would be a challenging goal for the future.

At the time this paper was written, the model had been set up and tested successfully, but only with made-up data, intelligent guesstimates at best. But the first results clearly show the effects of a changing system's environment on the endogenous variables. Given a certain reliability of the coefficients and a sufficient relevance of the assumed relations, one should expect useful insights for policy formulation.

4. CONCLUDING REMARKS

In the introduction we claimed to have set out a model providing solutions to practical problems in agricultural policy. The present paper is a first report on the

project only. A few notes on (some) open questions and likely weak points, however, seem to be appropriate. These are given below:

(i) The model has no time dimension. Any exogenous distortions lead to an 'immediate' adjustment of all prices and quantities. In reality, however, the adjustment process consumes time. The present model is drafted for medium term purposes in the sense, that short term problems of adjustment and long term repercussions on stocks can be neglected.

(ii) Our analysis is a comparative static one; it works without any stocks. The effects of agricultural and economic policy measures are derived.

(iii) The model is an equilibrium model. Possible objectives, that real disequilibria cannot be comprehended, overlook, that the different terms of equilibrium in economic analysis are pure theoretical constructs and that each empirical situation can be described as an equilibrium as well as a disequilibrium (Schlicht 1985).

The critique, that the model is deterministic, and thus cannot adequately comprehend the real dynamics, namely the emergence of new, unpredicted, events even at an explicit recognition of the variable time and in stochastic form, stems from a wrong epistomological goal of economic analysis.

We feel, that it is not the aim of economic theory, to formulate casual explanations, which can be verified empirically. Instead, the techniques of economic analysis are to be understood as equi-functional methods, which construct an area for comparing possibilities, with the help of which pending problems can be solved.

(iv) It is a second best model, because, besides the technological restrictions and the conditions of the market equilibrium, further restrictions are taken up by considering government activities.

(v) The inclusion of economic policy instruments of process policy, which steer the economic process indicatively, is possible without any problem. It should be regarded to be more difficult, to consider the imperative policy instruments, as it is applied especially in the form of price and quantum controls in many developing countries. On the one hand, there are often different controls (interventions) affecting the individual goods, which in a multi-market model are combined to groups of goods, and there is the question, how the different imperative interventions can be aggregated. On the other hand, it has to be clarified whether the control measures can be effective, since price and quantitative controls often are not effective in reality.

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Comments on "Subsidizing Agricultural Production on Imperfect Markets"

The paper presented by the learned authors is more a proposal than a paper. The text never mentions, 'Subsidizing agricultural production on imperfect markets" which is the title of the paper. There is no particular problem with approach of working with local changes, but it is not clear how the authors, will actually get the parameters or whether consistency is imposed or ignored. They are equally vague on the instruments that will bring about changes both endogenous and "exogenous on food demand". The specific comments on the paper are as follows:

- I do not understand how Equation 8 equilibrium conditions nor how *gl* = *glw* models wheat imports. There is no acknowledgement of differences between imports and exports partly or between border prices and "world prices".
- The balance of payments appears to have imports = exports which ignores remittances and transfers such as aid. Similarly, the role of the government which is central to the analysis is not clear.
- The paper makes perfunctory comments about the importance of the general equilibrium system to demonstrate policy instruments in the model presented in section 2.
- The authors state that the model was tested with 'rough figures' using SAS package on a mainframe, then blithely report, "at the time this paper was written, the model had been set and tested successfully, but only with made-up data, intelligent guesstimates at best. But the first results show the effects of changing the system's environments on the endogenous variables." Since the data are hypothetical, particularly the supply and demand equations, the authors have no basis to argue the merits of their results as a useful policy tool.

Finally, the authors describe their particular brand of research methodology as follows: "We feel, that it is not the aim of economic theory, to formulate casual explanations, which can be verified empirically. Instead, the techniques of economic analysis are to be understood as equi-functional methods, which construct an area for comparing possibilities, with the help of which pending problems can be solved". But PIDE does not deserve to be used as a platform for such derival.

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