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Comparative Advantage of Major Crops Production in Punjab: An Application of Policy Analysis Matrix

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Abstract

This study uses data from 1999/2000 to 2004/05 to determine the relative efficiency of major crops (wheat, rice, sugarcane, and cotton) in Punjab (Pakistan) and their comparative advantage in international trade as measured by economic profitability and the domestic resource cost (DRC) ratio. An economic profitability analysis demonstrates that Punjab has a comparative advantage in the domestic production of wheat for self-sufficiency but not for export purposes. In basmati production, Punjab has a comparative advantage, and increasing Basmati production for export is a viable economic proposition. The nominal protection coefficient (NPC), effective protection coefficient (EPC), and DRC for Irri rice are more than 1: the given input-output relationship and export prices do not give Punjab a comparative advantage in production of Irri for export. Sugarcane growers did not receive economic prices (i.e. prices reflecting true opportunity costs) during 2001/02 and 2002/03 in an importing scenario, while in 2003/04, the NPC was 1.02, indicating positive support to sugarcane growers. The NPCs estimated under an exporting situation range from 1.33 to 1.99, indicating that the prices received by growers are higher than the export parity/economic prices. This is also an indication that sugarcane cultivation for exporting sugar is not feasible in terms of economic value. The NPCs for cotton under an importing scenario were less than 1 while under an exporting scenario were either close to or greater than 1, implying an expansion in cotton production as imports have been more expensive than domestic production.

Keywords: Crops, comparative advantage, domestic resource cost, policy analysis matrix (PAM), Pakistan.

JEL Classification: Q17, Q18.

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1. Introduction

1.1. Agriculture in the Pakistan Economy

The agriculture sector is still one of the largest sectors of Pakistan's economy ahead of manufacturing, and accounts for 23.1 percent of gross domestic product (GDP). It accounts for 42 percent of the total employed labor force, and is the largest source of foreign exchange earnings. It also contributes to growth by providing raw materials as well as being a market for industrial products. During the 1990s, agriculture grew at an annual average rate of 4.5 percent per annum. The agriculture growth for 2004/05 is estimated at 7.5 percent. Major crops account for 37 percent of agricultural value added, minor crops contribute 12.2 percent to overall agriculture, livestock (the largest contributor to overall agriculture value added) accounts for 46.8 percent, fisheries account for 1.3 percent, while forestry accounts for 2.5 percent of agricultural value added (Government of Pakistan, 2005a).

1.2. Production of Major Crops

Wheat, rice, cotton, and sugarcane account for 91 percent of value added in major crops. Thus, the four major crops (wheat, rice, cotton, and sugarcane), on average, contribute 31.7 percent to value added in agriculture overall.

Cotton: Cotton is Pakistan's main cash crop and contributes substantially to national income. Cotton production fluctuated between 8 million and 14.6 million bales during the decade ending 2004/05. Pakistan, a net exporter of cotton, has now become a net importer as increasing consumption has outpaced its production. It accounts for 10.5 percent of the value added in agriculture and about 2.4 percent of GDP. Punjab is the main cotton producer, accounting for 80 percent of the area under cotton and 76 percent of production. In addition to providing raw material to the local textile industry, surplus lint cotton is exported. In 2004/05, the production of cotton was 14.618 million bales from an area of 3.221 million ha.

Rice: Rice is an important food cash crop. It is also one of Pakistan's main export items. It accounts for 5.7 percent of value added in agriculture and 1.3 percent of GDP. Rice is planted annually on an area of over 2 million ha and accounts for 18 percent of the area under cereals and 10 percent of the total cropped area. Rice production in 2004/05 was estimated at 4.991

million tonnes. Annual rice production (averaging 4.4 million tonnes in recent years) constitutes 17 percent of the overall output of cereals and 17 percent of the value added by major crops.

Sugarcane: Sugarcane is an important crop with high water requirements. Its share in value added in agriculture and GDP are 3.6 percent and 0.8 percent, respectively. Sugarcane was being cultivated over an area of 0.947 million ha during 2004/05. Its production increased from 52.1 million tonnes in 2002/03 to 53.4 million tonnes in 2003/04, but declined to 45.3 million tonnes in 2004/05.

Wheat: Wheat is the main staple food of the country's population and its largest grain crop. Production fluctuated between 15.21 million and 21.11 million tonnes during the decade ending 2004/05. Wheat contributes 13.8 percent to the value added in agriculture and 3.2 percent to GDP. Punjab is the largest producer of wheat, accounting for 76 percent of the area under wheat cultivation and 80 percent of the wheat produced by the country.

1.3. Problem Specification

In most developing countries, social or economic profitability deviates from private profitability because of distortions in factor and output markets, externalities, and government policy interventions that tend to distort relative prices. These include price fixation, restrictions on wheat movement, and quotas to flour mills. It is therefore necessary to assess the comparative advantage of the production of major crops in Pakistan. Analysis of this comparative advantage can help in deriving meaningful policy conclusions on how to transform the farming system toward more efficient crop activities.

As a member of the World Trade Organization (WTO), Pakistan is committed to the rules and regulations that the Uruguay Round applied to agriculture. The commitments cover a wide range of topics, including domestic support, market access, and export subsidies in agriculture. The potential benefits of this agreement for Pakistan will emerge from the trading regime in its present form and potential trading opportunities for both import substitution and export promotion. However, whether or not a country can take advantage of new trading opportunities will depend on its comparative advantage without the subsidies or with the limited subsidies that are permitted for all trading partners by the rules governing the new trading environment. Therefore, an assessment of the comparative advantage of crop production either for import substitution

or export can be helpful. The principal objectives of this study are to (i) determine the comparative advantage and competitiveness of Pakistan's major crops (wheat, rice, sugarcane, cotton); (ii) assess whether Pakistan qualifies for the export of wheat, rice, sugarcane, and cotton and/or whether it should produce these crops as an import substitution strategy; and (iii) measure the effect of policy incentives that might favor or discriminate against crop production.

2. Review of the Literature

Shahabuddin and Dorosh (2002) conducted a study on comparative advantage in Bangladesh's crop production. Their economic profitability analysis demonstrates that Bangladesh has a comparative advantage in the domestic production of rice for import substitution. However, at the export parity price, the economic profitability of rice is generally less than that of many nonrice crops, implying that Bangladesh has more profitable options than the production of rice for export.

