10-5-2010

Protection and comparative advantage of rice production in Bangladesh: A policy analysis matrix

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* The paper is extracted from the first author master's thesis submitted to the Humboldt-Universität zu Berlin

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Abstract

The study determines the policy incentive in terms of protection and efficiency of production through comparative advantages in the rice sector by using policy analysis matrix (PAM) for the period of 2003 to 2005 nominal average on the basis of secondary data from different published and unpublished sources. From policy analysis matrix in-line with private/financial profit, social/economic profit and policy divergences/transfers various protection coefficients such as NPCO, NPCI, EPC and PC and competiveness coefficients such as DRC, SCB, SNRL and PNRL were derived to measure the level of protection and comparative advantage in the rice sector of Bangladesh.The results of the policy transfer and protection coefficients (NPCO,NPCI, EPC and PCO criteria) shows that rice production in Bangladesh is subsidized for inputs (NPCI<1) and taxed for the product/output (NPCO<1).The net effect of output taxation and input subsidy resulted in a net taxation on value added (EPC<1) for policy goal of self sufficiency. On the efficiency ground, the estimated economic profitability criteria and competitiveness indicators (DRC, SCB, PNRL and SNRL) demonstrate that Bangladesh has comparative advantage in domestic rice production for import substitution and its opposite under export parity situation. Thus the results are consistent with the intuition of the simple Heckscher-Ohlin model because rice has a higher labor/land ration than other crops. The sensitivity analysis shows the sensitiveness of rice production competitiveness towards technological improvement, climate change and change in international and national price of input and output under import parity condition. Finally, based on the findings of the study some policy recommendations were made.

Keywords: **Rice, Policy analysis matrix, protection and comparative advantage.**

Introduction

The agricultural sector plays predominant role in the economy of Bangladesh since independence in 1971. It is the largest and most important source of livelihood in terms of providing food, income and employment in Bangladesh. It is also the major sources of economic development and recovery of the country. Thus productivity and efficiency of this sector is the central phenomenon to any economic planning of the country. Although the agricultural sector of Bangladesh has experienced a great deal of turbulence due to natural calamities (e.g. flood, Cyclone, S*idar* etc.) and acute governance problems but the growth in food grain production in Bangladesh, specially rice has outpaced population growth largely because of the spread of green revolution technology through input market liberalization since the shadows of famine and starvation. But due to continuous population growth cereals import mainly wheat is necessary to meet chronic shortage of food. Agriculture has also the major supplier of some basic raw materials for the domestic industry while at the same time it makes substantial contribution to the nation's trade balance, particularly through export earnings. Thus, any policy change/shock in this sector will greatly affect the wellbeing of majority of the people, mainly the poor rural people who are directly or indirectly engaged with this sector (Baffes and Gautam, 2001, Chowdhury. et.al, 2006, Ahmed et.al. 2000 and Kamruzzaman. et. al, 2006).

At the beginning, Bangladesh followed imports and exports restriction policy and provide heavy protection to domestic industries with the aim of overall economic development. Similarly for achieving self sufficiency and import substitution in food production, government provides input subsidy and occasional price support to producers. On the other hand consumer food price was also subsidized for making low and stable price for the consumers. But such policies was expensive and impose significant burden on government budget, hugely loss making with typically high incidence of leakage, they were *de facto* beneficiaries of subsidies on food grains but yet a political holy-grail. Due to these factors and donor induced pressure Bangladesh government started policy reforms through so called structural adjustment policy in the 1980s but extensive policy reform started in 1990s through privatization of agricultural input as well as output (both grains: rice and wheat) marketing and import. Subsidies on agricultural inputs phased out and remove the quantitative restrictions and anti-hoarding act, decreasing level of tariffs, rationalization of tariff structure, simplifying trade procedures, establishing a more flexible exchange rate system and provide institutional credit for carrying inventory etc although the country, as a least developed one, was exempted from reduction commitments by WTO. In the era of WTO, URAA and Doha Round lunching the agricultural markets liberalization in a global dimension. Thus any policy change in Bangladesh should take into account the expected changes in the global trade regime. The objectives of policy reform in Bangladesh as well as under Doha round are improving economic development and welfare of the society through improving the productive and allocative efficiency in the economy (Chowdhury. et.al, 2006; Alam, 2007; Rahman, 1993; Huda, 2001). The potential benefits of the URAA and Doha round agreements for Bangladesh would come out from the trading regime in its present form and the potential trading opportunities for both import substitution and export promotion in Bangladesh. However, eventually, whether or not a country can take advantage of the new trading opportunities would depend upon its comparative advantage, without subsidies and tariff or with limited subsidies and tariff that are permitted for all trading partners by the rules governing the new trading environment by WTO (Shahabuddin and Dorosh, 2002). Thus determining the level of protection and competitiveness of rice sector will determine the position of the Bangladeshi producers. Bangladesh following trade liberalization policy although, so it is important to determine how such reforms would affect Bangladesh rice sector and how it could be readied to face global competition. Thus the study is an attempt to assess the structure of policy incentive, comparative advantage of rice production in Bangladesh.

