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MEASUREMENT OF GOVERNEMENT INTERVENTION: A COMPARATIVE ANALYSIS OF ALTERNATIVE CONCEPTS

Introduction

The variation in protection awarded to agricultural commodities indicates some general patterns of protection across industrialized and developing countries. The observed patterns exhibit a positive relationship of the level of protection with the per capita incomes and negative relationship with the number of farmers and the share of agriculture in the national economy (Bureau and Kalaitzandonakes, 1995, Gautam, 1995). A predominant pattern of agricultural protectionism across countries is that, while farmers in industrialized countries receive subsidies through income enhancing and price support programs, their counterparts in developing countries are generally taxed (USDA, 1993; OECD, 1992). The producer support programs in industrialized countries invariably result in higher food prices for consumers while developing countries adopt cheap food policies to improve accessibility to food for poor urban consumers (Schultz, 1978; Miller, 1986; Byerlee and Sain, 1986).

This paper analyzes the different protection measurement concepts and their effectiveness in measuring the level of protection. An accurate measurement of the actual level of intervention is a prerequisite for effective analysis. Therefore, a comprehensive

comparative analysis of various measurement concepts and their policy coverage is provided. The choice of a measurement concept is also highlighted, along with its merits and limitations. The analysis is followed by a display of the comparative results with a graphic exposition of the food commodity market distortions in the cases of small and large countries. The case of price discrimination, where foreign markets are competitive and the domestic market is monopolized, is also discussed.

Comparative Analysis of Protection Measurement Concepts

Government intervention in agriculture affects market prices and producer incentives through a myriad of distortionary policies. The policy transfers to agricultural producers may be occasioned by price and nonprice supports. While some policy instruments may affect these variables directly with relatively transparent effects that are easily calculable, some other policies designed to affect the agricultural sector as a whole or the entire economy may also have substantial influence on market conditions for individual commodities. The product-specific effects of such indirect policies may not, at times, be easily discerned. One of the underlying elements of the policy analysis, therefore, is to determine the magnitude of the influence of such divergent policy instruments on market incentives (Josling and Tangermann, 1989).

The number of different policies as well as the ambiguity of the effects of certain policies requires that the measurement concept used to gauge the actual level of intervention must be capable of identifying the product-specific and aggregate effects of a wide range of diverse policies. The recent focus in international trade policy forums, such

as GATT, on using estimates of the extent of protection has espoused a variety of measurement concepts, each with its own specific coverage of given policies. The studies on the extent of government intervention and the trade distortion impacts of market price support and other policies have emphasized the measurement of the gaps generated between the domestic and border prices. The various concepts developed to determine market distortions are related to one another by modifications, extensions or derivatives of the measurements of this gap (Cahill and Legg, 1990).

We first provide a comprehensive analysis of these measures of estimation and their policy coverage. Various measures of protection are defined in the next subsection along with a comparative analysis of the policy effects captured by these measures

Alternative Measurement Concepts of Agricultural Protection

Studies of agricultural protection have employed alternative measurement concepts which differ in their meanings and in terms of their uses and degree of complexity. One of the most common concepts to measure the extent of government intervention is to determine the price wedge, the difference between domestic and border prices, for a specific commodity, as used by Bela Balassa (1965). The simplest and most widely used measurement of the price wedge is the nominal rate of protection (*NRP*) and the nominal protection coefficient (*NPC*) (for example, Tyers and Anderson, 1992; de Gorter and Tsur, 1991; Krueger, Schiff and Valdés, 1991; Miller, 1991; Balisacan and Roumasset, 1987; Anderson and Hayami, 1986; Honma and Hayami, 1986; and Bigman, 1985). However, where the effects of government policies are not directly translated into

domestic prices, these measures would provide only a partial indication of the extent of government intervention. While some concepts are restricted to the measurement of the price wedge alone, some other aggregate measures have also included the effects of a wide range of other interventionary policies. Some other measures have, therefore, been developed over time that try to capture the distortionary effects of a number of policies.

Table 1 lists the mathematical formulas for 14 different measures of the levels of agricultural producer and consumer protection. The *NPC* is defined as the ratio of domestic to border prices, expressed in a common currency. The *NRP* estimates the price wedge, measured in the domestic currency, in percentage terms. These estimates indicate the responsiveness of domestic prices to government policies. The consumer counterpart of *NRP*, the nominal rate of protection for consumers (*NRPC*), similarly measures the wedge between domestic consumer price and the border price of a given commodity. The novelty of these measures is the relative ease with which these estimates can be calculated if reliable statistics on domestic and border prices are available. However, these measures fail to take into account the effects of any policies that do not affect producer prices (Schwartz and Parker, 1988).

An extension of the *NRP* concept is provided by the nominal rate of assistance (*NRA*), which takes into account the aggregate returns to producers –the output produced times the domestic price plus other subsidies or taxes– and expresses it as a percentage of world prices (Cahill and Legg, 1990). Subsidies like deficiency payments that are not captured by *NPC* or *NRP* are included in the *NRA* estimates. The higher the level of such payments, the greater would be the difference between the estimate provided by *NRP* and

NRA. Nonetheless, the *NRA* and *NRP* measures do not capture the effects of distortions in the input markets.

Since input pricing policies effectively distort producer incentives, it is imperative to account for policies that affect both input and output markets. The effective rate of protection (*ERP*) provides a better measure of the level of protection since it considers the joint effects of input and output policies on the value added (Corden, 1971 and 1987, Josling and Tangermann, 1989). The *ERP* is calculated as the percentage difference in the unit value added at domestic and border prices, expressed in a common currency. Thus, *ERP* would capture the effects of a subsidy on an intermediate input that might distort the supply and prices of the final commodity. In the case of agricultural outputs that use the outputs of other sectors as an intermediary input, such as grain-fed livestock, the estimates of overall distortion provided by the *ERP* measure would be superior to those provided by the *NRP* or *NRA*. The *ERP*, therefore, may better indicate resource misallocation among various sectors of an economy (Corden, 1971).

A number of policies, such as investment subsidy for agriculture, that do not affect the value added are not incorporated in *ERP* calculations. Thus, *ERP* may not provide a complete picture of all policy-induced output distortions (Cahill and Legg, 1990). Moreover, information requirements for calculating *ERP* are quite stringent since *ERP* calculations involve estimating *NRP* for the final commodity, *NPRCs* for all intermediate inputs, and technical information on input-output coefficients, which are relatively difficult to obtain (Schwartz and Parker, 1988).

The effective rate of assistance, *ERA*, like the *NRA*, extends the *ERP* concept to include all other assistance to output and inputs, represented by δ in Table 1. The difference between the value added at border and domestic prices, then, is expressed as a percentage wedge, measuring the assistance to the production activity rather than to the product itself. The consideration of policy effects on the overall activity in the given commodity provides a clearer indication of the extent to which it would attract resources from other sectors. Since policies such as investment subsidy for agriculture do not affect the value added, these are not reflected in the calculations of *ERP* or *ERA*.¹

Some other variants of *NRP*, the nominal rates of protection due to direct and indirect policies (*NPR_D* and *NPR_I*), were recently proposed in a comprehensive World Bank investigation by Krueger, Schiff and Valdés (1991). These measures recognize the essential differences between the policies that affect agricultural prices (of both inputs and outputs) directly and those more general macroeconomic policies that affect producer returns indirectly but in a significant way (Krueger, 1989).² The *NPR_D* adjusts the domestic and border prices for differences in transportation and storage costs and other quality differentials while the *NPR_I* also considers the effects of economy-wide policies, such as exchange rate distortions and protection awarded to the nonagricultural sector, on the agricultural producer incentives. The total nominal protection rate includes both the direct and indirect components discussed earlier. The *NPR_T* thus considers agricultural protection in a general equilibrium framework. Since the general equilibrium effects may be rather significant in countries where agriculture constitutes a high proportion of the labor force and gross domestic product, *NPR_T* may be a useful measure. However,

excluding the income support policies limits the usefulness of these measures, especially for industrialized countries.

An alternative producer protection measurement concept, the producer subsidy equivalents (*PSEs*), was first used in Australia in the mid-1960s. The *PSEs*, and their consumer counterpart, the consumer subsidy equivalents (*CSEs*), were later formally advanced by Tim Josling of the Food and Agricultural Organization (FAO) of the United Nations, in the early 1970s (FAO, 1973 and 1975). The *PSE* concept has been further refined, extended and used in various forms and several versions of these measures exist. For example, the FAO, the OECD, the USDA and IIASA (International Institute for Applied Systems Analysis) have developed their own estimates of *PSEs* and *CSEs* for selected countries (Gardner, 1991). The OECD uses these measures to monitor the level of government intervention in member countries while the USDA calculates the *PSE* and *CSE* estimates for a number of industrialized and developing countries. The usefulness of *PSE* and *CSE* estimates is in their ability to summarize the effects of multiple policy interactions into a single monetary estimate that can be readily used to compare protection levels across commodities and countries (Bray et al., 1992). The flexibility of these measures to include or exclude any number of policies makes them useful because they can be tailored to meet the different objectives of any specific investigation.

A *PSE* is defined as the level of subsidy that would be necessary to compensate agricultural producers if all farm policies were removed. Similarly, a *CSE* is defined as the amount of compensation to be given to consumers to keep their incomes unchanged after removing all agricultural programs. Unlike the measures discussed earlier, the *PSE* and

CSE concepts focus on income transfers to producers and consumers from government programs. The estimation of *PSEs* includes the effects of a number of diverse agricultural policies that directly and indirectly affect producer incentives. As is evident from Table 2, the policy coverage under *PSEs* extends to direct payments to farmers, input market distortions, marketing assistance and economy-wide policies. The government outlays to assist agricultural production in the longrun, such as expenditures on research and extension, land improvement, conservation programs, development of irrigation facilities, etc., are also a part of the *PSE* calculations. The USDA estimates of *PSEs* also incorporate the indirect effects of exchange rate distortions, so prevalent in developing countries. The *PSEs* account for nonborder policy measures that are not included in the *NRP* and *ERP* calculations.

Thus, the policy coverage of *NRA* is wider than that of *NPC* and *NRP*, but shorter than *ERP* and *ERA* (not shown in Table 2) which, in turn, include the effects of a lesser number of policies than are covered by the *PSEs*. In short, the calculations of *NRP* and *ERP* measures require similar amounts of information as do *PSEs*, whereas the estimates provided by *NRP* and *ERP* measures are neither as complete nor as flexible as those provided by the *PSEs* (Tangermann et al., 1987).³

Among these measures, *NPC*, *NRP*, *NRA*, *NPRC*, *NPR_p*, *NPR_r*, *ERP* and *ERA* aptly capture the effects of border measures (such as tariffs, quotas, variable levies and export subsidies), domestic price support policies and distortions created by the national marketing board activities and state trading operations as well as the effects of other policies that distort domestic producer and consumer prices (Table 2). The *NRA* includes

the effects of more policies (such as deficiency payments and producer levies) than the *NRP* and *NPC* measures. But the *NRA* falls short of the *NPR_T* concept in its policy coverage that also includes effects of economy-wide policies. However, these measures would underestimate the overall protection levels where policies such as direct payments, input assistance (besides *ERP* and *ERA*), marketing and infrastructure assistance, which do not affect the domestic prices directly, are an integral part of the national protectionistic policies.

Figure 1 provides policy-wise producer protection expenditures captured by alternative measures of support for the United States for wheat sector for the period 1979 to 1994. The figure also illustrates the comparison of the extent of the policy coverage for *NRP*, *ERP* and *PSE*. While all three measures account for the market price support component of the overall policy intervention, the *NRP* excludes input subsidies, direct payments, general services, subnational policy programs, plus other miscellaneous policies. The *ERP*, on the other hand, includes input subsidies but fails to account for the effects of the rest of the policies.⁴ The *PSE* concept, therefore, is more comprehensive in its policy coverage as compared to the alternative measures of protection. The estimates provided by consumer subsidy equivalents are superior to those provided by the *NPRC* measure since *CSE* calculations also incorporate direct and indirect consumer assistance policies.⁵ However, the protection measures discussed thus far ignore the effects of supply-control policies. This variant of *PSEs* concentrates only on the producer income transfers to gauge the extent of government intervention and ignores the trade distortionary output effects of the policies.

The relatively recent contributions in the measurement of producer protection levels have been the introduction of aggregate measures of support being considered in the GATT (AMS_G) to account for the trade distortionary effects of agricultural policies.⁶ The ongoing GATT negotiations have favored another variant of PSE , the AMS_G concept, in order to define a base level of protection for each country on which to define the future protection reduction targets. The AMS_G expresses the price wedge as the difference between the domestic “policy” price of a commodity for 1986 and the average world reference price of that commodity for 1986-88. The AMS_G concept mainly focuses on the supply-control policies by evaluating the level of distortion by maintaining the current output levels in the absence of current farm support programs.