Nelson and Panggabean (1991) find that the Indonesian sugar policy is a complex web of contradictory policies, including mandatory production, price supports, and fertilizer and credit subsidies. The policy analysis matrix (PAM) developed by Monke and Pearson (1989) provides a more complete perspective on social profitability and the divergence between and social costs than other commonly used social cost-benefit measures.

Khan and Ashiq (2004) use a PAM to conclude that seed cotton production has a strong national comparative advantage. The study further reveals that Sindh regained its historical dominance over Punjab in the crop by making a quantum jump in yield from 1997 onward. The nominal protection coefficient (NPC) indicates that seed cotton production in Pakistan is heavily taxed. Their findings suggest that, to exploit the potential of cotton cultivation to cater to local needs and earn foreign exchange, concerted efforts need to be made to improve the performance of the production and processing sectors.

Using the PAM, the Food and Agriculture Organization (FAO) (2004) measures the comparative advantage of production systems in Syria. In the study, the National Agricultural Policy Center has selected a number of specific agro-food chains: cotton, wheat, and olives as strategic crops, tomatoes as vegetables, oranges as fruit, and beef and milk production as livestock. The results conclude that all these systems achieved

a positive profit at private prices, the highest profit per hectare being achieved by tomatoes, followed by orange and olive production. Field crops such as cotton and wheat achieved a much lower return per hectare compared to the tomato and perennial production systems. However, cotton still generates a profit that is around four times the profit per hectare obtained by wheat-based systems, while flour production yields the lowest profit per hectare. The groups that achieved the highest profit at private prices were tomatoes, fresh oranges, and olive oil, while the field crops (hard wheat flour and soft wheat) maintained their profitability. In the livestock group, only the production of packed milk was profitable at its social price while meat production became unprofitable in live or fresh meat form. Cotton production was also not profitable at its social price.

Tweeten (1986) concluded that the southern US has a comparative advantage in the production of grains and soybean based on supply/demand and input and output prices under normal circumstances but with open markets, the southern US does not have a comparative advantage in the production of sugar, wool, and manufactured milk products. These commodities, along with additional tobacco, cotton, fruit, and vegetables, would have to be imported in the absence of price supports and trade restrictions. Red meat, poultry, eggs, and milk for fluid consumption have the characteristics of nontraded goods. In an open world market, the US would export or import only modest amounts of these commodities.

Gonzales, Kasryno, Perez, and Rosegrant (1994) examine trends in government policies and the production of five major food crops in Indonesia: rice, corn, soybean, sugar, and cassava. They analyze the effects of government input-output pricing policies on domestic production and incentives for these crops, and assess their relative comparative advantage under three trade regimes: import substitution, interregional trade, and export promotion. The measures used to assess economic incentives include direct, indirect, and total nominal and effective protection rates. The study finds that Indonesian rice has a comparative advantage as an import substitute but not as an export crop because of poor quality and a thin world rice market. Corn is the most efficient of the five crops as an import substitute. If corn productivity continues to improve, it could become competitive as an export crop. Soybean production despite rapid expansion is not efficient. Sugar is also economically inefficient.

Ahmad and Martin (2000) use a PAM to investigate the efficiency of Pakistani agriculture and the effect of policy interventions in six

primary agricultural systems: wheat, rice, cotton, maize, sugarcane, and potatoes. Of these six systems, only wheat was found to be socially inefficient. Cotton and rice, in contrast, were found to be highly profitable both privately and socially. Pakistan appears to enjoy a considerable comparative advantage in the production of both these crops.

Akhtar, Sharif, and Akmal (2007) also use the PAM methodology to determine the level of economic efficiency and competitiveness in the production of rice crop in Pakistan's Punjab. Their results indicate that expanding the production of Basmati rice could lead to an increase in exports. The production of Irri in Punjab is characterized by a lack of economic efficiency, implying the inefficient use of resources to produce the commodity. On the other hand, both Basmati and Irri rice production in Punjab demonstrate a lack of competitiveness at the farm level for the period under analysis. Moreover, the prevailing incentive structure has affected farmers negatively. A negative divergence between private and social profits implies that the net effect of policy intervention is to reduce the farm-level profitability of both rice production systems in Punjab. The results highlight the need to remove existing policy distortions in the structure of economic incentives to enhance economic efficiency and attain farm-level competitiveness in rice production.

Very few studies on Pakistan look at the relative efficiency of its major crops. Akhtar et al. (2007) compare Irri and Basmati rice but ignore the other major crops, while Ahmad and Martin (2000) make their conclusions based only on one-year datasets. There is a need to compare multiple-year data for multiple major crops to determine comparative crop advantages. Our study uses a six-year dataset (1999/2000 to 2004/05) to examine the relative efficiency of Punjab's major crops (wheat, rice, sugarcane, and cotton) and their comparative advantage in international trade as measured by economic profitability and domestic resource cost (DRC) ratio.

3. Methodology for Measuring Economic Incentives

This study assesses the impact of government interventions on the relative incentives and competitiveness of the four major crops under import substitution and export promotion trade regimes. Since agriculture is the dominant economic sector in Pakistan, government policies that promote agricultural production in general or affect relative incentives within agriculture can have substantial economy-wide effects (Krueger, Schiff, and Valdes, 1988). Annex-1 clarifies the concepts and terminology used here.

3.1. Measures of Economic Incentive

A wide range of government policies influences economic incentives in agricultural production. Price and subsidy policies, import and export policies, and more general macroeconomic policies such as changes in the exchange rate and interest rate policies may affect relative incentives in agriculture. These effects can be measured by using the nominal and effective protection rates as indicators (Gonzales et al. 1994).

3.1.1. Nominal Protection Rate

The border price of a commodity is used as a reference price when measuring the effects of government intervention policies. Without government intervention, the domestic producer price is expected to be closely related to the border price. The nominal protection rate (NPR) is then defined as the amount by which the domestic price of a tradable output deviates from its border price. It is stated as

$$NPR = (P_o^d / Po^b) - 1$$

P_o^d is the domestic producer price of the tradable agricultural product o, and P_o^b is the border price of o, evaluated at the official exchange rate, adjusted for quality, transport, storage, and other margins, measured under competitive conditions, and expressed in local currency. A positive NPR implies price protection and a positive incentive for the production of the commodity.