Methodology of the Study: Policy Analysis Matrix (PAM)

There are two types of theoretically correct and easily understandable summery measures are used in welfare economics for measuring policy impact. One stand for analysis focuses on the private and social cost of public sector investment e.g. Projects. Popular measure in this area is the benefit cost analysis which includes further three measures, which are internal rate of return (IRR), net present value (NPV) and benefit cost ratio (BCR) (Gitinger, 1982, Kanapiran and Fleming, 1999). The second stand for analysis focuses on the static effects of price-distorting policies. In the analysis of trade, price policy incentives and comparative advantage, it has become customary to estimate the Nominal Protection Coefficients (NPC), Effective Protection Coefficients (EPC), domestic resource cost (DRC) although there have some limitations for estimation (detail see Corden, 1979; Balassa and Schydlowsky, 1972; Bruno 1967, 1972 ; Krueger, Schiff and Valdes, 1988; Byerlee and Morris, 1993). A new summery measure, the policy analysis matrix (PAM) which tackled the limitations of previous measures and includes all these ratios is used as an analytical technique for this study to measure the comparative advantage and policy distortions in the rice sector of Bangladesh (Monke and Pearson, 1989). In the near past lot of studies used PAM for measuring comparative advantage and policy distortions in different countries including Bangladesh.

The policy analysis matrix is a system of double-entry bookkeeping analytical framework developed by Monke and Pearson (1989) and improved by Masters and Winter-Nelson (1995) for measuring the impact of policy on competitiveness and farm-level profits, the influence of investment policy on economic efficiency and comparative advantage, and the effects of agricultural research policy on changing technologies. PAM provides a complete and consistent coverage to all policy influences on costs and returns of agricultural production. Primary strength of the PAM is that it allows varying levels of disaggregation and it makes the analysis of policy induced transfers straightforward. The PAM also makes it possible to identify the net effect of a set of complex and contradictory policies and to sort out the individual effects of those policies. Along with strength, PAM also suffers some sorts of weaknesses, one of which is the assumption of fixed input-output coefficients. (Nelson and Panggabean, 1991).

The PAM contains two accounting identities (Table 1), one as the difference between revenues and costs which define the profitability and the other measuring the effects of divergences (distorting policies and market failures) as the difference between observed parameters and parameters that would exist if the divergences were removed. The PAM is based on estimation of budgets by using market prices and social prices (Monke and Pearson, 1989).

The data in the first row of table provide a measure of private profitability (D), which assesses the values of outputs and inputs using private prices, which are equal to the actual or expected financial (market) prices for goods and services that are bought or sold by farmers, merchants, or processors in the agricultural system. The private or actual market prices thus include the underlying economic costs and valuations plus the effects of all policies and market failures. The private profitability illustrates the competitiveness of the agricultural system, given current technologies, output and input prices and policy transfers (Monke and Pearson, 1989; Masters and Winter-Nelson 1995; Nelson and Panggabean, 1991). The second row of the matrix in the table measures the social profits (H) that reflects social opportunity costs. Social profits measure efficiency or inefficiency of resources use and provide a measure of comparative advantage. To determine the second row of the matrix, social prices (which reflect the underlying scarcity and thus the optimal allocation of resources) are used for valuation of inputs and outputs. Social value/price demonstrates a benchmark policy environment for comparison as these are considered those that would hypothetically occur in a free market without policy interventions (Monke and Pearson, 1989; Masters and Winter-Nelson, 1995).

The second accounting identity, in the third row of the table measures the divergences, which is defined as the difference between the first and second rows. The difference between private (actual market) and social (efficiency) values of revenues, costs, and profits can be explained by the policy interventions or existence of market failure. If market failure correction policies by the government do not exist (or are negligible) than any differences between the first row and the second row must be caused by distorting policies. But if the efficient policies by the government for correcting the effect of market failure create greater income and thus correct divergences by reducing difference between private and social valuations. The third row also reflects transfers between producers on one side and government treasury and consumers on the other side (Monke and Pearson, 1989; Masters and Winter-Nelson, 1995).

Important indicator for calculating the protection rate by different ratio such as NPC (NPCO and NPCI) and EPC, and also DRC, SCB, PNRL and SNRL ratio for measuring comparative advantage used in this study. These are defined as;

Nominal protection coefficient (NPC)

One of the most widely used simplest and easiest measure of price distortions is the Nominal Protection Coefficient (NPC) (Corden, 1971; Balassa and Schydlowsky, 1972; Gulati et al., 1990; Taylor and Phillips, 1991; Sadoulet and de Janvry, 1995; Fang and Beghin, 2000), defined as

$NPCi = Pd^i / Pr^i * ER$

From the PAM table NPC is the ratio of private price with a comparable social price of the commodity. This ratio indicates the impact of policy on divergence between the two prices for output (NPCO) and tradable inputs (NPCI). Subsidies to output are indicated by NPCO (which is A/E) if its value larger than one, and inputs subsidies lead to NPCI (which is B/F) if its value smaller than one (Fang and Beghin, 2000).

If NPC>1, producer are protected and consumers taxed, from a strictly trade theoretic point of view, suggest inefficiency in producing and price is heavily affected by government policies or other factors of that commodity. Thus the welfare (and efficiency) of the economy can be improved by letting domestic price secure around the appropriately adjusted world price or by eliminating discriminatory policy interventions. (Corden, 1979; Timmer, 1989; Anwar, 2004; Shilpi, 1996).