We now elaborate trade distortionary effects of domestic policies. We provide a comparative analysis of two variants of $PSEs$, one that accounts for income transfers to domestic producers, thus gauging the extent of government intervention, and another that measures the trade distortionary effects of agricultural policies. We also highlight the choice of PSE as the dependent variable for the empirical part of this study.

Choice of a measurement concept

The discussion in the previous section highlights the distinction in the meaning and policy coverage of various measurement concepts used in the studies aimed at determining the extent of government intervention or the trade distortionary impacts of intervention.

The analysis suggests that the producer subsidy equivalents, with the widest coverage of agricultural policies, are the most comprehensive and flexible means of gauging the effects

of government intervention in agricultural markets. Nonetheless, the choice of a measurement concept is directly contingent upon the desired objectives of any empirical work. For instance, if the aim of a particular study is only to gauge the extent of price distortion, the *NRP* or *NPC* may not only provide the intended comparison but are also relatively easy to calculate. However, to ascertain the actual level of government intervention, the *PSEs* may be the most suited measurement concept.

PSEs have been quoted as having the attraction of pragmatism (MacLaren, 1991) while Cahill and Legg (1990) singled out *PSEs* on the basis of their practicality over a number of other measurements. The flexibility of the *PSE* approach is manifest in its ability to include or exclude any 'desirable' policies, in its potential to handle supply-control policies (through a modified version), and in its additivity property that allows aggregation across commodities to arrive upon a comprehensive protection index for the overall agricultural sector (Tangermann et al., 1987). The data needs for calculating *PSEs* are also manageable (Josling and Tangermann, 1989). The *PSEs* have been widely used by organizations such as OECD and USDA and this approach has also found favor with GATT's Uruguay Round negotiations since it summarizes the effects of a number of agricultural policies into a single monetary or percentage unit that can be readily used to make comparisons across commodities and countries (Bray et al., 1992).⁷

Gardner (1990a) cites various problems in using *NPCs* and *NRPs* as a measurement of protection levels. First, since the overvaluation of currencies is common in developing countries, the conversion of domestic and world prices into a common currency tends to underestimate the actual level of taxation. Second, since input subsidies

are also common in some developing countries, the actual level of taxation would be lower than the *NPC* and *NRP* estimates. Third, in the case of a large country, the internal prices of a commodity may also influence world prices.⁸ Finally, the measurements of world price are not based upon the price that would have existed in the international market in the absence of farm policies. However, all of the alternative measures are equally vulnerable to the choice of world price (Tangermann et al. 1987).

The main assumptions underlying the calculations of *PSE* and *CSE* concepts include partial-equilibrium framework; homogeneous goods with no substitution possible in production or consumption; prices of nontraded goods and other sectors held constant; domestic and foreign goods considered to be perfect substitutes; and a small country case. These concepts do not account for social costs and benefits. Nevertheless, as MacLaren (1991) points out, “one of the practical reasons why the methodology [of *PSE* and *CSE*] has been used in the Uruguay Round is that it is a partial-equilibrium approach that can be used on a commodity-by-commodity and country-by-country basis on price, quantity and trade data which are readily available.” He further contends that “while these assumptions are not satisfactory from a theoretical point of view, they do allow consistently calculated values of transfers to be placed before negotiators.”

Regarding the partial equilibrium framework employed in the *PSE* concept, it is noted in Josling and Tangermann (1989) that “general-equilibrium-adjusted rate of protection in agriculture is probably only marginally different from the rate of protection measured in the traditional partial approach” (p. 345). They further opine that the rate of protection that is based on a general equilibrium framework tends to be less than that

estimated using the partial equilibrium approach. One other assumption in the calculation of *PSE* is the notion that a dollar in government expenditures results in a dollar increase in producers' income.

In short, the benefits of using subsidy equivalents for measuring protection levels include being simple and flexible; a wider policy coverage; and enabling cross-country and cross-commodity comparisons on individual and aggregate basis –the additivity property (Ballenger, 1988). Overall, the extent of distortions captured by *PSEs* and *CSEs* can be up to 30 percent *more* than captured by other alternative measures (Schwartz and Parker, p. 1143). However, all of these measures of protection suffer from two problems: ignoring general equilibrium effects and being based on a small country assumption

The basic definition of *PSEs*, with its emphasis on income transfers to agricultural producers, is more suitable for gauging the extent of government intervention. This measure aptly suits the purpose of an investigation where the focus is on analyzing the income redistribution effects and determinants of government intervention in agriculture across countries. However, where the focus is on measuring trade distortions and effects of liberalization by looking into how much the output of a sector is influenced by a policy, this measure seems to be less satisfactory (Hathaway, 1987). For example, a country can switch to a policy that further distorts producer incentives without changing the actual transfers to producers. As originally proposed, the *PSE* approach was designed to capture income transfer effects and not the distortions to production caused by domestic farm policies. This inability has resulted in the development of a variant of the *PSE*, the '*trade distortion producer subsidy equivalent*' (PSE_{TD}), that focuses primarily on the output

distorting effects of policies. The advocates of *PSEs* in multilateral trade negotiations have favored using the PSE_{TD} , which would capture the effects of a policy switch that distorts output. The original version of the *PSE* in this case would stay the same since income transfers remain unchanged. These two variants of *PSEs*, as well as *NRP* measure, are compared below under a small country case (i) where the producer incentives are influenced through indirect government outlays, and (ii) where producer incentives are influenced without involving budgetary expenditures.

Consider the case of a closed small country where supply of the commodity in question is represented by the curve S and the domestic demand by D , as shown in Figure 2, panel A. Suppose that the domestic price is maintained at P_d to support the domestic farmers, which is above the world price P_w . The output produced is OQ_1 . If the government supports the agricultural sector by subsidizing research and extension activities, this would shift the supply curve in the long run to S' , with the new output level OQ_2 . The gross total value of the *NRP* measure, in this case, is $OP_d bQ_2 - OP_w aQ_2 = P_w P_d b a$. The similar estimate of *PSE* is $OP_d bQ_2 - OP_w aQ_2$ plus the indirect government expenditures on research and extension, given by the area $P_d P_p c b$. In order to compare these estimates with the absolute trade distortion effects captured by the PSE_{TD} , the policy incentive price needs to be identified that would elicit the same amount of output (OQ_2) in the absence of the indirect subsidy. The incentive price that would support OQ_2 level of output at the old supply curve would be P_p . The trade distortionary effects captured by this measure extend the price wedge to $OP_p cQ_2 - OP_w aQ_2 = P_w P_p c a$.

In this case, it is apparent that the *NRP* and *PSE* capture the same extent of the market price support but the *PSE* also incorporates the government outlay on research and extension in its calculations. Therefore, the distortionary effects captured by the *PSE* are higher than those captured by the *NRP* measure. The overall estimates of the distortion provided by the trade-distortion and the government-intervention variants of *PSE* are similar in this case although the market price support measured by the PSE_{TD} is relatively higher than the *PSE* by the area P_dP_pcb , which is also the amount of government expenditures.

However, in the case where the policies that influence output but do not involve government expenditures, the similarity of the estimates provided by the two *PSE* measures would cease to exist. In other words, the policies that result in a shift of the supply curve but do not enter the regular calculations of *PSE*, the estimates of the distortion provided by the two *PSE* measures would no longer be identical. For example, Bray et al (1992) show that in case of supply restraint programs like the flex acres in the United States, the resulting estimates of the trade distortion and government intervention *PSEs* would be different.⁹

Consider initially that the world price, P_w , is allowed to prevail in the domestic market and the total output produced is OQ_1 . Further, consider a case where the government policies result in a disincentive for producers that shifts the supply curve back from S to S' (Figure 2, panel B). The shift due to the disincentive policy reduces the domestic output to OQ_2 at the world price. In this case, the policy incentive price that would restrict the output to OQ_2 without the policy, will be P_p . Here, the *NRP* and *PSE*

measures would show zero distortions since the price wedge is nonexistent and there are no government outlays. The PSE_{TD} , however, would capture the negative trade distortionary effects of this policy on the producers and would be equal to the area $OP_p c Q_2 - OP_w b Q_2 = -P_p P_w b c$.

In contrast, now consider the case where the government maintains the domestic price at higher than the world price level at P_d , resulting in the domestic output OQ_3 along the supply curve S (Figure 2, panel B). The shift in the supply curve to S' due to this policy would, in this case, decrease the domestic output to OQ_1 . Here, the effects of this policy would provide different estimates of the three measures of support. The numerator of NRP as well as PSE estimates would be $P_w P_d a$, which represents the market price support or the wedge between the domestic and the border price. The policy incentive price that would maintain the output at OQ_1 without the policy would be the same as the world price P_w . The trade distortion measuring definition of PSE – the PSE_{TD} – would in this case be zero. The effects of a decoupled payment, a payment that is unrelated to the output, would also be similar.

These examples appropriately illustrate the differences in the policy coverage between NRP and the two variants of producer subsidy equivalents. The PSE focuses on the income transfers to the producers while the PSE_{TD} captures how the output of the commodity is influenced by the distortionary policy, highlighting the trade distortionary effects of the policies. Therefore, the discussion suggests that for studies aimed at measuring the extent of government involvement in a given sector and its effect on producers' income, the appropriate measure would be the PSE . On the other hand, in the

case where the interest is to analyze the effects of policies on the trade distortions in the commodity markets, as was the case in GATT negotiations, the PSE_{TD} would provide more consistent estimates.

In international trade forums, the main focus is on how the government policies distort the incentives for domestic production and on the adverse effects of the distorted supply on the trading partners of a country. In such negotiations, the extent of government outlays and the transfers to the domestic producers seem to be much less of a concern. In case where negotiations are based upon the estimations of the distortion provided by the producer subsidy equivalent measures, the trade distortionary version of this measure would provide more meaningful information. The use of PSE_{TD} has recently received considerable support in trade negotiations (Bray, et al., 1992; Meilke and Warley, 1989; Rossmiller and Elliott, 1989; Tangermann, 1989; Tangermann, et al., 1987). The measures proposed earlier by the Canadian government (trade distortion equivalent, TDE) and the E.U. (the support measurement unit, SMU) also represent the constant output version of the producer subsidy equivalents (FAPRI, 1992; Colman, 1991; IATRC, 1990).

The emphasis of aggregate measure of support (AMS) is on finding a commonly agreeable definition of the measurement concept and, later, on gradual reduction in the support levels as measured by this concept. The AMS is calculated on a product-specific basis for each product that receives the market price support and other specified assistance while the nonproduct-specific support is combined into a single composite monetary estimate. The AMS calculates the market price incentives by using the wedge between the hypothetical policy price (or the applied administered price) for the commodity for 1986

and the average of the fixed external reference price for 1986-88. The wedge is multiplied by the quantity of output eligible to receive the policy price in that period to obtain the resulting base for future negotiations on trade liberalization and reductions in government support. Since the focus here is on trade distortion and not on domestic expenditures for farm programs, unlike *PSE*, the budgetary outlays made to maintain this gap, such as buying or storage costs, are not considered in the *AMS* calculations.

Table 3 highlights the policies covered under the two data sets: USDA (1990) and OECD (1991). Although there are some differences between the estimates calculated by these two organizations, they are broadly comparable (Blandford, 1990). The following discussion highlights the compatibility of using these two data sets in the empirical analysis in this study since both account for similar policies and provide similar estimates of the extent of government intervention.

Generally, the USDA and OECD calculations of support to domestic producers can be summarized into six similar broad categories: market price support, direct income enhancing policies, programs assisting variable costs of production, marketing assistance services, programs affecting long-term agricultural production and controlled exchange rate distortions (Table 2). Market price support policies include border measures and price stabilization schemes designed to raise (or lower, in case of some developing countries) domestic producer prices. Since the higher prices are untenable to be sustained in an open economy, the border measures also follow restriction on competition in domestic markets by applying trade restrictions. The direct payments to producers, or producer levies which have negative effects on production, are also included in the *PSE*

calculations, as mentioned earlier. Input and marketing assistance policies, such as transportation subsidies, also lower producer costs although their effect on producer revenues are ambiguous. These policies are included as indirect protection policies in both USDA and OECD calculations.

Long-term production assistance policies included in the calculations cause fewer trade distortions in the shortrun than do market price support policies. However, certain long-term and other policies may fall under different categories in these data sets due to their effect on current output. For example, the electricity subsidy to Indian farmers is counted in the USDA calculations as an input subsidy rather than under the infrastructure support, as mentioned in the government outlays.