In calculating the NPR for an agricultural tradable, the market point for comparison is of crucial importance. Since the NPR is an indicator of output incentives or disincentives, there are two marketing points at which comparisons can be made. One is at the production point to determine the incentives that farmers receive at the farm level. The other is at the wholesale or consumption point to determine the effects of pricing policy over a broader spectrum of farm production-processing marketing activities.

3.1.2. Effective Protection Rate

The NPR can measure separately the sectoral and economy-wide effects on both outputs and inputs but not their net effects on the total agricultural production system. The effective protection rate (EPR) measures these net effects through their effects on the value-added of the agricultural product. Formally, it is conventionally expressed as

$$EPR = (P_o^d - \sum_j a_o P_j^d) / (P_o^b - \sum_j a_o P_j^b) - 1 = (V_o^d / V_o^b) - 1,$$

P_j^d is the domestic price of input j, Pj^b is the border price of input j expressed in local currency, V_o^d is the value added in domestic prices, and V_o^b is the value added in border prices expressed in local currency.

The numerator is the value added expressed in actual domestic market prices, while the denominator is the value added expressed in border prices converted to local currency. Again, the border price is used as the reference price that would prevail in the absence of interventions. In effect, the ratio is a summary measure of the incentives or disincentives caused by government policies and market distortions in both the output and input markets. A positive EPR, therefore, implies that a particular production activity is receiving a positive incentive through protection at the existing exchange rate and trade policies, while a negative EPR indicates a production disincentive.

3.2. Measure of Comparative Advantage

Comparative advantage in the production of a given food crop for a particular country or region is measured by comparing with its border price the social or economic opportunity costs of producing, processing, transporting, handling, and marketing an incremental unit of that food commodity. If the opportunity cost is less than the border price, then that country has a comparative advantage in the production of that particular food crop. In most developing countries, social or economic profitability deviates from private profitability because of distortions in the factor and output market, externalities, and government policy interventions that tend to distort relative prices. Comparative advantage or comparative efficiency in Punjab's economy is estimated here using the DRC.

The DRC of foreign exchange earned or saved from a particular production activity can be expressed as the ratio of domestic (nontaxable) factor costs in shadow prices per unit of output to the difference between the border price of output and foreign (tradable) costs (both expressed in foreign currency). In effect, the DRC is the "own exchange rate" of a particular production activity. Since the numerator is expressed in local currency and the denominator in foreign currency, the DRC can be used to determine the economic competitiveness of a production activity by comparing it with the shadow exchange rate (SER) of the currency. Thus, an activity is economically competitive or displays comparative advantage if the opportunity cost of earning or saving an incremental unit of foreign

exchange is less than the SER. The smaller the DRC relative to the SER, the greater is the activity's comparative advantage. Activities with the smallest DRCs display the greatest relative comparative advantage.

3.3. Policy Analysis Matrix

The concept of the PAM was developed by Monke and Pearson (1989) and augmented by developments in price distortion analysis by Masters and Winter-Nelson (1995). A PAM allows us to study the impact of policy by constructing different enterprise budgets, one valued at market prices and the other valued at social prices. After the formulation of the matrix, it provides an expedient method of calculating the measure of policy effects and events of competitiveness and economic efficiency/comparative advantage. A wide range of government policies can influence the protection/lack of protection of agricultural production, which can be measured using the NPR and EPR as indicators. This structure is particularly useful in identifying an appropriate way to change policy (Gonzales et al., 1993).

Several recent studies have used a PAM that relates to the comparative advantage and policy effect (Khan, 2001). The assessment of the comparative advantages of a given productive system encompasses a broad range of concepts emanating from cost-benefit analysis and the theory of international trade. The basic idea is that any economic activity in a given country has a comparative advantage insofar as it can compete with alternative sources of supply through import without benefiting from any specific support from the rest of the economy in the form of transfer of resources. Using the PAM framework, private profit (D) is equal to total revenue (A) less the cost of tradable inputs (B) and domestic resources such as land, labor, and capital (C), all evaluated at private prices (Table-1). Similarly, social profit (H) is defined as total revenue (E) less the cost of tradable inputs (F) and domestic resources such as land, labor, and capital (G), all evaluated at their social opportunity cost (social prices).

Table-1: Policy Analysis Matrix

	Revenue	Tradable Input	Domestic Factor	Profit
Private Prices	A	B	C	D
Social Prices	E	F	G	H
Divergence	I	J	K	L

Notes: Private profit (D) = A-B-C

Ratio indicators for comparison of unlike outputs are:

Social profit (H) = E-F-G	Private cost ratio (PCR) = C/ (A-B)
Output transfer (I) = A-E	DRC = G/(E-F)
Input transfer (J) = B-F	Nominal protection coefficient on tradable output (NPC) = A/E
Factor transfer (K) = C-G	Nominal protection coefficient on tradable
Net transfer (L) = D-H= I-J-K	input (NPC) = B/F

Source: Monke and Pearson (1989).

The profit generated by a selected system is measured by subtracting from the value of the total tradable output the value of the tradable inputs and the values of the domestic factors utilized to produce the output. Considering that the total output sale is the revenue of the system, this accounting identity is computed using two price systems. The first line of the PAM contains the value for the accounting identity measured at private prices (A, B, C, D), which are the prices actually used by the different agents to purchase their inputs and domestic factors and sell their outputs. The second row of the PAM gives the value of the same identity but measured at social prices. These prices are the prices that would prevail if the value of tradable inputs and outputs and domestic factors were not modified either by the economic policy in place (tax, subsidy, price intervention) or by output, input, or factor market failure, which results in a distorted price system. The third row of the PAM is obtained by subtracting the social value from the private value, and indicates the magnitude of the divergence between the situation at private prices and social prices.