If NPC<1, producer are taxed and consumers subsidized may be due to market failure or government intervention, and

If NPC=1, the structure of protection is neutral.

Effective protection coefficient/rate (EPC/R)

EPC is such type of measure defined as the ratio of distorted tradable value added at market price to its un-distorted value at border prices. EPC captured the effect of government policies (tax and subsidy) on input as well as output market (Corden, 1966; Bureau and Kalaitzandonakes, 1995; Sadoulet and de Janvry, 1995; Anwar, 2004).

The formula for EPC is;

$$EPC=Va_i^d/Va_i^b= P_i^d-\sum_j a_{ij}p_j^d / P_i^b- \sum_j a_{ij}p_j^b$$

From the PAM table EPC is a ratio of value added in private prices (A-B) to value added in social prices (E-F). This coefficient indicates the degree of policy transfer from output and tradable input distortions. A value greater (or less) than one indicates a net subsidy (or net tax) to value added (Beghin and Fang, 2002; Monke and Pearson, 1989).

Domestic resource cost (DRC)

The domestic resources cost (DRC) is widely used in developing countries for measuring comparative advantage, efficiency and guiding for policy reforms. The DRC was developed simultaneously in the 1960s by Bruno (1965) in Israel and by Krueger (1966) in United States. The DRC, defined as the shadow value of nontradable inputs used in an activity per unit of tradable value added. In other way it's the ratio of the shadow value of domestic resources and nontraded inputs to the net foreign exchange earned or saved by producing the good domestically (Morris, 1989; Masters and Winter-Nelson, 1995; Sadoulet and de Janvry, 1995; Anwar, 2004).

The formula is;

$$DRC= \sum_{j=k+1}^{N} a_{ij}p_j^{dni}/P_i^b - \sum_{j=1}^{k} a_{ij}p_j^b$$

DRC has been rigorously used for measuring comparative advantage and guiding for policy reform in developing countries (World Bank, 1991; Appleyard 1987; Morris 1990; Gonzales et.al., 1993; Alpine and Pickett, 1993) as well as in academic research (Mcintire and Delgado 1985; Nelson and Panggabean, 1991; Nishimizu and Page, 1986; Weiss, 1991). However, Master and Winter-Nelson showed that the DRC may be biased against activities that rely heavily on domestic non-traded factors, (e.g land and labour). They proposed social cost benefit (SCB) is a good alternative for the DRC, which accounts for all cost and avoids classification errors in the calculation of DRC (Masters and Winter-Nelson 1995; Fang and Beghin, 2000). From PAM framework SCB is defined as (F+G)/E. The interpretation of SCB is same as like DRC. Moreover, land is a more scare factor than other domestic factors in Bangladesh's crop production (Highest densely populated country in the world) (Ahmed. et.al. 2000). Thus the indicator, private net return to land (PNRL) and social net return to land (SNRL) are used to measure the return to this fixed factor for this study like Yao (1997) used in case of Thailand. Scandizzo and Bruce also mentioned that the net economic benefit per unit of land is likely to be a more appropriate guide for the ranking of crops, compared with that of per unit (or taka/domestic currency) of the domestic resources. The PNRL, define as A-B-C without land use cost and SNRL as E-F-G without land use cost in PAM table. Higher values of PNRL indicates the crops is more desirable for the producer but not necessarily for the society and higher value of SNRL indicates stronger competitiveness as well as desirable for the society (Fang and Beghin, 2000; Scandizzo and Bruce, 1980; Yao, 1997).

Data requirement for different element of PAM

For estimating PAM need comprehensive set of data. The basic information needed for constructing a PAM are yields, input requirements, and the market and social prices of inputs and outputs. For this study data were collected from different national and international published and unpublished sources and manipulation and assumption where necessary are mentioned in every section below. Output and input coefficients are physical quantities of output and input. We use output/yield and input coefficient for this study from Zohir (1993) which is also quoted by Mahmud et.al (1994), Shahabuddin and Dorosh (2002), Huda (2001), IRRI survey on cost and return in crop cultivation in Bangladesh, (2000-2001) cited in Hossain and Deb (2003) and Shahabuddin et.al (2002), and DAE (2005-06). Shahabuddin and Dorosh (2002) mentioned that these data (Zohir, 1993), was a fairly large-scale survey which covered the different agro-ecological zones of the country, with a special emphasis on generating information on the relatively minor crops which not usually covered in most farm surveys. These output and input coefficients assume constant over the year under the study period. Here we compiled all the output and input coefficients are on per hectare basis of land. We use the farm gate price as a financial or private price, which is paid by the farmers for purchasing their necessary inputs and price received from selling of their output. The output and input (Chemical fertilizer, Urea, TSP and MP) farm gate prices were collected from various issues of statistical yearbook published by BBS. In Bangladesh farmers use both cash-purchased and family-owned inputs, all are valued at market prices. In particular, for valuing both family and hired labour the similar wage rates have been used in this study. The wage rate of labour taken from IRRI (2000) cited in Hossain and Deb (2003), which was for the year of 2000. So the wage rate converted for the period under study by using the relevant deflators. Other financial cost such as irrigation cost taken from Zohir (1993). However as all these costs are relate to the survey period of that study, they are subsequently converted to the costs for the study period by using relevant sectoral deflators. Inputs are divided into two categories; a) Tradable inputs: Chemical fertilizers; Urea, TSP and MP considered as 100% tradable inputs in this study. b) Non-tradable inputs: The domestic resources include labour, land, irrigation, manure and pesticide treated as non-tradable inputs in this study. Social prices are calculated on the basis of import and export parity prices depending on the commodity tradability status. However, in our study we use import and export parity price for output to know the comparative advantage under import and export situation. For tradable input the chemical fertilizer, we use import parity price as they are imported to Bangladesh regularly. For estimating parity price of these tradable output and input we use CIF or FOB price as a world market or border price. We collect the CIF price of coarse quality rice and official exchange rate from Ahmed. et.al (2007) and for fertilizer we get FOB price for urea (Europe), TSP (US Gulf ports) and MP (Vancouver, Canada) from IRRI (IRRI collected from World Bank, commodity trade and price trends and FAO food outlook, various issues) in foreign currency ($). For social valuation of output under importable hypothesis we use import parity price. So, social value of output is quantity multiplied by import parity price of rice/output. Similarly under exportable hypothesis just use export parity price of rice for social valuation. In case of tradable input we use import parity price for social valuation. Likewise social value of tradable input is import parity price multiplied by quantity. There have mismanagement in exchange rate in Bangladesh. So it is necessary to estimate the shadow exchange rate to know the distortions caused by exchange rate (Shahabuddin et.al, 2002; Shilpi, 1998). In our case shadow exchange rate (SER) calculated from the official exchange rate (OER) by using a social conversion factor (SCF).