The USDA calculations, in addition to the OECD classification, also include the effects of exchange rate distortions in case of developing countries but account for the effects of subnational policies only for the United States and Canada. None of these calculations include the cross-commodity effects of protection awarded to an agricultural commodity. Nor are the effects on producer incentives of subsidies to the agribusiness sector (the food processing industries, for example) included in these estimates. The administrative costs as well as the social security benefits and general economywide taxation policies are also excluded. The reduction in incomes due to policies that control supplies such as uncompensated acreage reduction programs in the United States (as discussed in the case illustrated earlier) and the dairy production quotas in E.C. and Canada, are also not included in these estimates. The overall product-specific as well as aggregate estimates of producer and consumer protection levels provided by these

organizations are similar to a great extent (Figure 3). Therefore, the estimates from these sources can be merged to enhance the coverage of countries and commodities in the present study. The USDA data are shown only for 1982-87.

There have been relatively few quantitative studies on the determination of government intervention in agriculture in a product-specific framework. The majority of these studies have adopted an aggregative approach to analyzing agricultural protection. Since most protectionistic policies are based upon individual commodities and vary significantly across commodities, aggregating the effects of policies designed to influence different commodities individually would obscure the significance of the results. For example, the Indian government provides subsidies to oilseeds while it taxes the cereal producers.

Table 4 shows the protection awarded to specific commodities as well as the effect of aggregating the protection level for all these commodities. The table shows that while individual commodities may be rather heavily taxed or subsidized, the aggregate agricultural protection levels, as are used in most earlier studies, reflect only mild interventions in such cases. For example, the aggregate *PSEs* for 1984 show zero level of government support while there was substantial taxation (corn, cotton-long, sorghum, soybean and wheat) or subsidization (cotton-medium, peanuts, rapeseed and rice) of individual commodities in that year. Therefore, the aggregate estimates may lead one to believe falsely that the government intervention is rather less pervasive in some cases while the opposite might be the case. The aggregation across commodities thus obscures these differences (Herrmann, 1989). This certainly poses a problem in cases where governments

subsidize certain commodities, while they tax others. Such policies are widespread in developing economies for reasons such as food security for poor consumers or national concerns, among others. Results of studies that include developing countries in their analysis of cross-country agricultural protection using the aggregate protection levels may be adversely influenced by this problem. Therefore, the present analysis would adopt a *product-specific* approach to study the extent of government intervention in the agricultural sector. A graphical comparison of the ability of selected measures to capture the market distortions is presented for different policy scenarios in a trade theoretic framework.

Comparative Graphic Analysis of Measurement Concepts

We now provide a comparative analysis of selected measurement concepts within a theoretical framework. The analysis compares the Marshallian producer surplus measure with *NRP* and *PSE* estimates for small and large country cases under a variety of policy scenarios. The commodity in question is assumed to be a staple food commodity (normal good).

Measuring Market Distortions in Case of a Small Country

Consider a small country with supply and demand of a staple agricultural commodity shown by S and D , respectively (Figure 4). The assumption here is that the country's share of the world market for that commodity is too small to influence the world market prices. In addition, this particular commodity constitutes an insignificant part of the domestic economy to have any effects on the foreign exchange rate. In the absence of

any distortionary policy, the world price, P_w , prevails in the domestic market. At this price, domestic production is OQ_1 , domestic consumption is OC_1 and the Q_1C_1 quantity is imported. Here the gross returns to the producers are OQ_1bP_w , which, after taking into account the variable production costs, result in the producer surplus equivalent to the area aP_wb .

Now suppose that the government decides to increase the producers' income by providing them a direct subsidy per unit of production such that the market price still stays at P_w .¹⁰ Farmers are promised the difference $P_p - P_w$ as deficiency payments per unit. The domestic production increases to OQ_2 and, since consumption remains at the same level, imports drop to Q_2C_1 . Farmers' gross income now is $OP_p dQ_2$ and the producer surplus is $aP_p d$. This involves the cost to the government equal to the area $P_w P_p dj$, which clearly is higher than the gains to the domestic producers by the area bdj .

In order to determine the extent of market distortions captured by the *NRP* and *PSE* measures of protection, the estimates provided by these measures can be compared with the change in producer surplus. To facilitate such comparisons, the change in producer surplus may be converted into the percentage change ($\% \Delta PS$) at (i) border value, using the base of the nominal protection rate; and (ii) market value, using the base of producer subsidy equivalent.

$$NPR = \frac{Q \cdot P_d - Q \cdot P_w}{Q \cdot P_w} = \frac{OP_w f Q_2 - OP_w f Q_1}{OP_w f Q_2} = 0,$$

$$\% \Delta PS|_{\text{Border Prices}} = \frac{P_w P_p db}{OP_w f Q_2}.$$

The *NRP* measure is not capable of capturing the market distortions that do not affect domestic prices. Here, while producers evidently gain due to this direct transfer, the *NRP* fails to capture this gain. Therefore, in this case, *NRP* underestimates the actual market distortions.

On the other hand, *PSE* does consider the transfers to producers such as deficiency payments as:

$$PSE = \frac{Q \cdot P_d - Q \cdot P_w + (D+I)Q}{Q \cdot P_d + D \cdot Q} = \frac{OP_w f Q_2 - OP_w f Q_2 + P_w P_p dj}{OP_w f Q_2 + P_w P_p dj} = \frac{P_w P_p dj}{OP_p d Q_2},$$

whereas,

$$\% \Delta PS \Big|_{Market Prices} = \frac{P_w P_p db}{OP_p d Q_2}.$$

Clearly, *PSE* overestimates the gains to producers by the area *bdj* which represents extra cost associated with producing quantity Q_1 to Q_2 domestically rather than importing it. This brings forth the weakness associated with the calculating the extent of distortion using the *PSE*. The *PSE* measures the effects of some government programs by the level of government expenditure, which may bear little relationship to its effect on market distortion (Schwartz and Parker, 1988). Comparing these three measures, it is evident that,

$$PSE > \% \Delta PS \Big|_{Border Prices} > \% \Delta PS \Big|_{Market Prices} > NPR.$$

Now, suppose that the government provides a price subsidy that raises the producer price to P_p rather than providing a direct income transfer to the farmers as in the previous case. Here, the estimates of *NRP* and comparative producer surplus would be:

$$NPR = \frac{OP_p d Q_2 - OP_w f Q_2}{OP_w f Q_2} = \frac{P_w P_p dj}{OP_w f Q_2},$$

$$\% \Delta PS|_{\text{Border Price}} = \frac{P_w P_p db}{OP_w j Q_2}.$$

NRP overestimates the percent change in producer surplus at border price by the area *bdj*.

The *PSE* measure also overestimates the percentage change in producer surplus at market prices but underestimates the same at border prices:

$$\begin{aligned} PSE &= \frac{OP_p d Q_2 - OP_w j Q_2}{OP_p d Q_2} = \frac{P_w P_p dj}{OP_p d Q_2}, \\ \% \Delta PS|_{\text{Market Price}} &= \frac{P_w P_p db}{OP_p d Q_2}. \end{aligned}$$

Therefore,

$$NRP > \% \Delta PS|_{\text{Border Prices}} > PSE > \% \Delta PS|_{\text{Market Prices}}.$$

Clearly, for price induced producer subsidy, *NRP* overestimates the distortion by a larger amount as compared to the *PSE*, which is contrary to the assertions made in Schwartz and Parker (1988) that “For ... the price induced producer subsidy, the *PSE* is identical to the *NRP*.” 11

Now consider a case where the government institutes a tariff on the imports of the commodity that raises the domestic price to P_p from P_w . The government uses all of the tariff revenue, *oenk*, to further assist the domestic producers by providing a price subsidy of $P_p P_t$. These trade distortions cause changes in real economic variables. Consumption now is OC_2 down from OC_1 , domestic production is OQ_3 , and imports drop to $Q_3 C_2$, representing restrictions on market access. The policy also results in price-induced income effects. Consumer surplus decreases by the area $P_w P_p ec$ whereas producer surplus now is equal to $aP_t f$. This revenue-neutral tariff plus the producer subsidy policy results in net economic loss to the domestic economy equal to the triangles *bfk* (which represents the additional cost associated with producing quantity $Q_1 Q_3$ domestically rather than

importing it) and *net* (since consumers buy C_1C_2 less in quantity and pay higher per unit price for it).

In this case, the comparison among the *NRP*, *PSE* and percentage changes in producer surplus at border and market prices yields:

$$NPR = \frac{P_w P_{jk}}{OP_w k Q_3} > \% \Delta PS|_{Border\ price} = \frac{P_w P_{jb}}{OP_w k Q_3} > PSE = \frac{P_w P_{jk}}{OP_{jQ_3}} > \% \Delta PS|_{Market\ price} = \frac{P_w P_{jb}}{OP_{jQ_3}}.$$

It may be stated, therefore, that the market distortion captured by the *NRP* and *PSE* measures would provide identical estimates of the level of distortion both in the case of a price subsidy or import tariffs. Nonetheless, it should be noted that the absolute differences in the two estimates would be contingent upon the size of the direct payments since the direct payments enter both the numerator and the denominator of the *PSE*.

Since these distortions also affect the domestic consumer prices, their effects on domestic consumers can be approximated using the *NPRC* and *CSE* measures which can further be compared with the respective percentage change in the consumer surplus:

$$NPRC = \frac{-[OP_{pe}C_2 - OP_{wn}C_2]}{OP_{wn}C_2} = \frac{-P_w P_{pen}}{OP_{wn}C_2},$$

and

$$\% \Delta CS|_{Border\ price} = \frac{-P_w P_{pec}}{OP_{wn}C_2}.$$

Here, *NPRC* underestimates the (absolute) amount of market distortion affecting consumers. *CSE*, on the other hand, also underestimates the percentage change in consumer surplus at market prices:

$$CSE = \frac{-[OP_{pe}C_2 - OP_{wn}C_2]}{OP_{pe}C_2} = \frac{-P_w P_{pen}}{OP_{pe}C_2},$$

and

$$\% \Delta CS|_{Market\ price} = \frac{-P_w P_p e c}{OP_p e C_2}$$

Comparing both the results together, it is obvious that,

$$\% \Delta CS|_{Border\ price} > \% \Delta CS|_{Market\ price} > NPRC > CSE.$$

if the area $P_w P_p e n < e n c$. If the area $P_w P_p e n > e n c$, then

$$\% \Delta CS|_{Border\ Prices} > NPRC > \% \Delta CS|_{Market\ Prices} > CSE.$$

$NPRC$ thus seems to overestimate the market distortions as compared to the CSE measure although $NPRC$ underestimates the distortion as compared to the consumer surplus at border prices.

All of these cases implicitly assumed the case of industrialized countries where domestic prices are usually kept at levels higher than the international prices to support domestic producers. Such policies adversely affect consumer welfare as is depicted by the negative values obtained in the case of these measures.

Next, assume the case of a small, poor agrarian economy where the aim of the government is to provide consumers with cheap food and, therefore, they institute policies that keep the food prices at levels below the international market. The earlier assumptions regarding the ineffectiveness of the country to influence the border prices or of the particular commodity to influence the foreign exchange rates, are still in effect.

Let P_w be the price of the commodity in the world markets (Figure 5). At this price, assuming no distortionary policies in the domestic economy, output OQ_i is produced, of which the quantity OC_i is consumed domestically and the remainder, $C_i Q_i$, is exported. The international price is higher than what would ensure the domestic

consumer sufficient consumption of the commodity. Therefore, the government imposes an export tax equivalent to the amount $P_w P_d$ per unit of output which decreases the domestic consumer and producer price to P_d .

The export tax thus induces changes in real variables. Domestic production decreases to OQ_2 , domestic consumption increases to OC_2 and exports are now C_2Q_2 .

The price-induced income effects of this policy would result in the loss in producer surplus equal to the area $P_d P_w c e$, of which consumers gain $P_d P_w b d$, and the government earns the area $d f g e$ in export revenues. In net national economic welfare terms, the deadweight loss is equal to the triangles $b f d$ and $e g c$.