The PAM provides a range of indicators for assessing the efficiency of a system. If D is positive, then the system generates profit under the current policy and market conditions and is competitive. Similarly, if H is positive, then the system would be able to make a profit even without benefiting from a subsidy or being constrained by taxes, and is said to have a comparative advantage. If a system is benefiting from input use or has to pay higher prices for labor, then it can be

competitive, i.e., D>0, while having no comparative advantage, i.e., H<0 (Shahabuddin & Dorosh, 2002).

- The financial cost benefit ratio (FCB) is the value of the domestic factors against the difference between the revenue minus tradable input: FCB = C/(A-B). If this ratio is above 1, it means that the system utilizes a greater value of domestic factors than the value added, and is not profitable. If the FCB<1, the system is profitable.

- The DRC ratio provides a measure of the level of comparative advantage achieved by the selected system: DRC = G/(E-F). If the DRC is above 1, the system has no comparative advantage; if it is below 1, the system has a comparative advantage.

- The nominal protection coefficient (NPC) measures the level of protection for the tradable output by looking at the ratio of revenue at private prices to revenue at social prices: NPC = A/E. If the NPC is above 1, it indicates that the system benefits from protection. An NPC below 1 indicates that the main output is undervalued at its private price, resulting in a transfer of wealth from the production system to the economy.

- The effective protection coefficient (EPC) compares the value added at private prices to value added at social prices: EPC = (A-B)/(E-F). This gives us a combined index of the level of trade distortion on both tradable inputs and outputs, and provides a more accurate measure of the level of protection than the NPC. An EPC above 1 means that the selected system is protected while an EPC below 1 means that the system generates less value added at market prices than it would at social prices.

4. PAM Results

4.1. Wheat

Wheat is the leading food grain in Pakistan as well as in Punjab, and gets the highest priority in the government's agricultural development strategy. Punjab is the main wheat-producing province, accounting for 80 percent of national production and 76 percent of cropped area (Government of Pakistan, 2005b). In view of its importance, it is imperative to examine its competitiveness from the farmer's as well as national perspective. In view of the upcoming WTO regime, domestic

crop production in general and wheat in particular has become a challenging issue. To determine whether Pakistan has a comparative advantage in producing wheat, we have to estimate the NPC, EPC, and DRC in the context of wheat farming, based on detailed data for average farmers and the import/export prices of wheat. The efficiency parameters have been calculated for the period from 1999/2000 to 2004/05 (crop years). Data on the private and social profitability for these years is given in Annex-A.

4.1.1. NPC and EPC

Empirical estimates of the NPCs and EPCs for wheat in Punjab are given in Table-2. The NPCs are estimated by dividing domestic output prices by social prices, i.e., import/export parity prices. They measure the impact of output pricing policies without considering interventions/distortions in input markets. The table reveals that, during 1999/2000 to 2004/05, producer prices ranged from 18 to 32 percent less than their export parity levels, implying implicit taxation of producers as producer prices were less than the border prices. Over time, wheat has not received any protection during the period as both coefficients are less than 1.

Table-2: NPC and EPC for Wheat

Year	NPC = A/E	EPC = (A-B)/(E-F)
1999-2000	0.82	0.65
2000-01	0.72	0.52
2001-02	0.70	0.43
2002-03	0.68	0.41
2003-04	0.81	0.55
2004-05	0.76	0.53
Average	**0.75**	**0.52**

The EPC is the ratio of the difference between the revenue and tradable inputs' costs in private prices to that in social prices. Table-2 reveals that the EPC for wheat decreased from 0.65 in 1999/2000 to 0.41 in 2002/03. However, during 2003/04 and 2004/05, increased domestic prices of wheat and simultaneously increased input prices led to an increase in the EPC to 0.55 and 0.53, implying a reduction in implicit tax. It also shows that value added at domestic price was around 41 percent to 65 percent of value added at international prices during the observed period.

4.1.2. DRC

Table-3 presents the results of a DRC analysis for wheat for the period 1999/2000 to 2004/05. The DRC coefficients declined from 0.61 in 1999/2000 to 0.47 in 2004/05. The average DRC coefficient of 0.53 reflects that we earn/save one rupee of foreign exchange by employing our domestic resources of Rs0.53 in wheat production. It also implies that wheat has a comparative advantage, as the product can generate foreign exchange at a lower resource cost than the direct purchase of foreign exchange.

Table-3: DRC for Wheat

Year	DRC = G/(E-F)
1999-00	0.61
2000-01	0.56
2001-02	0.52
2002-03	0.48
2003-04	0.52
2004-05	0.47
Average	**0.53**

4.1.3. Import/Export Parity Prices

Pakistan was a regular importer of wheat up to 1999/2000. During 2002/03, the country exported about 1.7 million tonnes of wheat, but imported 1.5 million tonnes of wheat in 2003/04. Estimating the import parity prices of a commodity is helpful in determining the opportunity cost of resources used in its domestic production while export parity prices are helpful in ascertaining its competitiveness in the international market.

Both import and export parity prices have been calculated on the basis of the FOB (Pacific) quoted price of US Western White Wheat. The calculation of import/export parity prices is based on economic analysis.

The computational details of estimated import/export parity prices and NPCs of wheat for the study period are given in Table-4 (A&B). The estimates presented indicate that wheat producers have not received any protection. The prices received by the growers have been substantially below the corresponding import parity prices. The results

show that Pakistan (Punjab) has a comparative advantage in wheat production for food self-sufficiency.

Table-4A: NPC for Wheat in Import Parity Price Scenario (Rs/40 kg)

Year	CIF Price of Wheat	Transportation and Handling Charges	Transportation From Karachi to Lahore	Procurement Centre to Lahore	Import Parity price at Procurement Centre	Market Price	NPC
2001-02	374.2	55	40	6.7	462.5	281	0.61
2002-03	417.9	55	40	6.7	506.2	310	0.61
2003-04	467.6	55	40	6.7	556.0	385	0.69
2004-05	466.8	55	40	6.7	555.1	432	0.78

Table-4B: NPC for Wheat in Export Parity Price Scenario (Rs/40 kg)

Year	FOB Price of Wheat Karachi	Incidental Charges (Multan)	Export Parity Price at Procurement Centre	Procurement Centre to Lahore	Market Price	NPC
2001-02	259.5	73.6	185.9	6.7	281	1.57
2002-03	303.0	73.6	229.4	6.7	310	1.39
2003-04	350.4	74.8	275.6	6.7	385	1.43
2004-05	346.0	74.7	271.3	6.7	432	1.63

4.1.4. NPC in Export Parity Price Scenario

The NPCs estimated under an exporting situation range from 1.39 to 1.63, indicating that the prices received by growers were higher than the export parity/economic prices. This is also an indication that wheat cultivation for export at the current input-output and price relationship is not feasible as the current export of wheat is subsidizing consumers of the importing country through taxpayer money from Pakistan (Table-4B). On the whole, the results show that Pakistan (Punjab) does have a comparative advantage in wheat production for self-sufficiency but not for export given the current input-output and price structure.