In our study we assume rice; the output is importable as well as exportable and the inputs mainly the chemical fertilizers are under importable hypothesis. So, cost insurance and freight (CIF) and free on board (FOB) prices are the import and export parity prices at the border respectively. These prices are used as reference prices. By using shadow exchange rate these border or reference price converted to domestic currency than it called social border price. These entire parity prices measured at farm gate level. The import and export parity price at farm gate level computed from the border parity price by adjusting the social cost associated with moving the import commodity from border to the farm-gate or moving the export commodity from the farm gate to the border. For determining the parity price at farm gate level, the border price adjusted with the marketing, transportation and processing cost. This adjustment depends on the assumption of producing areas of the output and marketing level (please sees Timmer, Falcon and Pearson, 1983). In our study, Dhaka is taken as a wholesale market because most of the rice marketing, import and export routed and centred through Dhaka (other studies such as Mahmud.et.al, 1994; Huda, 2001; Shahabuddin and Dorosh, 2002 also used in the similar way). The relevant transport cost taken from Huda (2001) for the year 1998 and marketing and processing cost taken from Siddiquue, (2000) for the year 2000 and it converted for the study period by using relevant deflators. We assume these cost same as private and social as these are competitive price and cost. We also assume these cost are average for whole the country (as like Mahmud et.al, 1994). In case of fertilizer to convert FOB price to CIF price at Chittagong port done by adding the freight cost to the FOB price of fertilizer. The freight cost data are collected from FAO food outlook, various issues. (For parity calculation methodology, details see in Dembele. et.al, 2008). For constructing social budget, 35% of the social costs of irrigation, 90% of the social costs of draft power, 50% of the social cost of power tiller, and full social costs of labour , seed/seedlings, pesticides and manure have been treated as domestic resources and remaining as traded factors in this study. For social valuation of this cost and price of non-tradable inputs, the standard conversion factor[i] is used. These are converted from financial/private to social/economic price and cost by multiplying the standard conversion factor to financial/private price or costs. But for land and power tiller cost standard conversion factor is not available. So for social valuation (Pxi) of these factors we use the value of marginal product approach that uses factor shares (Si) of various inputs (Xi) together with the mean value of inputs and outputs (Y) and price (Py). Social cost is estimated as Pxi = $\{(Si/Xi) \times Y\} \times Py$ (as like Reddy.et.al, 2005). From the estimation of private value of revenue, cost and prices, private budget is constructed and by the social price or values of input and output, social budget is constructed. The financial and social budget is estimated in this study on the basis of full-costing of inputs.

Result of the Policy analysis matrix

In this section the results of policy analysis matrix as well as the coefficients derived from policy analysis matrix and sensitivity analysis under import and export parity condition are discussed sequentially with necessary interpretations.

Policy analysis matrix under import parity price of rice

For constructing policy analysis matrix the initial steps is to estimate the return and cost of production. For estimating return and cost of production in this study the input and output coefficients are assume fixed over three years[ii] and price of input and output is average of three years. After that cost and return are calculated through input and output coefficients multiplied by the average price of input and output per hectare. Then from this we construct the private budget of rice production in Bangladesh which shows the return and cost of production of rice per hectare in private or financial or domestic prices. The total cost of production, total return and net return or profit per hectare are 31498.42, 39836.16, 8337.74

Tk. respectively. After that we calculate the shadow exchange rate which is necessary to construct the policy analysis matrix specially, for estimating shadow or social price of input and output and constructing social budget. The estimated average shadow exchange rate is 64.99 Tk[iii] per dollar ($).