The estimation of the market distortion from the producers' point of view may be approximated using the *NRP*, *PSE*, and producer surpluses at border and market prices:

$$NRP = \frac{OP_d e Q_2 - OP_w g Q_2}{OP_w g Q_2} = \frac{-P_d P_w g e}{OP_w g Q_2},$$

$$\% \Delta PS|_{\text{Border price}} = \frac{-P_d P_w c e}{OP_w g Q_2},$$

$$PSE = \frac{OP_d e Q_2 - OP_w g Q_2}{OP_d e Q_2} = \frac{-P_d P_w g e}{OP_d e Q_2},$$

and

$$\% \Delta PS|_{\text{Market price}} = \frac{-P_d P_w c e}{OP_d e Q_2}.$$

Both *NRP* and *PSE* are smaller than the percent change in producer surplus at border and market price, respectively, by the area $e g c$. However, although the absolute estimates of *NRP* and *PSE* are identical, in percentage terms, the *NRP* estimates underestimate the distortionary effects by less than the *PSE*:

$$\% \Delta PS|_{\text{Market price}} > \% \Delta PS|_{\text{Border price}} > NRP > PSE.$$

Evaluating the distortionary effects of the export tax on the consumers using *NPRC*, *CSE* and consumer surplus measures yield the following:

$$NPRC = \frac{-[OP_d dC_2 - OP_w fC_2]}{OP_w fC_2} = \frac{P_d P_w f d}{OP_w f C_2},$$

$$\% \Delta CS|_{Border\ price} = \frac{P_d P_w b d}{OP_w f C_2},$$

$$CSE = \frac{-[OP_d dC_2 - OP_w fC_2]}{OP_d dC_2} = \frac{P_d P_w f d}{OP_d d C_2},$$

and

$$\% \Delta CS|_{Market\ price} = \frac{P_d P_w b d}{OP_d d C_2}.$$

NPRC overestimates percent change in consumer surplus at border price by the area *bfd*. Similarly, *CSE* also overestimates the percent change in consumer surplus at market price by the area *bfd*. However, the estimate for *CSE* for this policy is greater than that for *NPRC*. In short, for the case of an export tax, *CSE* and *NPRC* provide identical absolute estimates yet differ in percentage terms:

$$CSE > \% \Delta CS|_{Market\ price} > NPRC > \% \Delta CS|_{Border\ price}$$

It should be noted that the market distortion captured by the *NPRC* and *CSE* measures may also provide identical estimates of the level of distortion in case of any policy instruments that affect domestic prices only. However, any policy that does not affect consumer prices would result in different estimates of these measures. In that case, *CSE* would approximate the distortion levels more precisely than *NPRC*, which would fail to account for income transfer measures, like food stamps, as explained below.

Further assume that the government redistributes some part or all of its export tax revenues to provide an income support to the poor consumers, which shifts the demand

curve out to the right to D_1 (Figure 5). Consumer and producer prices remain below the international prices at P_d . Consumption now increases to OC_3 while output remains at OQ_2 and, therefore, exports decrease to C_3Q_2 . Consumer surplus is now P_dhj while the producer surplus remains unchanged at nP_de .

In this case, on the producer side, since there is no further change in producer price and output, the earlier results for the *PSE*, *NRP*, and producer surpluses at border and market prices would remain unchanged. The direct income transfer to the consumer would, however, change the estimates of protectionary effects on the consumer side, since:

$$NPRC = \frac{-[OP_{dj}C_3 - OP_{wi}C_3]}{OP_{wi}C_3} = \frac{P_d P_{wi}}{OP_{wi}C_3} ,$$

$$\% \Delta CS|_{\text{Border price}} = \frac{ahjd}{OP_{wi}C_3} ,$$

$$CSE = \frac{(Q_c \cdot P_c - Q_c \cdot P_w) + (D_c + I_c) Q_c}{Q_c \cdot P_c + D_c \cdot Q_c} = \frac{-[OP_{dj}C_3 - OP_{wi}C_3] + dfij}{OP_{dj}C_3 + dfij} = \frac{P_d P_{wi} + dfij}{OP_{dj}C_3 + dfij} ,$$

and

$$\% \Delta CS|_{\text{Market price}} = \frac{ahjd}{OP_{dj}C_3 + dfij} .$$

Here *CSE* estimates are higher than those provided by the *NPRC* because *NPRC* fails to capture the income transfer subsidy to consumers. Since *NPRC* accounts for only the wedge between the domestic and border prices but not the direct transfers to consumers, *CSE* provides a better measure of how government policies influence incentives for consumers. This finding is also consistent with earlier studies.¹² The comparisons among the *NRP* and *CSE* with consumer surpluses at border and market prices yield ambiguous results.

$$NPRC > \%ACS_{\text{Border price}} \text{ iff area } P_d P_{wfd} > ahmb;$$

$$CSE > \%ACS_{\text{Market price}} \text{ iff area } P_d P_{wff} > ahmb;$$

$$\text{and } NPRC > \%ACS_{\text{Market price}} \text{ iff area } P_d P_{wbd} > ahmb.$$

Tables 5 through 7 provide calculations of *NRP*, *PSE*, *NRPC* and *CSE* to support this analysis for small country. The small wheat-importing industrialized countries like Norway and Switzerland have market price support (*MPS*) greater than zero with different levels of direct and indirect producer support. In case of absolute measurements (considering only the numerator of *NRP* and *PSE*), the existence of direct or indirect payment would result in higher estimates of *PSE*. But where the percentage addition to numerator is smaller than the denominator, the *PSE* estimates would be lower than the *NRP*. For example, in Table 5, the *NRP* estimates for Norway for 1980 are smaller than those provided by the *PSE* measure, while the reverse is true for 1990. In case of developing countries, like Nigeria and India, where *MPS* and direct payments are zero, *NRP* would be zero. Here, *PSE* would provide more accurate measures of distortion since it would capture any positive or negative indirect support, and thus would be significantly different from the *NRP* estimates.

The greater the level of direct and indirect transfers, the more significant would be the difference in the estimates provided by these measures (Table 6). In Sweden, for example, the *NRP* for 1990 is 240 percent while the *PSE* is only 73 percent. When the *MPS* is not zero but there are no direct payments, such as for India, the absolute *NRP* estimates would exceed those of *PSE*. The differences among the estimates provided by

consumer protection measurement concepts are similarly different (Table 7). If domestic consumer price is less than the border price and there are some direct or indirect payments, the *CSE* would always be larger than *NPRC*.

It may be useful to further analyze the case where the staple food commodity commands a large percentage of consumers' budget. In that case, the change in prices will have real income effects. This is particularly true in case of poor developing economies. This case may be studied using the compensated demand analysis instead of the standard Marshallian demand curves.

Measuring Distortions in the Case of A Large Country

Large industrialized wheat exporting countries in wheat (the United States, the European Union, Australia and Canada) have also relied, besides other measures, upon export subsidies to safeguard the interests of their domestic producers. The European Community has become a net exporter of most commodities, from being a net importer during the 1960s, by using variable levies and export subsidies. Export subsidies alone accounted for about 30 percent of the total support provided to grain farmers. The Union provided its wheat growers \$7.09 billion through its trade measures designed to protect the domestic producers from world price fluctuations (OECD, 1991). The Australian Wheat Board, on the other hand, manages the marketing of 80 percent of total Australian wheat production, which is sold in international markets. Domestic wheat prices have exceeded export prices, resulting in an assistance of about \$7 per ton to the domestic producers (USDA, 1987). The recent policy trend for the United States is to rely more on

export subsidies and deficiency payments (Gardner, 1990a). The Canadian dairy industry is characterized by extreme political involvement and protection and the Canadian dairy farmers received about \$1.78 billion in 1990 in market price supports including export subsidies (OECD, 1991). The following case analyzes the distortions caused by such subsidies in large exporting countries which face an upward sloping excess demand curve (ED) by the rest of the world (Figure 6).

Let the world price be P_w at which the domestic production is OQ_1 and domestic consumption is OC_1 . The quantity C_1Q_1 is exported, which equals OX_1 in panel (B). Domestic producers lobby for higher output prices and the government agrees to provide an export subsidy of P_dP_w per unit of output. This raises the domestic price to P_d and also induces changes in real variables. Domestic consumption decreases to OC_2 and domestic production increases by Q_1Q_2 . Exports are now C_2Q_2 , which is equal to OX_2 . The consumer surplus decreases by the area P_wP_dca whereas the producer surplus increases by P_wP_dcb , resulting in a net gain of $adcb$, which is equal to the area ghP_dP_w in panel (B).

The increase in exports shifts the excess supply in the world market to ES_1 , thereby decreasing the world price to P_{w_1} . The cost to the government of exporting country is given by the amount of exports times the difference between the domestic price and the new world price. Hence the cost of the policy is $kdem$, which is equivalent to the area $jhP_dP_{w_1}$ in panel (B). Of this cost, the producers' gain is $adcb$ (or ghP_dP_w). The lower prices in the world markets increase the consumer surplus of the importing countries by the area $fgP_wP_{w_1}$, leaving the net economic loss to the world of jhg . Of this loss, the

exporting country bears the portion ihg , which equals the sum of the two triangles eda and bcf in panel (A), while the rest, area jig , is borne by the rest of the world.

The distortions in the exporting country's economy caused by the export subsidy can be approximated by NRP and PSE and compared with the distortion estimates provided by the Marshallian producer surplus measures. In absolute values, the NRP and PSE estimates would be identical and would overestimate the distortion. However, in percentage terms, the estimates of distortion obtained using the NRP would be higher than those obtained from PSE . Moreover, both these estimates would exceed the producer surplus estimates by the area P_wbcm . Overall, the NRP would overestimate the distortion by a larger amount as compared to the PSE , which would overestimate the distortion at market prices but would underestimate it at the border prices.

The analysis reveals that the large exporting country loses by maintaining domestic prices above the world price levels and the domestic economy witnesses the redistribution of income from consumers and taxpayers to the domestic producers and foreign importers. Compared to a small country case, when a large country raises its domestic prices above international prices, it depresses the international prices and the cost to the domestic economy is much higher than is reflected in gains to domestic producers. The level of the distortion due to the export subsidy for a large exporting country, as measured by the NRP and PSE , reveals that both these measures clearly overstate the actual extent of distortion.

The differences in the estimates provided by these measures are also substantiated in Tables 8 through 10. As discussed earlier, where MPS is zero but producers are given positive direct payments, the PSE estimates would always be greater than NRP .

since *NRP* would be zero, as is the case of United States (wheat) for 1990 (Table 8). On the contrary, when *MPS* is positive but there are no direct or indirect payments, the *PSE* estimates would be smaller than those of *NRP* because in these countries, domestic prices are maintained above the world prices. In low-income countries like Argentina that tax domestic farmers and provide no direct payments but provide positive indirect subsidies, the numerator of *PSE* would be smaller, resulting in different estimates.

Likewise, in the case of large importing countries with a significant positive price wedge, the *NRP* estimates would far exceed those of *PSE* (Table 9). The *NRPC* and *CSE* estimates would be negative for large industrialized countries that maintain higher consumer prices as compared to the world prices (Table 10). The higher this wedge, the smaller would be the *CSE* as compared to the *NRPC*.

Measurement of Protection Levels Under Price Discrimination¹³

In many countries, the governments set up agencies that have monopoly control in important food grains and manage domestic supply and international trade in order to influence domestic prices (Anderson and Tyers, 1992). For example, the Japanese Food Agency, Canadian Wheat Board (CWB), and the Australian Wheat Board (AWB) are engaged in such efforts. The AWB has had a monopoly on marketing of wheat overseas and domestically. The board has long been administering domestic wheat prices above international levels. Although the domestic wheat marketing has almost been deregulated since 1989, the AWB still exercises monopoly power over marketing of wheat exports, which constitute about 80 percent of total production (Edwards, 1990). In the case of

many developing countries, government agencies, such as Food Corporation of India and National Logistics Agency of Indonesia, also hold monopoly power to maintain control over domestic prices and engage in international trade. These agencies, however, maintain domestic prices below the international prices in order to ensure accessibility to cheap food for poor people.

In the case of industrialized countries where domestic prices are usually maintained above the world price level, these agencies may engage in price discrimination. Assuming that the world market price of an agricultural commodity is determined competitively, it becomes important to analyze the effects of the distortions caused by the actions of these agencies.¹⁴ It is of further interest whether such policies may result in biased estimates of protection levels using the *NRP* and *PSE* measures.

Consider the case where the monopolist is facing a perfectly elastic demand in the world markets but a downward sloping demand in the home market (Figure 7).¹⁵ First, assume that the world market price, P_{w_1} , which is also the competitive marginal revenue, is such that domestic marginal revenue curve, *MR*, is everywhere below P_{w_1} . The total output produced at this price is OQ_1 but, since no domestic buying occurs, all of this output is exported. In this case, the total revenues for the monopolist are $OP_{w_1}aQ_1$. Of this area, $OfaQ_1$ represents the total variable costs and the Marshallian producer surplus is given by the area $fP_{w_1}a$. Moreover, since no domestic price exists at which any buying may occur, the *NRP* and *PSE* may not be defined.