4.2. Rice

Rice, an important food and cash crop, is the third-largest crop of Pakistan in terms of area after wheat and cotton. Punjab accounts for 69 percent of the area under rice cultivation as a whole and 58 percent of total production.

The estimation of the NPC, EPC, and DRC is based on detailed data for average farmers and export prices of rice. The efficiency parameters have been calculated for the period 1999/2000 to 2004/05

(crop years). Data on the private and social profitability for these years is given in Annex-B.

4.2.1 NPC and EPC

Empirical estimates of NPCs and EPCs with respect to Basmati and Irri (paddy) in Punjab are given in Table 5. The NPC is estimated by dividing domestic output prices by social prices, i.e., import/export parity prices. It measures the impact of output pricing policies without considering any interventions/distortions in input markets. The NPCs estimated for Basmati and Irri paddy for 1999/2000 to 2004/05 reveal that producers' prices for Basmati ranged from 1 percent less during 2002/03 to 28 percent less in 1999/2000 than the export parity prices, implying that producers' prices were less than the corresponding border prices. Over time, Basmati prices did not receive any protection during 1999/2000 to 2004/05. The EPCs indicate that the extent of implicit taxation of domestic producers of Basmati was higher during 1999/2000 to 2004/05. In the case of Irri, both the NPCs and EPCs are generally higher than 1, implying protection in its production.

Table-5: NPC and EPC for Basmati and Irri (Paddy)

Year	NPC = A/E		EPC = (A-B)/(E-F)	
	Basmati	**Irri**	**Basmati**	**Irri**
1999-00	0.72	1.21	0.65	1.35
2000-01	0.57	1.03	0.52	0.98
2001-02	0.89	1.43	0.43	1.67
2002-03	0.99	1.37	0.41	1.54
2003-04	0.97	0.95	0.55	0.78
2004-05	0.99	0.97	0.88	0.82
Average	**0.86**	**1.16**	**0.57**	**1.19**

4.2.2. DRC

The DRC indicates the opportunity cost of domestic resources used per unit of value added in the production of a commodity. If the DRC is less than 1, it indicates a commodity system with a comparative advantage, and if it is greater than 1, it implies a situation of disadvantage. Table-6 shows that the DRCs for Basmati were less than 1 during 1999/2000 to 2004/05, implying that Pakistan (Punjab) has a comparative advantage in Basmati production. The DRC ranged from 0.62 in 1999/2000 to 0.77 in 2004/05. This also means that the domestic resources involved in earning one US dollar through Basmati rice export

were consistently less than the corresponding exchange rate. Therefore, increasing Basmati production for exports is an economic proposition.

The DRCs for Irri are greater than 1, indicating that, at a given input-output relationship and price relationship in the export market, Pakistan does not have a comparative advantage in producing Irri for export.

Table-6: DRC for Rice

Year	DRC = G/(E-F)	
	Basmati	**Irri**
1999-00	0.62	1.83
2000-01	0.65	2.00
2001-02	0.70	2.22
2002-03	0.71	2.22
2003-04	0.72	1.08
2004-05	0.77	1.12
Average	**0.68**	**1.75**

4.2.3. Export Parity Prices of Rice (Paddy)

Pakistan exports both fine and coarse varieties of rice. The export of rice totaled 1.82 million tonnes in 2003/04, of which 0.816 million tonnes were of the fine variety. The export parity prices have been calculated on the basis of actual export prices and Thai White quoted prices (for coarse varieties) and economic parity prices have been worked out accordingly. Details are given in Table-7.

The NPCs for Basmati and Irri (paddy) estimated under an exporting situation range from 0.75 to 0.92 and 1.03 to 1.21, indicating that the prices received by growers of Basmati were lower, while for Irri, the prices received by growers were higher than the export parity/economic prices, indicating that Basmati prices in Punjab received no protection while Irri prices did.

Table-7: NPC for Rice (Paddy) in Export Parity Price Scenario (Rs/40 kg)

	Basmati	Irri	Basmati	Irri	Basmati	Irri	Basmati	Irri
Ave. fob (Karachi) Price	1153.20	410.9	1176.32	411.72	1184.74	461.50	1241.25	540.09
Expenses from Sheller	186.00	48.00	186.00	48.00	186.00	48.00	186.00	48.00
Product Recoveries per 100 kg of Paddy	45 kg	48.60	45	48.60	45.00	48.60	45kg	48.60
Value of Rice	435.24	176.37	445.64	176.77	449.43	200.96	474.86	239.15
Total Value of Products	526.93	239.11	561.51	236.87	565.26	268.88	600.00	318.46
Processing Charges	50.80	40.00	50.80	40.00	50.80	40.00	50.80	40.00
Export Parity Price of Paddy	476.13	199.11	510.71	196.87	514.46	228.88	549.20	278.46
Market price	356	205	468	218	473	257	451	338
NPC	**0.75**	**1.03**	**0.92**	**1.11**	**0.92**	**1.12**	**0.82**	**1.21**

4.3. Sugarcane

The economic efficiency of sugarcane production has been evaluated by estimating the NPC, EPC, and DRC through a PAM for both importing and exporting scenarios. The efficiency parameters have been calculated for the period 1999/2000 to 2004/05 (crop years). Data for the private and social profitability for these years are given in Annex-C.