The input and output parity price is calculated for estimating social price of input and output. The output is paddy[iv] in our cases. At the beginning of Bangladesh imported rough rice i.e. paddy but after that rice is imported from international market. So import parity price of paddy is indirectly estimated from import price of rice, which is calculated on the basis of average CIF price of coarse quality rice in Bangladesh. The average CIF price of rice is 258 US $ per tonne. After estimating by necessary formula we get the private and social import parity price of paddy at farm gate level are 8086.93 and 9047.75 Tk. per tonne respectively. On the other hand for estimating the social price of 100 percent tradable inputs i.e fertilizer (urea, TSP and MP) we estimate the import parity price of Urea, TSP and MP at farm gate level. The private and social import parity prices of Urea, TSP and MP per tonne are 17538.82, 17674.48, 14880.10 Tk. and 18792.95, 18934.16, 15876.86 Tk. respectively.

After calculating private budget and necessary parity price we construct the social budget. For estimating social budget we need to calculate social price or social value of all input and output. For 100 percent tradable inputs and output we use the social import parity price of that input and output as social price. On the other hand for non tradable[v] we use the specific conversion factor to change the private value into social value in social budget analysis (it just private value multiplied by specific conversion factor). The private and social values are further decomposed into tradable and non-tradable components.

To know the state of the art of government policy incentives situation and to evaluate these government policy, the policy analysis matrix illustrated in table 2. In the table 2 we see the tradable and non tradable input cost at private price are 3277.24 and 28221.18 Tk per hectare respectively. On the other hand at social price the subsequent costs are 9473.13 and 25353.15 respectively. The private profit per hectare of rice production is 8337.74 Tk which is greater than zero (0) which indicate the supernormal returns and possible to expand rice production in future, unless the farming area cannot be expanded or substitute crops are more profitable at private price. This also indicates that existing input and output prices, technologies, and government policies leads to the profitable rice production in Bangladesh. On the other hand social profit of rice production is 12104.41 TK per hectare which is also greater than zero. This value point out that rice production under free trade will be in favour of producers compare to existing situations. Thus, Bangladesh has a static comparative advantage of domestic rice production for import substitution and it uses scarce resources efficiently.

The table 2 also shows different policy transfer or divergences such as output, input, factor and net policy transfers. It is evident that output transfer (difference between private revenue and social revenue) is -7094.54. The value is negative which indicates that government protective policies affect negatively to the producer incentives. The input transfer (difference between private and social price of tradable inputs) is -6195.89 which is also negative. The negative value illustrates that the domestic producer buy the imported inputs less than the world price for rice production. Thus the government has implemented input subsidy policy to the rice sector to decrease cost of production. Therefore producer receives input subsidies for rice production in Bangladesh. The factor transfer (difference between private and social price of non-tradable inputs) is 2868.03 which is positive. The positive value shows the opportunity costs of non-tradable inputs are lower than their market prices. On the other hand the net policy transfers (difference between private and social profit or social revenue minus social cost of tradable and not tradable inputs) is -3766.68 which is negative. This negative value illustrate that rice producer could earn higher profit (or less loss) without government intervention. That means under free trade producer will make more profit contrast to the existing policy situation. It can be concluded that rice producers earn less profit under current government policy orientation.

Ratio indicators under import parity price of rice

From the above policy analysis matrix we estimate different ratio indicators that are shown in table 3. The interpretations of these indicators are discussed below.

Protection coefficients

At the beginning, Bangladesh was a major importer of rice but lately it has been a marginal rice importer. So the import parity price is still the relevant world reference price which is used in this study. Import parity price is calculated by assuming that import competes with domestic production at the producer level. Rice is a predominant crop in Bangladesh agriculture. So, any effect of trade policy on the rice sector largely affects the incentive on agricultural sector. We use coarse quality rice for comparison with border price, which represents the most of the rice produced in Bangladesh. Bangladesh government often tries to compensate producers for low product prices by subsidies on inputs.

For determining the protection and policy incentive in the rice sector we estimate the NPCO, NPCI, EPC and PC coefficients which are shown in table 3. The NPCO coefficients shows that domestic prices of rice have remained below to the corresponding international reference prices, i.e. NPCO<1. So the NPCO indicates that policies do not provide nominal protection for rice sector. NPCO=0.85 means that policies are decreasing the market price to a level 15 percent lower than the world price. Similarly, NPCI values of less than one suggest that the government policies are reducing input costs for rice production in Bangladesh. NPCs values of less than one both in the input and output markets clearly indicate the government efforts to support the rice sectors by providing rice at a cheaper price. On the other hand we also estimate EPC which is more consistent indicator of effective incentive than the NPC, which find out the impact of protection on inputs and outputs, and depict the degree of protection accorded to the value addition process in the production activity (Mohanty. et.al, 2002). The EPC values in Table 3 shows that rice farmers face a net tax of around 2 percent on their value added.

Thus in conclusion, rice production in Bangladesh is subsidized for inputs (NPCI<1) and taxed for the product/output (NPCO<1).The net effect of output taxation and input subsidy resulted in a net taxation on value added (EPC<1). These results are supported by the findings from Huda (2001). In Huda (2001) EPC was 0.99 in 1998. So over the years EPC had been declining, which implies an increasing rate of competitiveness of rice. This might be due to the emergence of efficient production technology[vi] and the impact of economic reforms[vii] in Bangladesh.