Now assume that the world market price drops to P_{w_2} and, thus, it becomes feasible for the monopolistic agency to engage in price discrimination. The total output produced in this case would be OQ_2 at point c where the foreign marginal revenue curve intersects the marginal cost curve, MC . Of this total output, the monopolist will be able to sell OQ_3 in the domestic market at price P_{d_1} , which is higher than the world price. The remaining output, Q_3Q_2 , will be exported. The producer surplus is $fP_{d_1} bdc$, which is equivalent to the areas $fP_{w_2} c + P_{w_2} P_{d_1} bd$. As $P_{d_1} > P_{w_2}$, the producer receives an increase in revenue equivalent to $P_{w_2} P_{d_1} bd$ due to price discrimination. These estimates of producer surplus in the commodity market can now be compared with the estimates of distortion provided by the *NRP* and *PSE*. Here, two scenarios can be analyzed: first, the case where trade is ignored and only domestic consumption is considered, and, second, where both domestic consumption and exports are considered. In the first case, the estimates of *NRP* and *PSE* would be:

$$NRP = \frac{OP_{d_1} bQ_3 - OP_{w_2} dQ_3}{OP_{w_2} dQ_3} = \frac{P_{w_2} P_{d_1} bd}{OP_{w_2} dQ_3}$$

$$PSE = \frac{OP_{d_1} bQ_3 - OP_{w_2} dQ_3}{OP_{d_1} bQ_3} = \frac{P_{w_2} P_{d_1} bd}{OP_{d_1} bQ_3}.$$

The total producer surplus, considering total output, OQ_2 , is equal to the area $fP_{d_1} bdc$. Here, the *NRP* and *PSE* estimates clearly understate the total producer surplus at border and market price, respectively, by the area $fP_{w_2} c$. Nevertheless, the *NRP* estimate is consistent with the *change* in the producer surplus at border price due to price discrimination by the monopolist, which creates the wedge $P_{w_2} P_{d_1}$ and the change in

producer surplus is $P_{w_2}P_{d_1}bd$. The estimate for PSE would compare similarly with the change in producer surplus at the market price.

Next, when trade is considered, the NRP and PSE measures would overestimate the above change in producer surplus by the area $bdhc$:

$$NRP = \frac{OP_{d_1}Q_2h - OQ_2cP_{w_2}}{OQ_2cP_{w_2}} = \frac{P_{w_2}chP_{d_1}}{OQ_2cP_{w_2}},$$

$$PSE = \frac{OQ_2hP_{d_1} - OQ_2cP_{w_2}}{OQ_2hP_{d_1}} = \frac{P_{w_2}chP_{d_1}}{OQ_2hP_{d_1}}.$$

However, the overestimation is less for PSE as compared to the NRP estimates when trade is considered. If, due to increased competition in the international market, the world price falls down to somewhere between P_{w_3} and f , domestic consumer welfare would increase. The increase in consumer surplus would clearly be much higher in the case where there is no price discrimination. The PSE and NRP estimates would still be biased upwards. The monopolist would lose due to falling world prices. The monopolist would be able to recover some of the loss by exercising price discrimination in the domestic market as compared with the case where world price was allowed to prevail in the domestic market.

Next, suppose that the world market price is too low, say at P_{w_3} , such that P_{w_3} is less than the monopolist's average total cost at all output levels. In this case, the domestic monopoly situation prevails and no trade occurs. The monopolist would operate at g where the monopolist's marginal cost and marginal revenue curves intersect and would charge the maximum price that the consumers are willing and able to pay (P_{d_2}) for the output OQ_4 .¹⁶ The producer surplus will then be $fP_{d_2}eg$ and both NRP and PSE would

overestimate the distortion in domestic markets by the area $P_{w_3}fgj$.¹⁷ The percent *PSE* would, however, overestimate the distortion by less amount than the percent *NRP* estimate:

$$NRP = \frac{OP_{d_2}eQ_4 - OP_{w_3}jQ_4}{OP_{w_3}jQ_4} = \frac{P_{w_3}P_{d_2}ej}{OP_{w_3}jQ_4},$$

$$PSE = \frac{OP_{d_2}eQ_4 - OP_{w_3}jQ_4}{OP_{d_2}eQ_4} = \frac{P_{w_3}P_{d_2}ej}{OP_{d_2}eQ_4}.$$

Although this example illustrates an extreme case, it is not far from the situation in some industrialized countries where domestic producers face very low international prices yet manage to get a higher domestic price for their output. In some cases, the controlling agencies may also establish export subsidies to compensate producers for overproduction, which is then exported at international prices. The cases where such subsidies are provided are relatively complicated to analyze. However, two such cases are discussed below where domestic consumers and producers are subsidized by direct payments.

Consider first the case of a direct consumer subsidy. The world price is P_w and domestic production is OQ_1 , of which OQ_2 is consumed domestically at price P_{d_1} and the rest, Q_2Q_1 , is exported (Figure 8). A per unit subsidy equivalent to nh would shift up the curve AR_o to AR_1 and MR_o to MR_1 , as shown in the figure. 18 The total domestic production remains unchanged at OQ_1 since the monopolist's MC curve and the foreign MR curve do not change. However, due to increased demand in domestic market, it becomes profitable for the price discriminating monopolist to sell more output in the domestic market at a higher price, P_{d_2} . Since the domestic sales increase to OQ_3 , exports drop to Q_3Q_1 . At the total output produced, the *PSE* (and *NRP*) overestimate the

distortions by the area $bhgc$. Note, however, that without the subsidy, the PSE overestimate was equivalent to the area $aijc$. Whether the overestimation is less or more now depends on whether the area $aikb$ is more or less than the area $khgj$. It may be further noted that the demand and MR curves may shift in such a way as to leave the domestic price unchanged after the subsidy. In that case, the PSE estimates would be less biased by the area $aikb$ as compared to the case without the subsidy.

Since PSE is the sum of two types of government policies, the wedge between the border and domestic prices, and the direct and indirect transfers to agricultural producers, the absolute estimates of PSE and NRP do not differ in the case where income transfers are made to consumers only. The CSE , on the other hand, would capture these budgetary transfers from the government to consumers, and would, therefore, provide relatively accurate estimates as compared to the $NPRC$.

$$NPRC = \frac{OP_{d_2} hQ_3 - OP_w bQ_3}{OP_w bQ_3} = \frac{P_w P_{d_2} hb}{OP_w bQ_3},$$

$$CSE = \frac{OP_{d_2} hQ_3 - OP_w bQ_3 + mP_{d_2} hn}{OP_{d_2} hQ_3} = \frac{P_w P_{d_2} hb + mP_{d_2} hn}{OP_{d_2} hQ_3}.$$

The $NPRC$ measure fails to capture direct consumer transfers. Therefore, the $NPRC$ underestimates the distortion compared to CSE by the amount of government expenditures. The consumers now consume higher quantities but also the domestic price has risen from P_{d_1} to P_{d_2} . Therefore, the consumers gain the area $sthx$, but lose the area $P_{d_1} P_{d_2} xi$. Therefore, the overall effect on consumers is ambiguous. Moreover, the comparison of CSE and $NPRC$ with the consumer surplus at border and market prices, respectively, is also inconclusive.

Now, assume that instead of consumer subsidy, the government provides specific input subsidy to farmers which shifts the marginal cost curve down to MC_1 (Figure 9). The output increases to OQ_2 . However, since domestic demand remains unchanged, the domestic component of price discrimination is unaffected and the consumers still consume at OC_1 . Exports increase to C_1Q_2 from C_1Q_1 . The producer surplus increases by the area $fdhg$ to $fP_d eag$. The numerator of NRP measures the area $P_w P_d kg$. Whether the area $P_w P_d kg$ is greater or less than the area $fdhg$ would depend upon the elasticities and the extent of the shift. Compared with the no input subsidy case, the overestimation by NRP here would increase by the area $bhkg$. The PSE , which would also include the amount of government expenditures, $nP_w gm$, would provide even more inflated estimates of the distortion. The comparison of these measures with the respective percentage change in producer surplus would still be ambiguous.

In short, the graphic analysis in this section examines how different intervention policies distort producer and consumer incentives. Under highly simplistic assumptions, the analysis compares and contrasts the level of distortion captured by different methods of measurement. The market distortion captured by the NRP and PSE and $NRPC$ and CSE measures would provide identical estimates of the level of distortion where the market distortion is translated into the wedge between border and domestic prices. There are certain policies that result in distortions that do not affect the wedge. In that case, PSE or CSE estimates would be closer to the actual effects whereas the NRP and $NRPC$ would fail to account for them. There are certain policies whose effects and the direction of change

would not possibly be captured by any of these measures. In such cases, empirical examination of the effects becomes desirable

Summary

This paper provides an analytical overview of the political economy market of agricultural protection. A comprehensive comparative analysis of different measurement concepts and their respective policy coverage is discussed. Finally, a graphic exposition of the policy effects captured by some selected measurement concepts is provided under many different scenarios and market conditions. The choice of the measurement concept that emerges from the analysis apparently favors the producer subsidy equivalent on the basis of its comprehensive and wider coverage of different policies and its suitability to analyze the extent of government intervention.

Endnotes

- 1 However, the *ERP* measure would include the deficiency payments if these distort the output price (see Table 1).
- 2 Krueger also emphasizes that indirect interventions in agriculture seem to be much more important than the direct support policies. Discrimination against agricultural commodities in policies external to agriculture has a greater impact on agricultural incentives than do policies aimed directly at agriculture. This is mainly true in case of developing economies of the Third World.
- 3 However, although the *NRP* measures partially make up for the shortcoming by virtue of the ease of their calculations, the *ERP* measure is neither complete nor easy to calculate. The *ERP* calculations are quite stringent since they involve estimating *NRP* for the final commodity, *NRPC* for all intermediate inputs, and technical information on input-output coefficients, which are notoriously difficult to obtain on a representative basis (Schwartz and Parker, 1988).
- 4 *ERP* calculations, at times, may include direct payments such as deficiency payments that translate directly into output price effects.
- 5 The USDA, ERS calculations, however, make no distinction between the direct and indirect assistance to the consumers, as is evident from Table 1.
- 6 Since trade distortionary implications of agricultural policies are not indicated by the *PSEs*, Roningen and Dixit (1991) have proposed the "trade distorted by support" measure (*TDS*) to "measure the change in the volume of net trade from existing levels if a country completely eliminates all support to the commodity."
- 7 The *PSEs* may be expressed either as a percentage of the value to producers, in monetary units per ton, or in total monetary value of transfers.
- 8 Some adjustments in this case are suggested by Josling and Tangermann (1989) that would mostly benefit in the framework of studies of trade models dealing with the effects of liberalization rather than the studies on the extent and reasons of government intervention.
- 9 In order to qualify for assistance under the U.S. government's set-aside program (which is aimed at restricting production acreage under the grain support program), a certain percentage of a producer's base acreage must be left fallow. The normal flex acreage is about 15 percent of the base, with an additional 10 percent under optional flex acres. Producers do not receive deficiency payments on these flex acres although alternative crops may be planted on this land. For a detailed discussion, see Note 3 in Bray *et al.*
- 10 Assuming that this policy does not shift the supply curve but rather results in increase in the quantity supplied.

- 11 Although the absolute measures of PSE and NRP would provide identical estimates in this case, converting them into percentages, the two measures yield different results. Since in most of the studies, the PSEs and NPRs are used in percentage terms, the above conclusion seems more meaningful.
- 12 See, for example, Josling and Tangermann (1989), Schwartz and Parker (1988), and Gardner (1989b)
- 13 Although some studies have analyzed price discrimination, the following discussion represents the first systematic demonstration of price discrimination in the context of extent of distortion captured by alternative measures of protection.
- 14 Price discrimination is generally defined as the situation where any product produced under single control is sold at different prices to different buyers (Robinson, 1938).
- 15 It is being assumed here that both markets are separable with no arbitrage possibilities, different price elasticities exist, and in cases discussed below, that the domestic government bars imports from impinging upon the monopolized domestic market with no similar restrictions by other countries that might affect this country's exports.
- 16 It may be noted that the world price may decrease further with no change in the domestic price and output
- 17 However, it must be noted that the foreign price component in this case is arbitrary and could be anything
- 18 It may be noted here that an *ad valorem* subsidy would alter the slopes of the *AR* and *MR* curves between the pre- and post-subsidy scenarios. The overall policy effects in this case can be shown analogous to the per unit subsidy case analyzed below and are not discussed separately.