4.3.1. NPC and EPC

Empirical estimates of NPCs and EPCs with respect to sugarcane in Punjab are given in Table-8. The NPCs are estimated by dividing domestic output prices by social prices, i.e., import/export parity prices. They measure the impact of output pricing policies without considering any interventions/distortions in input markets. The table reveals that, during 1999/2000 to 2004/05, producer prices ranged from 1 to 12 percent less than their import parity levels implying implicit taxation of producers as producer prices were less than the border prices. Over time, sugarcane in Pakistan received no protection during the observed period as the coefficients were less than 1. The NPCs using export parity prices revealed that cane growers received higher prices than export parity prices, implying that sugarcane cultivation is uneconomical for export.

Table-8: NPC and EPC for Sugarcane

Year	NPC = A/E		EPC = (A-B)/(E-F)	
	Import Parity Prices	Export Parity Prices	Import Parity Prices	Export Parity Prices
1999-00	0.99	1.54	1.59	0.97
2000-01	1.07	1.55	1.59	1.07
2001-02	0.93	1.38	1.35	0.86
2002-03	0.90	1.33	1.28	0.81
2003-04	0.90	1.99	2.08	0.80
2004-05	0.93	1.35	1.35	0.85
Average	**0.95**	**1.50**	**1.51**	**0.89**

The EPC is the ratio of the difference between the revenue and tradable input costs in private prices to that in social prices. Table 8 reveals that the EPC decreased from 0.97 in 1999/2000 to 0.85 in 2004/05. It also reveals that cane growers were implicitly taxed, ranging from 3 to 20 percent during the study period under an importing country scenario. The EPCs estimated using export parity prices of sugarcane in output pricing reveal positive support to sugarcane ranging from 28 to 93 percent.

4.3.2. DRC

Table-9 presents the results of a DRC analysis of the sugarcane crop for the period 1999/2000 to 2003/04. The DRC coefficients increased from 0.62 in 1999/2000 to 0.72 in 2004/05. The average DRC coefficient of 0.67 reflects that we earn/save one rupee of foreign exchange by employing our domestic resources of Rs0.67 in cane production. It also implies that sugarcane has a comparative advantage as the product can generate foreign exchange at a lower resource cost than the direct purchase of foreign exchange. Using export parity prices, the DRC for sugarcane production in Punjab is on average more than 1. It suggests that sugar export is not a viable proposition at the prevailing input-output relationships and prices.

Table-9: DRC for Sugarcane

Year	DRC = G/(E-F)	
	Import Parity Prices	**Export Parity Prices**
1999-00	0.62	0.97
2000-01	0.51	0.71
2001-02	0.66	1.00
2002-03	0.71	1.08
2003-04	0.81	1.57
2004-05	0.72	1.02
Average	**0.67**	**1.02**

4.4. Seed Cotton

The economic efficiency of cotton production has been evaluated by estimating the NPC, EPC, and DRC through a PAM. These parameters have been estimated under both import and export situations. The efficiency parameters have been calculated for the period 2002/03 to 2004/05 (crop years). Data on the private and social profitability of these years is given in Annex-D.

4.4.1. NPC and EPC

Empirical estimates for NPCs and EPCs with respect to sugarcane are given in Table-10. The NPC is estimated by dividing domestic output prices by social prices, i.e., import/export parity prices. It measures the impact of output pricing policies without considering any interventions/distortions in input markets. The NPCs in an export scenario were either close to or greater than 1, whereas under an import situation, they were less than 1. This implies an expansion in cotton production to meet the increasing raw material requirements, as imports have been more expensive than domestic production. The EPC takes into account the impact of policy interventions in input markets, which reveals the same inferences as drawn from the NPCs.

Table-10: NPC and EPC for Cotton

Year	NPC = A/E		EPC = (A-B)/(E-F)	
	Import Parity Prices	Export Parity Prices	Import Parity Prices	Export Parity Prices
2002-03	0.75	0.98	0.61	0.88
2003-04	0.92	1.22	0.83	1.21
2004-05	0.74	**0.96**	0.57	0.83
Average	**0.81**	**1.07**	**0.68**	**1.02**

4.4.2. DRC

The results of the analysis (Table-11) indicate that the DRC was less than 1 during the study period under both importing and exporting situations. Thus Punjab (Pakistan) enjoys a comparative advantage in cotton production. The DRC coefficients range from 0.52 to 0.68, implying that the cost of domestic resources involved in earning one US$ through cotton export is 32 to 48 percent less than the current exchange rate. Therefore, increasing cotton production is an economic proposition for export. Under the importing scenario, the DRC coefficients are lower than the corresponding coefficients estimated under the exporting situation, implying that the cost of domestic factors involved in saving one unit of foreign exchange through increased cotton production is only 33 to 49 percent of its market price. Thus, an expansion in cotton production for import substitution is highly cost effective.

Table-11: DRC for Cotton

Year	DRC = G/(E-F)	
	Import Parity Prices	Export Parity Prices
2002-03	0.43	0.62
2003-04	0.36	0.52
2004-05	0.46	0.68
Average	**0.41**	**0.67**

5. Conclusion and Policy Implications

The PAM was modeled to assess the competitiveness and comparative advantage of major crops such as wheat, rice, sugarcane, and cotton production in Punjab (Pakistan) and whether the province qualifies for export or should produce for self-sufficiency.

Economic efficiency in wheat production in Punjab during the study period was determined by estimating the NPC, EPC, and DRC. The results of the NPC revealed that, under an importing scenario, wheat production did not receive any protection. The prices received by growers were below the import parity prices. The same conclusion was drawn from the NPC, but the implicit tax on the producers under an importing situation was higher under the EPC than estimated from the NPC's. The DRC for wheat was less than 1, also indicating that Punjab has a comparative advantage in producing wheat. Overall, the PAM results showed that Punjab has a comparative advantage in wheat production for self-sufficiency but not for export given the current input-output and price relationships.

An analysis of Basmati production revealed that Punjab did not receive any protection during the study period as the NPC was less than 1. The EPC also supported this conclusion. The DRC, which was less than 1, indicated that Basmati production has a comparative advantage. It further implies that the cost of domestic resources involved in earning one US$ through export has been consistently less than the corresponding exchange rates. Thus, increasing Basmati production for export is an economic proposition. As far as Irri rice is concerned, both the NPC and EPC for Punjab are higher than 1, implying protection to its production in Punjab. The DRCs for Irri were greater than 1 during the study period, implying that, with the given input-output relationships and prices in export markets, Punjab does not have a comparative advantage in producing Irri for export.