Other than these we also estimate profitability coefficient (PC) which measures the incentive effect of all policies (output, tradable and non-tradable input policies) as it is not possible by NCP and EPC (Monke and Pearson, 1989). The PC value in the table is 0.69 which indicates that policy transfers (and a capital market failure) have permitted private profits 0.69 times less than social profits. Thus without policy transfer private profit could be 0.69 times higher than that now.

Competitiveness coefficients

For estimating the competitiveness of the rice sector in Bangladesh, we use DRC, SCB, SNRL and PNRL coefficients, the results of these indicators are reported in table 3. For estimating DRC ratio we need to calculate the rental value of land which is difficult task due to complex nature of land tennural arrangement. This valuation and traded and non-traded classification is sometimes difficult for measuring DRC ratio in case of different competing crops (Scandizzo and Bruce 1980; Mahmud. et.al, 1994). But Anderson and Ahn, 1984 (Mahmud. et.al, 1994) mentioned that DRC could be a convenient method for assessing comparative advantage in case of single dominant crop such as paddy/rice in Bangladesh like many other Asian countries. Thus the estimate of DRC revealed that Bangladesh has a comparative advantage in rice production (DRC<1). The level of DRC (0.68) shows that the value of domestic resources used in producing per hectare of rice in Bangladesh is less than the cost of its import. DRC level decreased in the post-liberalization period (by comparing with Huda, 2001 and Shahabuddin and Dorosh, 2002), which reveals an improvement in the comparative advantage of rice production after liberalization. We also estimate the superior measure i.e. Social cost benefit (SCB), because Master and Winter-Nelson (1995) mentioned that DRC is a biased indicator for measuring comparative advantage in-case of activities those use few tradable inputs. In our study it is almost true, so we estimate the social cost benefit ratio (SCB) shows in table 3. The SCB is also less than one. So according to SCB criteria also, Bangladesh has comparative advantage in rice production. We also calculate the PNRL and SNRL, but for single crop are not possible to compare or rank the activity. But both the value of PNRL and SNRL are much higher. So, PNRL and SNRL criteria also confirms that Bangladesh has comparative advantage in rice production and its desirable for the producer as well as for the society (all of these results supported by the conclusion from other previous study like Shahabuddin (1999); Ahmed (2000); Huda, 2001; Shahabuddin and Dorosh, 2002; Shahabuddin et.al;, 2002)..

Policy analysis matrix under export parity price of rice

For constructing policy analysis matrix under export parity hypothesis, the procedure is the same as like discuss above in case of import parity but only difference is that we have to calculate social price of output under exportable hypothesis, other thing remaining the same as like under import parity status. So for this we calculate the export parity price of rice according to the methodology discussed above. After that we construct the private and social budget like the similar way under import parity. From the private and social budget we construct the policy analysis matrix that shown in table 4.

The interpretations of the figure of the above table are more or less similar to table 2. Only the different figures are discussed here. The different figures are social revenue, social profit, divergence of output and profit. The social profit of rice production under export parity price is -679.11 TK per hectare which is also less than zero. This value point out that rice production under free trade will not favour to the producers compare to existing situations. Thus, Bangladesh does not have a static comparative advantage of domestic rice production for export as it was the opposite under import parity price.

It is evident that output transfer (difference between private revenue and social revenue) is 5688.99. The value is positive (it is positive in case of import parity price also) which indicates that government protective policies affect positively to the producer incentives. On the other hand the net policy transfers (difference between private and social profit or social revenue minus social cost of tradable and not tradable inputs) is 9016.84 which is positive (as it is negative in case of import parity price). This positive value illustrate that rice producer could earn less profit (or high loss) without government intervention. That means under free trade producer will make less profit contrast to the existing policy situation. It can be concluded that rice producers earn high profit under current government policy orientation which is opposite in case of importable hypothesis. The findings supported by the conclusion drawn from the study Shahabuddin (1999) and others.

Ratio indicators under export parity price of rice

From the above policy analysis matrix we estimate different ratio indicators as the similar way which is shown in table 5. The interpretations of these indicators are discussed below.

Protection coefficients

In the similar way we also estimate the NPCO, NPCI, EPC and PC coefficients under export parity condition, which are shown in table 5. The NPCO coefficients shows that domestic prices of rice is higher to the corresponding international reference prices, i.e. NPCO>1(in case of import parity it is <1). So the NPCO indicates that policies provide nominal protection for rice sector. NPCO=1.17 means that policies are increasing the market price to a level 17 percent higher than the world price. The NPCI is same as it is in case of import parity. So in this case producers are protected and consumers taxed, it suggests inefficiency in producing and price is heavily affected by government policies or other factors of that commodity. The EPC values in table 5 show that rice farmers getting a net subsidy of around 48 percent on their value added. Likewise the PC value in the table is -12.28 which indicates that policy transfers have permitted private profits 12.28 times higher than social profits. Thus without policy transfer private profit could be 12.28 times lower than that now.

So, rice production in Bangladesh is subsidized for inputs (NPCI<1) as well as for the product/output (NPCO>1).The net effect of output and input subsidy resulted in a net subsidy on value added (EPC>1). Thus implies that rice production under export parity condition is not competitive (just the opposite under import parity).