Table 1. Comparison of alternative agricultural protection measurement concepts

Measurement Concept ^a	Acronym	Definition ^b
Nominal Protection Coefficient	NPC	P_d / P_w
Nominal Rate of Protection	NRP	$Q (P_d - P_w) / Q \cdot P_w$
Nominal Rate of Protection for	$NRPC$	$- Q_c (P_c - P_w) / Q_c \cdot P_w$
Nominal Rate of Assistance	NRA	$Q \{ (P_d \cdot \omega) - P_w \} / Q \cdot P_w$
Effective Rate of Protection	ERP	$(VA_d - VA_w) / VA_w$
Effective Rate of Assistance	ERA	$\{ (VA_d \cdot \delta) - VA_w \} / VA_w$
Direct Nominal Protection Rate	NPR_D	$\{ (P_d - C) - (P_w - C) \} / (P_w - C)$
Indirect Nominal Protection Rate	NPR_I	$\{ (P_{NA}^* \cdot E_o) - (P_{NA} \cdot E) \} - 1$
Total Nominal Protection Rate	NPR_T	$\{ [(P_d - C) / P_{NA}] - (P_w - C) - P_{NA}^* (E^* - E_o) \} / \{ (P_w - C) - P_{NA}^* \}$
Producer Subsidy Equivalent	PSE	$\{ Q(P_d - P_w) - D + I - L \} / \{ Q \cdot P_d - D - L \}$
Producer Subsidy Equivalent, Trade Distortion Variant	PSE_{TD}	$\{ Q(P_p - P_w) + D - I - L \} / \{ Q \cdot P_p - D - L \}$
Consumer Subsidy Equivalents	CSE	$- \{ Q_c(P_c - P_w) - D_c \} / (Q_c \cdot P_c)$
Trade Distortion by Support	TDS	$Q \cdot \varepsilon_i \cdot S_m - Q_c \cdot \varepsilon_i \cdot S_m + Q \cdot \varepsilon_i \cdot S_p - Q_c \cdot \varepsilon_i \cdot S_c - Q \cdot \varepsilon_i \cdot SSO$
Aggregate Measure of Support, GATT	AMS_t	$Q_t (P_{p,t} - P_{w,ref})$

a The measurement concepts refer to the protection levels for a single agricultural commodity. However, these can easily be aggregated to reflect overall protection to the agricultural sector. Percentage values can be derived by multiplying the each measure by 100, except the TDS and AMS .

b The variables used are defined as: P_d : Domestic Producer Price; P_w : World price (measured in domestic currency); Q : Domestic production; ω : Set of other subsidies/tax on output (including deficiency payments); C : Adjustment for differences in quality, storage, transportation, handling costs and other margins; C^* : Adjustment for differences in quality, storage, transportation, handling costs and other margins measured under competitive conditions; P_{NA} : Price index of non-agricultural sector; P_{NA}^* : Price index of non-agricultural sector in the absence of trade distortions; E_o : Nominal official exchange rate; E^* : Equilibrium exchange rate in the absence of intervention; VA_d : Value Added per unit of output at domestic prices; VA_w : Value Added per unit of output at world prices (measured in domestic currency); δ : Assistance on all outputs and inputs; D : Direct transfers to agricultural producers; I : Indirect transfers (budgetary-financed support) to agricultural producers; L : Agricultural producer levies; P_p : The "Policy", "Incentive" or "Shadow" price of the commodity that would keep the output the same as the current policies if all policies were removed; ε_i and ε_c : Own-price supply and demand (negative) elasticities, respectively; S_m : Market support ratios; S_p and S_c : Direct income support rates for producers and consumers, respectively; Q_c : Quantity consumed; SSO : Set-aside offset resulting from direct payments to producers; Q_t : Output produced in time period t ; $P_{p,t}$: The "Policy" Price of the commodity in period t ; $P_{w,ref}$: Fixed reference price based on the years 1986-88, generally the average f.o.b. unit value for the commodity in a net exporting country and the average c.i.f. unit value for the commodity in a net importing country in the base period, measured in domestic currency; P_c : The consumer price of the commodity; and D_c : Budgetary-financed assistance to consumers.

Sources: Bray, C., T. Josling and J. Cherlow (1992), "Adjustments for Set-aside Acres in Agricultural Trade Agreements: An Example from the Canada-U.S. Free Trade Agreement," *Canadian Journal of Agricultural Economics*, 40 (1): 25-35; Cahill, C and W. Legg (1990), "Estimation of Agricultural Assistance Using Producer and Consumer Subsidy Equivalents: Theory and Practice," *OECD Economic Studies*, 13 (Winter 1989/90): 13-43; Krueger, A. O., M. Schiff, A. Valdés (1991), *The Political Economy of Agricultural Pricing Policies*, Vol. 1-V, John Hopkins University Press: Baltimore, MD; Roningen, V. O. and P. M. Dixit (1991), Measuring Agricultural Trade Distortions: A Simple Approach, Agriculture and Trade Analysis Division, Economic Research Service, USDA, Staff Report AGIS 9145, December 1991, Washington, D.C.; Schwartz, N. E. and S. Parker (1988), "Measuring Government Intervention in Agriculture for the GATT Negotiations" *American Journal of Agricultural Economics*, 70 (5): 1137-1145; Josling, T. and S. Tangermann (1989), "Measuring Levels of Protection in Agriculture: A Survey of Approaches and Results," in Allen Maunder and Alberto Valdés (eds.), *Agriculture and Governments in an Interdependent World*, Aldershot: Gower Publishing Company.

Table 2. Policy effects captured by alternative protection measurement concepts

Policy measure ^a	Producer							Consumer		
	NPC	NRP	NRA	NPR _D	NPR _I	NPR _T	ERP	PSE	NRP	CSE
Market Price Support										
Border Measures	x	x	x	x		x	x	x	x	x
Domestic Price Support	x	x	x	x		x	x	x	x	x
Market Board & State	x	x	x	x		x	x	x	x	x
Other Output Price	x	x	x	x		x	x	x	x	x
Direct Payments										
Deficiency Payments			x				b	x		
Disaster Payments								x		
Crop Insurance								x		
Producer Levies		x	x	x		x	x	x		
Income Stabilization								x		
Input Assistance Policies										
Primary Input Policies							x	x		
Intermediate Input							x	x		
Marketing Assistance										
Advisory and Inspection								x		
Transportation								x		
Infrastructure Assistance										
Research and Extension								x		
Land Improvement								x		
Irrigation								x		
Economy-wide Policies										
State and National					x	x		c		
Taxation and Other					x	x		d		
Consumer Assistance Policies										
Consumer Price Policies									x	x
Consumer Food Donations										x
Other Consumer										x

a. Border Measures also include the effects of tariffs, quotas, variable levies, export subsidies. Other output policies may include price premium, two-tiered pricing systems and price stabilization schemes. Primary inputs may include purchased inputs such as fuel, fertilizer, chemicals and disease control measures. Examples of an intermediate input subsidies would include feed subsidies on meat production. The estimates of *CSEs* as calculated by OECD (1991) have explicitly assumed the equivalence of producer and consumer prices and have used the farmgate or producer prices in their calculations of *CSEs*. However, since it is observed that, at times, the producer and consumer prices may differ significantly, it is more appropriate to recognize the differences in the two and use the observed consumer prices in the estimation of *CSEs*. Other consumer subsidies include both direct and indirect transfers to consumers. It may be noted that USDA, ERS calculations of *CSEs* (1990) do not make any distinctions between these direct and indirect transfers.

b. The *ERP* calculations include the deficiency payments in case where such payments directly affect input prices or production of output.

c. State and national policies include programs administered by state, provincial or national governments which tax or subsidize agricultural producers, such as state programs in the U.S., provincial programs in Canada and national programs in the E.C. The USDA (1990) calculations of *PSEs* include the effects of these policies in case of the U.S. and Canada only.

d. Other economy-wide policies such as taxation and exchange rate policies have an important but indirect impact on agricultural returns.

Source: OECD (1991), *Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents: 1979-90*, OCDE/GD (91)128, Paris; Webb et al. (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, USDA, ERS Statistical Bulletin No. 803; Washington, D.C.; USDA, ERS (1988), *Agriculture in the Uruguay Round: Analysis of Government Support, Agriculture and Trade Analysis Division, Staff Report AGES880802*, December; Washington, D.C.; Schwartz, N. E. and S. Parker (1988), "Measuring Government Intervention in Agriculture for the GATT Negotiations," *American Journal of Agricultural Economics*, 70 (5): 1137-1145; Cahill, C. and W. Legg (1990), "Estimation of Agricultural Assistance Using Producer and Consumer Subsidy Equivalents: Theory and Practice," *OECD Economic Studies*, Winter 1989/90: 13-43.

Table 3. Policies covered under *PSE* calculations by OECD and USDA

<i>Policies</i>	<i>USDA</i>	<i>OECD</i>
Market Price Support	x	x
Direct Income Support	x	x
Research and Extension	x	x
Producer Levies	x	x
Primary Input Policies	x	x
Intermediary Input Policies	x	x
Infrastructure Support	x	x
Exchange Rate Controls ^a	x	
Marketing Assistance ^b	x	
Sub-National Policies ^c		x
Administrative Costs		
Social Security Benefits		
Subsidies to Agribusiness Sector		
General Income Tax Policies		
Voluntary Export Restraints ^d		

a The effects of exchange rate distortions are captured primarily in the estimates of *PSEs* in case of developing countries only where substantial differences exist between the official and unofficial exchange rates. Moreover, the relatively large size of the agrarian sector in these countries implies that exchange rate distortions would translate into greater impacts on the overall agricultural sector than would be the case in industrialized countries.

b The OECD calculations aggregate all other support that does not directly related to producer income but constitutes budgetary expenditures into a composite "general services" category.

c The sub-national policies in case of USDA calculations include such policies for only two countries, namely, the United States and Canada.

d Voluntary export restraints agreements can be interpreted as implicitly included in their effects on border measures

Sources: Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, USDA, ERS, Statistical Bulletin No. 803, April; Washington D.C.; OECD (1991), *Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents: 1979-90*, OCDE/GD (91)128, Paris; USDA, ERS (1987), *Government Intervention in Agriculture: Measurement, Evaluation, and Implications for Trade Negotiations*, Foreign Agricultural Economic Report No. 229, April; Washington, D.C.; Josling, T. and S. Tangermann, (1989), *Measuring Levels of Protection in Agriculture: A Survey of Approaches and Results*, in A. Maunder and A. Valdés (eds.), *Agriculture and Governments in an Interdependent World: Proceedings of the XVth International Conference of Agricultural Economists*, August, Dartmouth: Brookfield, VT.

Table 4. Standard deviations of product-specific and aggregate *PSEs* for India
(percent)

<i>Commodity</i>	<i>1982</i>	<i>1983</i>	<i>1984</i>	<i>1985</i>	<i>1986</i>	<i>1987</i>	<i>Std. Deviation^a</i>
Corn	-12	-7	-38	-56	-10	4	59.08
Cotton, Long	-2	-23	-19	-5	23	-36	53.7
Cotton, Medium	22	-15	2	2	23	-11	50.31
Peanuts	6	28	25	18	-3	-29	59.29
Rapeseed	28	32	23	1	24	57	80.65
Rice	-20	2	5	-8	10	4	12.29
Sorghum	-39	-31	-32	-40	-23	-10	50.3
Soybeans	-14	-12	-45	-36	-25	11	61.54
Wheat	-6	3	-7	-19	-1	7	12.25
All Commodities	-11	2	0	-12	5	2	0

a. The standard deviation of *PSEs* of various commodities represent deviations across the years in individual *PSEs* from the weighted average in that year.

Sources: *PSE* figures are taken from Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, USDA, ERS, Statistical Bulletin No. 803, April, 1990; Washington D.C

Table 5. Extent of distortions captured by *NRP* and *PSE*: Small importing countries

Year	World Reference Price ^a	Domestic Producer Price ^b	Domestic Production ^c	Direct Payments ^d	Indirect Payments ^e	<i>NRP</i> (Percent)	<i>PSE</i> (Percent)
	(P _w)	(P _d)	(Q)	(D)	(I)	$Q\{P_d - P_w\} - P_w \cdot Q$	$Q\{P_d - P_w\} - D - I - P_d \cdot Q - D$
<i>Norway (Wheat)</i>							
1980	963.7	1086	63	28	20	$\frac{63\{1086-963.7\}}{(63 \times 963.7)} = 13$	$\frac{0.063\{1086-963.7\} - 28 - 20}{(0.063 \times 1086) - 28} = 58$
1990	802.9	3189	224	46	24	$\frac{224\{3189-802.9\}}{(224 \times 802.9)} = 297$	$\frac{0.224\{3189-802.9\} - 46 - 24}{(0.224 \times 3189) - 46} = 79$
<i>Switzerland (Common Wheat)</i>							
1980	392.1	966	372	12	30	$\frac{372\{966-392.1\}}{(372 \times 392.1)} = 146$	$\frac{0.372\{966-392.1\} - 12 - 30}{(0.372 \times 966) - 12} = 69$
1990	277.9	1029	530	-33	51	$\frac{530\{1029-277.9\}}{(530 \times 277.9)} = 270$	$\frac{0.530\{1029-277.9\} - 33 - 51}{(0.530 \times 1029) - 33} = 81$
<i>Nigeria (Wheat)^f</i>							
1982	280	280	26	0	-0.91	$\frac{0.026\{280-280\}}{(0.026 \times 280)} = 0$	$\frac{0.026\{280-280\} - 0 - 0.91}{(0.026 \times 280) - 0} = 12.5$
1986	520	520	15	0	1.95	$\frac{0.015\{520-520\}}{(0.015 \times 520)} = 0$	$\frac{0.015\{520-520\} - 0 - 1.95}{(0.015 \times 520) - 0} = 25$
<i>India (Wheat)^g</i>							
1982	1565	1565	36,000	0	-17580	$\frac{36\{1565-1565\}}{(36 \times 1565)} = 0$	$\frac{36\{1565-1565\} - 0 - 17580}{(36 \times 1565) - 0} = 31.20$
1986	1744	1744	44,000	0	-24360	$\frac{44\{1744-1744\}}{(44 \times 1744)} = 0$	$\frac{44\{1744-1744\} - 0 - 24360}{(44 \times 1744) - 0} = 31.75$

a. World reference price is in domestic currency per ton, after adjustment for transportation costs.

b. Producer price is in domestic currency per ton.

c. Domestic production is in 1000 tons.

d. Direct Payments are in millions of domestic currency. The direct payments may include deficiency or disaster payments, area and hedge payments, diversions, levies fees, and double harvest promotions, among others.

e. Indirect Payments are also in millions of domestic currency. The indirect payments may include assistance through input subsidies, and general agricultural services like credit and rural electrification, in case of developing countries.

f. The formula used above has been modified by multiplying and dividing it by the domestic production, Q, to facilitate graphical comparisons with the graphical analysis of *PSE* estimates.

g. The world reference prices in case of Nigeria and India have been extrapolated from the USDA (1990) data set.