The NPCs estimated for Punjab in a sugar-importing scenario (less than 1 for the crop years 2001/02 and 2002/03) showed that cane growers did not receive economic prices during these years. However, in 2003/04, the estimated NPC was more than 1, reflecting support to cane growers as the prices received exceeded the import parity prices. The NPCs estimated under an exporting situation were more than 1, indicating that the prices realized by growers were higher than the corresponding export parity/economic prices. This further reflects that sugarcane production for exporting sugar is not an economic proposition.

Cotton production is efficient in term of economic prices. The NPCs under an export scenario were either close to or more than 1, whereas in an importing situation, they were less than 1. This implies that an expansion in cotton production has a comparative advantage since imports are expensive than domestic production.

The results of the present study suggest exploiting the available potential in cotton cultivation to cater to local needs and earn foreign exchange. Concerted efforts need to be made to improve the performance of the production and processing sectors. Policies conducive to cotton production in the province are also important.

It is also clear from the results that Punjab should not produce wheat for export given the current conditions and policies. The export of wheat is an efficiency loss of scarce resources that could be used to produce other more socially profitable products or needed crops.

Basmati production for export is an economic proposition. As far as Irri is concerned, the given input-output relationships and prices in exports markets imply that in Irri Punjab does not have a comparative advantage in production for export. Finally, sugarcane production for export is not an economic proposition.

Appendix 1

Basic Concepts and Terminology

Measures of Economic Incentives

A wide range of government policies influence economic incentives in agricultural production. Price and subsidy policies, import and export polices, and more general macroeconomic policies such as exchange rate and interest rate policies may affect relative incentives in agriculture. These effects can be measured by using the nominal and effective protection rates as indicators.

Nominal Protection Rate

Border prices of commodities are used as reference prices in measuring the effects of government intervention policies. Without government intervention, the domestic producer prices are expected to be closely related to the border prices. The nominal protection rate (NPR) is then defined as the amount by which the domestic price of a tradable output deviates from its border price. It can be stated as

$$NPR = \left(\frac{P_o^d}{P_o^b}\right) - 1$$

Where P_o^d is the domestic producer price of a tradable agricultural product *o*, and P_o^b is the border price of *o*, evaluated at the official exchange rate, adjusted for quality, transport, storage, and other margins, measured under competitive conditions, and expressed in local currency. A positive NPR implies price protection and positive incentives for the production of the commodity.

Measures of Comparative Advantage

Comparative advantage in the production of a given food crop for a particular country or region is measured by comparing with its border price the social or economic opportunity costs of producing, processing, transporting, handling, and marketing an incremental unit of the food commodity. If the opportunity costs are less than the border price, then

that country has a comparative advantage in the production of that particular food crop. In most developing countries, social or economic profitability deviates from private profitability because of distortions in the factor and output markets, externalities, and government policy interventions that tend to distort relative prices. Comparative advantage or comparative efficiency is estimated using three indicators.

The net social or economic profitability (NSP), the domestic resource cost (DRC), and the resource cost ration (RCR). These indicators are formally defined as follows:

$$NSP = \left(P_o^s - \sum a_{oj} P_j^s - \sum b_{ok} P_k^s\right) \times Y_o$$

$$= \left(P_o^b - \sum a_{oj} P_j^b - \sum b_{ok} P_k^s\right) \times Y_o$$

$$DRC = \frac{\sum b_{ok} P_k^s}{P_{of}^b - \sum a_{oj} P_{jf}^b}$$

And

$$RCR = \frac{\sum b_{ok} P_k^s}{P_{of}^b - \sum a_{oj} P_{jf}^b E^*}$$

Where world (border) prices are taken as shadow prices of tradable inputs and outputs,

$$P_o^s = P_o^b \text{ and } P_j^s = P_j^b$$

The terms are defined as follows:

P_o^s = shadow price of output o;

P_j^s =shadow price of tradable input j;

a_{oj} = quantity of the jth input needed to produce a unit of output o;

b_{ok} = quantity of the kth input needed to produce a unit of output o;

Y_o = yield per hectare of output o;

P_{of}^{b} = border price equivalent of output o in foreign currency, adjusted for transport, storage, distribution, and quality differences;

P_{jf}^{b} = border-price equivalent of input j in foreign currency, adjusted for transport, storage, distribution, and quality differences; and

E* = equilibrium nominal exchange rate, taken as the shadow value of the exchange rate.

Net Social Profitability

NSP is calculated on a per hectare basis. It is the difference between gross revenue and total costs expressed in economic prices. As an indicator of comparative advantage, the interpretation of NSP is straightforward. A production activity has comparative advantage if the NSP is greater than zero.

Domestic Resource Cost

The DRC of foreign exchange earned or saved from a particular production activity can be expressed as a ration of the domestic (non-tradable) factor costs in shadow prices per unit of output to the difference between the border price of output and foreign (tradable) costs (both expressed in foreign currency). In effect, the DRC is the "own exchange rate" of a particular production activity, since the numerator is expressed in local currency whereas the denominator is in foreign currency. The DRC measures the social opportunity cost of domestic resources employed in earning or saving a marginal unit of foreign exchange. As a measure of comparative advantage, the DRC can be used to determine the economic competitiveness of a production activity by comparing it with the shadow exchange rate (SER) of the currency.