Competitiveness coefficients

Likewise we estimate the DRC, SCB, PNRL and SNRL coefficients for assessing the comparative advantage under exportable hypothesis, the results of these indicators are reported in table 5. The estimate of DRC is 1.03 which is greater than one. So it indicates that under exportable hypothesis Bangladesh does not have a comparative advantage in rice production (DRC>1). The level of DRC (1.03) shows that the value of domestic resources used in producing per hectare of rice in Bangladesh is greater than the cost of its export. The other indicator SCB is also greater than one. So according to SCB criteria also, Bangladesh does not have any comparative advantage in rice production. The PNRL is same as before but SNRL is very less than before and less than PNRL. So it indicates that under exportable hypothesis rice production is desirable for producer but not for the society. So does not have any comparative advantage in this situation (all of these results supported by the conclusion from other previous study like Shahabuddin (1999); Shabduddin and Dorosh, 2002; Shahabuddin et.al, 2002).

Sensitivity analysis under importable hypothesis

As we know the comparative advantage measures are static in nature. Among the measures, PAM overcomes this shortcoming to some extent but not fully. So, by sensitivity analysis, can be determine the degree to which factors affect the comparative advantage. Morris et al, 1997 pointed out that, sensitivity analysis is necessary for two main grounds. First of all for some static assumption such as input-output coefficients, market conditions, prices (both financial and economic prices), government policies etc and secondly, the comparative advantages determined by the PAM framework are static because it represents a snapshot taken at a fixed point of time. But in practice all of these assumptions (resource endowments, production technology, market conditions in national and international, climate and environmental change, and government policies) are not static or constant. Other than these we can also identify the sensitive factors that can help for planning to give more importance on those factors to maintain or to increase comparative advantage of that product. Thus, it is important to determine the probable effect of changes in any of these basic assumptions/factors to the comparative advantages in future (Shahabuddin and Dorosh, 2002). In our study, we shock the PAM by 30 percent increasing and decreasing the variables such as labour cost, irrigation cost, tradable input cost, non-tradable input cost as well as yield per hectare, and border price. All these results are presented in table 6 and 7. It is evident that if the cost items increase than DRC as well as SCB ratio increase and vice versa, but the level/magnitude of increase and decrease is the highest in case non-tradable input cost this is due to high share of non-tradable inputs in rice production (Table 6). On the other hand, the table 7 shows that increase in income variables cause the decrease in DRC as well as SCB coefficients and vice versa. These means income variables affect positively to the comparative advantage of rice production in Bangladesh. So, if yield of rice increase due to technological improvement[viii] (so called green revolution) than comparative advantage will increase and if yield decrease due to climate[ix] and environmental[x] change than the result would be the opposite. As well as the result is similar in case of increase or decrease in border price of rice. This may cause due to volatile international market such as last year food and financial crises.

Conclusions and policy implication

We use the Monke and Pearson (1989) policy analysis matrix approach as an analytical framework which is a summery measure to determine the comparative advantage and policy distortions in the rice sector of Bangladesh. For construction of the matrix at first developed the private as well as social budget on the basis of financial and economic/social price respectively. From that matrix we derived different indicators such as NPCO, NPCI, EPC, DRC, SCB, PNRL, SNRL and PC which indicates the level of protection and comparative advantages in the rice sector of Bangladesh. The NPC (NPCO and NPCI) measures the ratio of domestic to border price and EPC provides a fuller measure of the effect of market distortions on the incentive offered to producer relative to those in the rest of the economy (Lutz et.al, 1980). We estimate import and export parity price of rice which were based on the assumption that import/export compete with domestic production at the producer level. The results of the policy analysis matrix under import parity assumption shows that rice producer under existing policy scenario earn less profit. The protection coefficients NPCO=0.85 indicates that due to policy bias (producer taxed and consumer subsidies) rice price 15% lower than world market price, NPCI= 0.35 indicates that due to policy intervention input cost for rice production reduces (input subsidy). The EPC=0.98 indicates that farmers are faces 2 percent net tax on their value added. The PC is 0.69 which means that private profit could be 0.69 times higher without existing policy transfers. The competiveness coefficients DRC and SCB are 0.68 and 0.74 respectively, which indicates that Bangladesh has comparative advantage in rice production for import substitution. The PNRL and SNRL value is 16703.74 and 22684.92 Tk per hectare respectively, which are very high. So these values also confirm that Bangladesh has comparative advantage in rice production. Thus the results are consistent with the intuition of the simple Heckscher-Olhin model because rice has a higher labor/land ration than other crops. On the other hand we also calculate above value under export parity assumptions, which shows that social profit is negative (-679.11) and competiveness coefficients are more than one (i.e. DRC=1.03 and SCB=1.02). These values indicate that under export parity condition, Bangladesh does not have comparative advantage in rice production. The sensitivity analysis of PAM by 30 percent increasing and decreasing of labour cost, irrigation cost, tradable input cost, non-tradable input cost as well as yield per hectare, and Border price shows that the competitiveness coefficients follow similar direction in case of cost items but for yield and border price it is opposite. This study gives necessary information on which is to support or improve the implementation of agricultural policy and to find out the policy recommendations for enhancing productivity as well as efficiency in the rice sector of Bangladesh. Keeping all these in view, the following policy implications can be made from the study;

i) Bangladesh, pursuing food self sufficiency policy for food. As we see Bangladesh has comparative advantage in rice production under import parity price not under export parity price. So self sufficiency policy is quite ok but it should not be rice export promotion policy in future. Further it can be possible for crop diversification policy to enhance competiveness for other crops than rice in future.

ii) As we see in sensitivity analysis in efficiency that productivity or yield increase or decreases have lot of influence in efficiency. Other than this population is rapidly growing and cultivable land is declining in Bangladesh. So it is recommended to invest more on new technology through rural infrastructure, strengthening research and extension support to enhance productivity as well as to protect from environmental and climate change negative impact.