Source: Own calculations using the data from OECD (1991), *Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents, 1979-90*, OCDE/GD (91)128, Paris; and Webb, A. M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, U.S.D.A., ERS, Statistical Bulletin No. 803, April, Washington, D.C.

Table 6. Extent of distortions captured by *NRP* and *PSE*: Small exporting countries

Year	World Reference Price ^a (P _w)	Domestic Producer Price ^b (P _a)	Domestic Production ^c (Q)	Direct Payments ^d (D)	Indirect Payments ^e (I)	<i>NRP</i> (Percent) $Q\{P_d - P_w\} / P_w \cdot Q$	<i>PSE</i> (Percent) $Q\{P_d - P_w\} \cdot D + I \cdot P_d \cdot Q \cdot D$
<i>Austria (Wheat)</i>							
1980	2731.5	3362	1201	-127	286	$\frac{1201\{3362-2731.5\}}{(1201 \times 2731.5)} = 23$	$\frac{1.201\{3362-2731.5\} \cdot (-127) - 286}{(1.201 \times 3362) - 127} = 23$
1990	1519.8	3623	1404	-241	134	$\frac{1404\{3623-1519.8\}}{(1404 \times 1519.8)} = 138$	$\frac{1.404\{3623-1519.8\} \cdot (-241) - 134}{(1.404 \times 3623) - 241} = 59$
<i>Sweden (Wheat)</i>							
1980	810	963	1193	11	48	$\frac{1193\{963-810\}}{(1193 \times 810)} = 19$	$\frac{1193\{963-810\} + 11 \cdot 48}{(1193 \times 963) + 11} = 21$
1990	400	1361	2165	402	-38	$\frac{2165\{1361-400\}}{(2165 \times 400)} = 240$	$\frac{2165\{1361-400\} + 402 \cdot (-38)}{(2165 \times 1361) + 402} = 73$
<i>South Africa (Wheat)^h</i>							
1982	286	286	2420	0	80.6	$\frac{2420\{286-286\}}{(2420 \times 286)} = 0$	$\frac{2420\{286-286\} + 0 \cdot 80.6}{(2420 \times 286) + 0} = 12$
1986	360	360	2285	0	205.6	$\frac{2285\{360-360\}}{(2285 \times 360)} = 0$	$\frac{2285\{360-360\} + 0 \cdot 205.6}{(2285 \times 360) + 0} = 25$
<i>India (Rice)^h</i>							
1982	2619	2090	53248	0	22.267	$\frac{53248\{2090-2619\}}{(53248 \times 2619)} = -20$	$\frac{53248\{2090-2619\} + 22.267}{(53248 \times 2090)} = -5$

a. World reference price is in domestic currency per ton, after adjustment for transportation costs.

b. Producer price is in domestic currency per ton.

c. Domestic production is in 1000 tons.

d. Direct Payments are in millions of domestic currency. The direct payments may include deficiency or disaster payments, area and hedge payments, diversions, levies/fees, and double harvest promotions, among others.

e. Indirect Payments are also in millions of domestic currency. The indirect payments may include assistance through input subsidies, and general agricultural services like credit and rural electrification, in case of developing countries.

f. The formula used above has been modified by multiplying and dividing it by the domestic production, Q, to facilitate graphical comparisons with the graphical analysis of *PSE* estimates.

g. The *PSE* estimates are calculated using the data set and in some cases may not necessarily match those provided in OECD (1991).

h. The world reference prices in case of Nigeria and India have been extrapolated from the USDA (1990) data set.

Source: Own calculations using the data from OECD (1991), *Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents, 1979-90*, OCDE/GD (91)128, Paris; and Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, U.S.D.A., ERS, Statistical Bulletin No. 803, April, Washington, D.C.

Table 7. Extent of consumer market distortions captured by *NRPC* and *CSE*: Case of small importing countries

Year	World Reference Price ^a (P _w)	Domestic Consumer Price ^b (P _c)	Domestic Consumption ^c (Q _c)	Direct Payments ^d (D _c)	Indirect Payments ^e (I _c)	<i>NRPC</i> ^f (Percent)	<i>CSE</i> (Percent)
						$-[Q_c \{P_c - P_w\} / P_w \cdot Q_c]$	$-[Q_c \{P_c - P_w\} \cdot D_c + I_c / P_c \cdot Q_c]$
<i>Poland (Wheat)</i>							
1987	16499	6573	8538	0	84746	$\frac{-[8538 \{6573 - 16499\}]}{(8538 \times 16499)} = 60$	$\frac{-[8538 \{6573 - 16499\} + 84746]}{(8538 \times 6573)} = 151$
<i>India (Wheat)</i>							
1984	2152	1932	43719	0	33009	$\frac{-[43719 \{1932 - 2152\}]}{(43719 \times 2152)} = 10$	$\frac{-[43719 \{1932 - 2152\} - 33009]}{(43719 \times 1932)} = 11$

Note: USDA, ERS calculations do not distinguish between direct and indirect payments to consumers.

a. World reference price is in domestic currency per ton, after adjustment for transportation costs.

b. Consumer price is in domestic currency per ton.

c. Domestic consumption is in 1000 tons.

d. Direct Payments are in millions of domestic currency. The direct payments may include food stamps, among others.

e. Indirect Payments are also in millions of domestic currency.

f. The formula for *NRPC* has been modified by multiplying and dividing by the domestic consumption level to facilitate comparisons with the *CSE* estimates.

Source: Own calculations using the data from Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, U.S.D.A., ERS, Statistical Bulletin No. 803, April, Washington, D.C.

Table 8. Extent of distortions captured by *NRP* and *PSE*: Large exporting country

Year	World Reference Price ^a	Domestic Producer Price ^b	Domestic Production ^c	Direct Payments ^d	Indirect Payments ^e	<i>NRP</i> (Percent)	<i>PSE</i> (Percent)
	(P _w)	(P _d)	(Q)	(D)	(I)	$Q\{P_d - P_w\} \cdot P_w \cdot Q$	$Q\{P_d - P_w\} \cdot D + I \cdot P_d \cdot Q + D$
<i>U.S.A. (Wheat)</i> ^h							
1980	144	144	64.6	596	767	$\frac{64.6\{144-144\}}{(64.6 \times 144)} = 0$	$\frac{64.6\{144-144\} \cdot 596 + 767}{(64.6 \times 144) \cdot 596} = 14$
1990	80.6	96	74.7	2403	620	$\frac{74.7\{96-80.6\}}{(74.7 \times 80.6)} = 19$	$\frac{74.7\{96-80.6\} \cdot 2403 + 620}{(74.7 \times 96) \cdot 2403} = 44$
<i>E.C. (Common Wheat)</i>							
1980	125.7	164	50.2	0	638	$\frac{50.2\{164-125.7\}}{(50.2 \times 125.7)} = 30$	$\frac{50.2\{164-125.7\} \cdot 0 + 638}{(50.2 \times 164) \cdot 0} = 31$
1990	107.1	171	72.8	-244	793	$\frac{72.8\{171-107.1\}}{(72.8 \times 107.1)} = 60$	$\frac{72.8\{171-107.1\} \cdot 244 + 793}{(72.8 \times 171) \cdot 244} = 43$
<i>Canada (Milk)</i>							
1980	161.7	282	7.95	149	207	$\frac{7.95\{282-161.7\}}{(7.95 \times 161.7)} = 74$	$\frac{7.95\{282-161.7\} \cdot 149 + 207}{(7.95 \times 282) \cdot 149} = 55$
1990	158.8	418	8.02	121	566	$\frac{8.02\{418-158.8\}}{(8.02 \times 158.8)} = 116$	$\frac{8.02\{418-158.8\} \cdot 121 + 566}{(8.02 \times 418) \cdot 121} = 80$
<i>Argentina (Wheat)</i> ⁱ							
1982	0.3	0.24	8.3	0	0.18	$\frac{8.3\{0.24-0.30\}}{(8.30 \times 0.30)} = -20$	$\frac{8.30\{0.24-0.30\} \cdot 0 + 0.18}{(8.30 \times 0.24) \cdot 0} = 16$
1985	54.18	37.4	13.2	0	77.17	$\frac{13.2\{37.4-54.18\}}{(13.2 \times 54.18)} = -31$	$\frac{13.2\{37.4-54.18\} \cdot 0 + 77.17}{(13.2 \times 37.4) \cdot 0} = 29$

a World reference price is in domestic currency per ton, after adjustment for transportation costs.

b Producer price is in domestic currency per ton.

c Domestic production is in million tons.

d Direct Payments are in millions of domestic currency. The direct payments may include deficiency or disaster payments, area and hedge payments, diversions, levies/fees, and double harvest promotions, among others.

e Indirect Payments are also in millions of domestic currency. The indirect payments may include assistance through input subsidies, marketing subsidies and general agricultural services like research advisory etc.

f The formula for *NRP* has been modified by multiplying and dividing it by the domestic production, Q, to facilitate graphical comparisons with the graphical analysis of *PSE* estimates.

g The *PSE* estimates are calculated using both the data set and in some cases may not necessarily match those provided in OECD (1991).

h The world reference price for 1980 was extrapolated from the OECD (1991) data set.

i The world reference price for Argentina was extrapolated from the USDA (1990) data set, considering trade policy transfers as the wedge between the domestic and world reference prices.

Source: Own calculations using the data from OECD (1991), *Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents, 1979-90*, OCDE/GD (91)128, Paris; and Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, U.S.D.A., ERS, Statistical Bulletin No. 803, April, Washington, D.C.

Table 9. Extent of distortions captured by *NRP* and *PSE*: Large importing country

Year	World Reference Price ^a	Domestic Producer Price ^b	Domestic Production ^c	Direct Payments ^d	Indirect Payments ^e	<i>NRP</i> (Percent)	<i>PSE</i> ^f (Percent)
	(P _w)	(P _d)	(Q)	(D)	(I)	$Q\{P_d - P_w\} + P_w \cdot Q$	$Q\{P_d - P_w\} \cdot D + I \cdot P_d \cdot Q \cdot D$
<i>Japan. (Wheat)</i>							
1980	47	178	583	24	22	$\frac{583(178-47)}{(583 \times 47)} = 279$	$\frac{583(178-47) \cdot 24000 + 22000}{(583 \times 178) \cdot 24000} = 96$
1990	24.8	154	946	12	22	$\frac{946(154-24.8)}{(946 \times 24.8)} = 521$	$\frac{946(154-24.8) \cdot 12000 + 22000}{(946 \times 154) \cdot 12000} = 99$
<i>Japan. (Rice)</i>							
1980	128.8	295	9751	322	314	$\frac{9751\{295-128.8\}}{(9751 \times 128.8)} = 129$	$\frac{9751\{295-128.8\} \cdot 322 + 314}{(9751 \times 295) \cdot 322} = 71$
1990	61.4	275	10350	234	238	$\frac{10350\{275-61.4\}}{(10350 \times 61.4)} = 348$	$\frac{10350\{275-61.4\} \cdot 234 + 238}{(10350 \times 275) \cdot 234} = 87$
<i>Japan. (Beet)</i>							
1980	304.6	1565	418	0	72	$\frac{418\{1565-304.6\}}{(418 \times 304.6)} = 414$	$\frac{418\{1565-304.6\} + 0 + 72}{(418 \times 1565) \cdot 0} = 92$
1990	236	1526	551	0	37	$\frac{551\{1526-236\}}{(551 \times 236)} = 547$	$\frac{551\{1526-236\} + 0 + 37}{(551 \times 1526) \cdot 0} = 85$

a World reference price is in domestic currency per ton, after adjustment for transportation costs

b Producer price is in domestic currency per ton.

c Domestic production is in million tons.

d Direct Payments are in millions of domestic currency. The direct payments may include deficiency or disaster payments, area and hedge payments, diversions, levies fees, and double harvest promotions, among others.

e Indirect Payments are also in millions of domestic currency. The indirect payments may include assistance through input subsidies, marketing subsidies and general agricultural services like research advisory etc.

f The formula for *NRP* has been modified by multiplying and dividing it by the domestic production, Q, to facilitate graphical comparisons with the graphical analysis of *PSE* estimates.

g The *PSE* estimates are calculated using both the data set and in some cases may not necessarily match those provided in OECD (1991).