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Appendix-A

Economic Efficiency of Resource Use in Wheat Policy Analysis Matrix (PAM) For Average Farmers (Based on Import Parity Prices)

Rs/Acre

	Revenue	Trade Cost	Domestic Factor Cost	Profit
1999-2000				
Private Prices	8310	4544	3765	1
Social Prices	10092	4343	3525	2224
Transfers	-1782	201	240	-2223
2000-01				
Private Prices	7705	4331	3891	-517
Social Prices	10725	4218	3633	2874
Transfers	-3020	114	257	-3391
2001-02				
Private Prices	7931	4917	3931	-917
Social Prices	11361	4357	3627	3377
Transfers	-3430	559	304	-4294
2002-03				
Private Prices	8384	5266	4005	-888
Social Prices	12330	4676	3711	3943
Transfers	-3946	590	294	-4831
2003-04				
Private Prices	10274	5769	4268	237
Social Prices	12617	5010	3961	3646
Transfers	-2344	759	307	-3409
2004-05				
Private Prices	11332	6443	4712	178
Social Prices	14961	5670	4365	4926
Transfers	-3629	773	347	-4749

Source: Support Price Policy for Wheat, 2005-06 Crop, APCom, Government of Pakistan, Islamabad.

Appendix-B

Economic Efficiency of Resource Use in Basmati and Irri (Paddy) Average Farmers

Rs/Acre

	Revenues		**Traded Cost**		**Domestic Factor Cost**		**Profit**	
	Basmati	**Irri**	**Basmati**	**Irri**	**Basmati**	**Irri**	**Basmati**	**Irri**
1999-2000								
Private Prices	8091	6737	3603	3247	4360	3719	124	-229
Social Prices	11194	5563	3461	2978	4773	4721	2959	-2136
Transfers	-3103	1173	145	269	-413	-1002	-2835	1907
2000-01								
Private Prices	6745	5848	3990	3433	4658	3884	-1904	-1468
Social Prices	11746	5653	3939	3184	5095	4955	2712	-2485
Transfers	-5001	195	52	249	-436	-1071	-4616	1017
2001-02								
Private Prices	10027	7927	4559	3872	4743	4331	-725	-276
Social Prices	11210	5546	3803	3112	5220	5392	2187	-2957
Transfers	-1183	2380	756	760	-478	-1062	-1462	2681
2002-03								
Private Prices	11483	7910	4660	3995	5083	4521	1740	-606
Social Prices	11639	5764	3853	3214	5561	5650	2225	-3100
Transfers	-156	2146	807	781	-479	-1129	-485	2494
2003-04								
Private Prices	11722	8647	5220	4377	5491	4708	1011	-438
Social Prices	12035	9116	4331	3645	5947	5910	1757	-439
Transfers	-313	-469	888	732	-456	-1203	-745	1
2004-05								
Private Prices	12760	9199	5665	4732	5728	4808	1367	-340
Social Prices	12939	9468	4832	4006	6230	6108	1876	-647
Transfers	-179	-268	832	725	-502	-1300	-509	307

Source: Support Price Policy for Rice (Paddy), 2005-06 Crop, APCom, Government of Pakistan, Islamabad.

Appendix-C

Economic Efficiency of Resource Use in Sugarcane Production Policy Analysis Matrix (PAM) Based on Import Parity Prices

(Rs/Acre)

	Revenue	Trade Cost	Domestic Factor Cost	Profit
1999-2000				
Private Prices	19393	5034	9399	4960
Social Prices	19516	4684	9180	5652
Transfers	-123	350	219	-692
2000-01				
Private Prices	25309	5070	9862	10377
Social Prices	23612	4714	9583	9315
Transfers	1697	356	279	1062
2001-02				
Private Prices	20239	5946	11337	2956
Social Prices	21692	5030	10972	5690
Transfers	-1453	916	365	-2734
2002-03				
Private Prices	19474	6060	12233	1180
Social Prices	21739	5122	11800	4817
Transfers	-2265	938	433	-3637
2003-04				
Private Prices	19048	6604	12945	-501
Social Prices	21055	5569	12473	3013
Transfers	-2006	1035	472	-3514
2004-05				
Private Prices	22436	7004	13645	1787
Social Prices	24057	5897	13004	5155
Transfers	-1621	1107	641	-3368

Source: Price Policy for Sugarcane 2005-06 Crop, APCom, Government of Pakistan, Islamabad.

Economic Efficiency of Resource Use in Sugarcane Production Policy Analysis Matrix (PAM) Based on Export Parity Prices

(Rs/Acre)

	Revenue	Trade Cost	Domestic Factor Cost	Profit
1999-2000				
Private Prices	19393	5034	8939	5420
Social Prices	13284	4265	8764	255
Transfers	6109	769	175	5165
2000-01				
Private Prices	25309	5070	9301	10938
Social Prices	17047	4288	9119	3640
Transfers	8262	781	182	7298
2001-02				
Private Prices	20239	5946	10772	3521
Social Prices	15209	4657	10513	38
Transfers	5031	1289	259	3483
2002-03				
Private Prices	19474	6060	10662	1751
Social Prices	15274	4791	11343	-860
Transfers	4200	1269	319	2612
2003-04				
Private Prices	22439	6628	12307	3508
Social Prices	12504	4914	10921	-4332
Transfers	9935	1712	386	7838
2004-05				
Private Prices	22436	7004	13645	1787
Social Prices	17332	5897	11635	-200
Transfers	5105	1107	2011	1987

Source: Price Policy for Sugarcane 2005-06 Crop, APCom, Government of Pakistan, Islamabad.

Appendix-D

Economic Efficiency of Resource Use in Seed Cotton Production in Punjab Policy Analysis Matrix (PAM)

(Rs/Acre)

	Revenue	Trade Cost	Domestic Factor Cost	Profit
	Based on Export Parity Prices			
2002-03				
Private Prices	15043	5780	7089	2174
Social Prices	15278	4766	6529	3983
Transfers	-235	1014	560	-1809
2003-04				
Private Prices	21751	6383	7223	8146
Social Prices	17861	5192	6646	6022
Transfers	3891	1190	577	2123
2004-05				
Private Prices	15549	6974	7548	1027
Social Prices	16141	5770	7016	3354
Transfers	-592	1204	532	-2327
	Based on Import Parity Prices			
2002-03				
Private Prices	15043	5780	7089	2174
Social Prices	20074	4881	6540	8653
Transfers	-5031	899	549	-6479
2003-04				
Private Prices	21751	6383	7223	8146
Social Prices	23764	5290	6655	11819
Transfers	-2012	1093	568	-3673
2004-05				
Private Prices	15549	6974	7548	1027
Social Prices	20978	5890	6883	8205
Transfers	-5429	1084	665	-7177