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Table 1 Policy analysis matrix (PAM)

Items	Revenue	Costs		Profit
		Tradable inputs	Domestic factors	
Private prices	A	B	C	D
Social prices	E	F	G	H
Divergences	I	J	K	L

Source: Monke and Pearson, 1989

Private profits (D) = A-(B+C), Social profits (H) = E-(F+G), Output transfers (I) = A-E, Input transfers (J) = B-F, Factor transfers (K) = C-G, Net transfers (L) = D-H or I-J-K

NPCO=A/E and NPCI=B/F, EPC= (A-B)/ (E-F), DRC=G/ (E-F) and SCB= (F+G)/E, PNRL= A-B-C without land use cost, SNRL= E-F-G without land use cost, Profitability coefficient (PC) = (A-B-C)/ (E-F-G) or D/H

Table 2 Policy analysis matrix for rice sector in Bangladesh (Average of 2003 to 2005)

Items	Revenue	Costs		Profit
		Tradable inputs	Domestic factors	
Private prices	39836.16	3277.24	28221.18	8337.74
Social prices	46930.70	9473.13	25353.15	12104.41
Divergences	-7094.54	-6195.89	2868.03	-3766.68

Source: Own estimation

Table 3 Different indictors of protection and comparative advantage (average for 2003 to 2005)

Items	Unit	Value
NPCO	Ratio	0.85
NPCI	Ratio	0.35
EPC	Ratio	0.98
DRC	Ratio	0.68
SCB	Ratio	0.74
PC	Ratio	0.69
PNRL	Tk/ha	16703.74
SNRL	Tk/ha	22684.92

Source: Own estimation

Table 4 Policy analysis matrix for rice sector in Bangladesh (Average of 2003 to 2005)

Items	Revenue	Costs		Profit
		Tradable inputs	Domestic factors	
Private prices	39836.16	3277.24	28221.18	8337.74
Social prices	34147.17	9473.13	25353.15	-679.11
Divergences	5688.99	-6195.89	2868.03	9016.84

Source: Own estimation

Table 5 Different indictors of protection and comparative advantage (average for 2003 to 2005)

Items	Unit	Value
NPCO	Ratio	1.17
NPCI	Ratio	0.35
EPC	Ratio	1.48
DRC	Ratio	1.03
SCB	Ratio	1.02
PC	Ratio	-12.28
PNRL	Tk/ha	16703.74
SNRL	TK/ha	9901.40

Source: Own estimation

Table 6 Coefficient changes due to 30 percent change in selected cost items of rice

Coefficient	Base value	Labour		Irrigation		Tradable inputs		Non-tradable inputs	
		Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
DRC	0.68	0.76	0.60	0.70	0.66	0.73	0.63	0.88	0.47
SCB	0.74	0.81	0.68	0.76	0.72	0.80	0.68	0.90	0.58

Source: Own estimation

Table 7 Coefficient changes due to 30 percent changes in selected income factors

Coefficient	Base value	Yield per hectare		Border prices of output	
		Increase	Decrease	Increase	Decrease
DRC	0.68	0.49	1.08	0.46	1.27
SCB	0.74	0.57	1.06	0.54	1.18

Source: Own estimation

End Note:

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[i] Shahabuddin and Dorosh, (2002) define the conversion factor is the ratio between financial costs and economic costs that is used to convert private/financial costs into social/economic costs. It takes into accounts the distortions in factor and output markets, externalities and government policy interventions that may create divergence between financial and economic costs. This is particularly true in case of non-tradable inputs such as irrigation and labor, especially for labour in rural Bangladesh because of widespread underemployment.

[ii] In-ordered to smooth out the fluctuation almost all the figures (prices, exchange rate etc) are average for three years in this study.

[iii] Taka is the currency of Bangladesh.

[iv] Paddy is called sometimes rough rice or before milling that is paddy. The standard conversion factor between rice and paddy is 0.6666 or 0.67 i.e. 100 kg paddy =67kg rice please see http://beta.irri.org/index.php/GIS-Data.html (downloaded in 06.06.2010)

[v] For social valuation of land and power tiller use other methodology that discussed in the previous section.

[vi] See the impact of technological innovation in Bangladesh (Hossain, 1988)

[vii] Since Bangladesh started policy reforms from the 1980s, now it is more or less liberalizes country (see, Ahmed et.al, 2007).

[viii] See the impact of green revolution in Bangladesh (Hossain, 1988)

[ix] See the impact of climate change on rice in Asia (Matthews. et.al, 1997)

[x] See the environmental impact of policy changes (Toufique, 2000)