Source: Own calculations using the data from OECD (1991), *Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents, 1979-90*, OCDE/GD (91)128, Paris; and Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, U.S.D.A., ERS, Statistical Bulletin No. 803, April, Washington, D.C.

Table 10. Extent of consumer market distortions captured by *NRPC*^a and *CSB*^b

Year	World Reference Price ^c	Domestic Consumer Price ^d	Domestic Consumption ^e	Direct Payments ^f	Indirect Payments ^f	<i>NRPC</i> ^a (Percent)	<i>CSB</i> (Percent)
	(P _w)	(P _c)	(Q _c)	(D _c)	(I _c)	$-\frac{[Q_c\{P_c - P_w\}P_w + Q_c]}{(Q_c \times P_w)}$	$-\frac{[Q_c\{P_c - P_w\} + D_c + I_c]P_c}{Q_c}$
<i>U.S.A. (Wheat)</i>							
1987	70	109	29507	0	0	$-\frac{[29507\{109-70\}]}{(29507 \times 70)} = -56$	$-\frac{[29507\{109-70\}]}{(29507 \times 109)} = -36$
<i>E.C. (Sugar)</i>							
1987	148	896	9540	0	0	$-\frac{[9540\{896-148\}]}{(9540 \times 148)} = -50.5$	$-\frac{[9540\{896-148\}]}{(9540 \times 896)} = -83$
<i>Japan (Beef and Veal)</i>							
1987	381500	2209420	880	0	-838190	$-\frac{[880\{2209420-381500\}]}{(880 \times 381500)}$ • -479	$-\frac{[880\{2209420-381500\}-838190]}{(880 \times 2209420)}$ • -83

Note: USDA, ERS calculations do not distinguish between direct and indirect payments to consumers.

a. World reference price is in domestic currency per ton, after adjustment for transportation costs.

b. Consumer price is in domestic currency per ton.

c. Domestic consumption is in 1000 tons.

d. Direct Payments are in millions of domestic currency. The direct payments may include food stamps, among others.

e. Indirect Payments are also in millions of domestic currency.

f. The formula for *NRPC* has been modified by dividing and multiplying it by the domestic consumption in order to facilitate graphical comparisons with the *CSB* estimates.

Source: Own calculations using the data from Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, U.S.D.A., ERS, Statistical Bulletin No. 803, April, Washington, D.C.

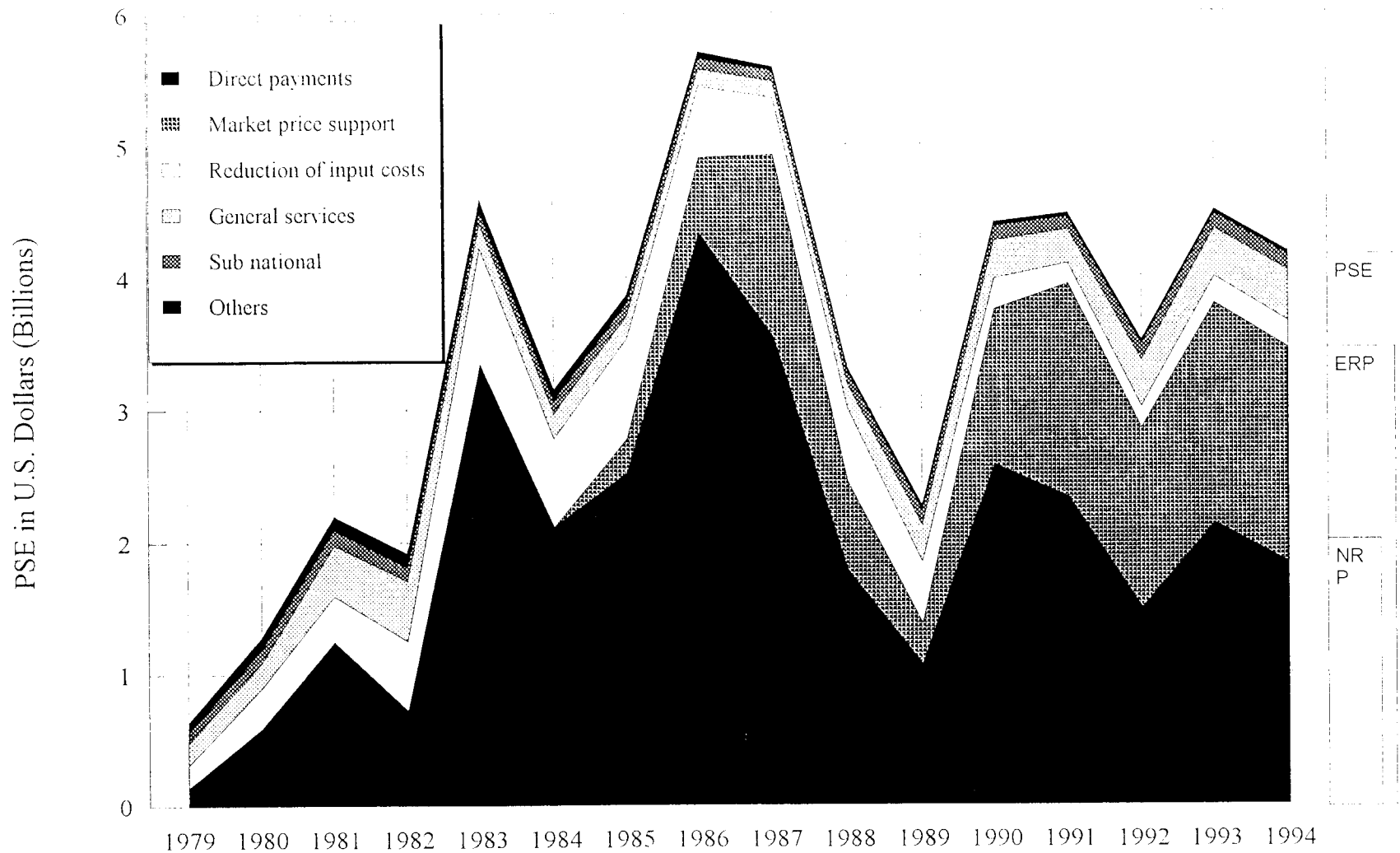


Figure 1. Policy-wise producer protection expenditures captured by alternative measures of support for United States: Wheat, 1979-94

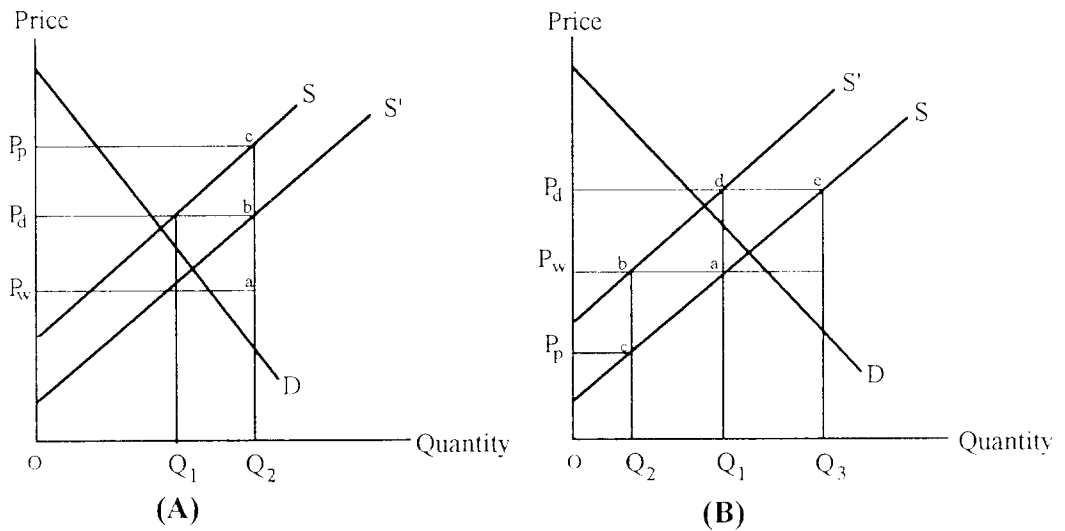
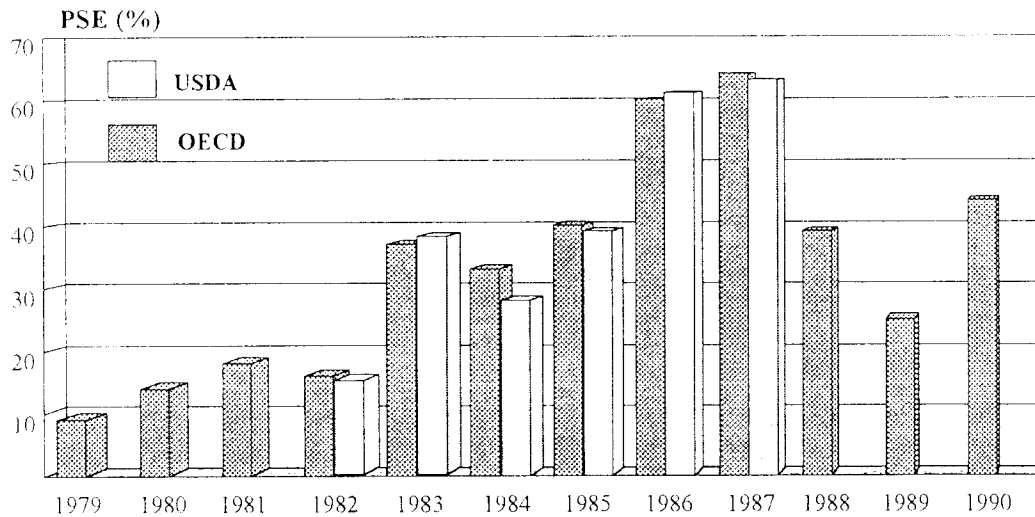


Figure 2. Comparative analysis of policy effects captured by PSE and PSE_{TID}



Source: The PSE wheat figures are from OECD (1991), *The Tables of Producer Subsidy Equivalents and Consumer Subsidy Equivalents: 1979-90*. OCDE GD (91)128. Paris; and Webb, A., M. Lopez and R. Penn (1990), *Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-87*, USDA, ERS, Statistical Bulletin No. 803, April; Washington D.C.

Figure 3. Comparison of wheat PSEs of United States as estimated by OECD and USDA

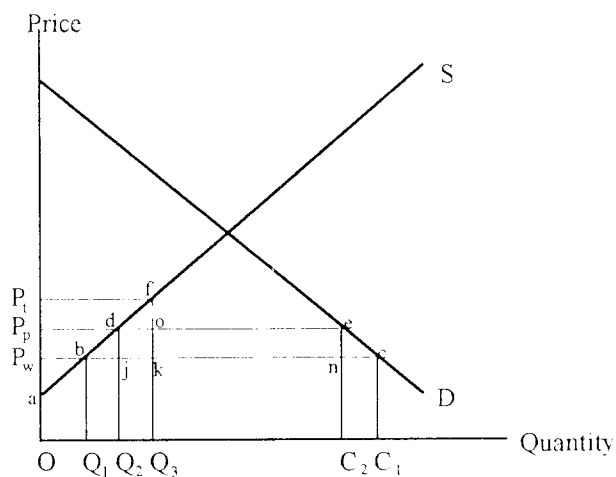


Figure 4: Measuring distortions in a small country case

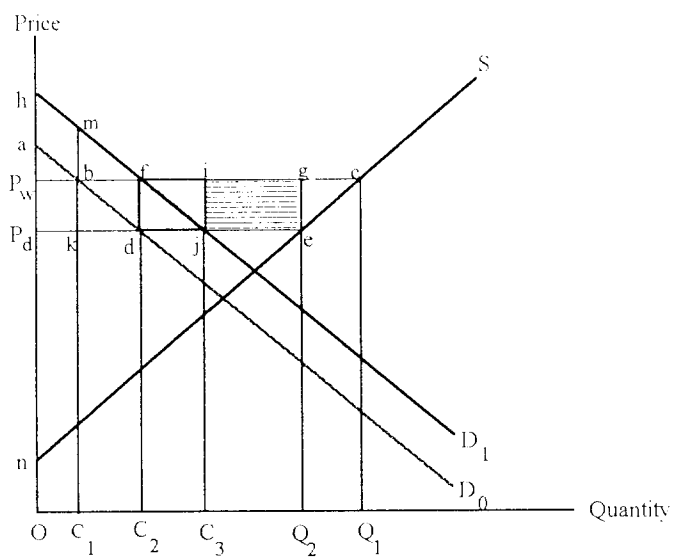


Figure 5. Measuring distortions in a small developing country case

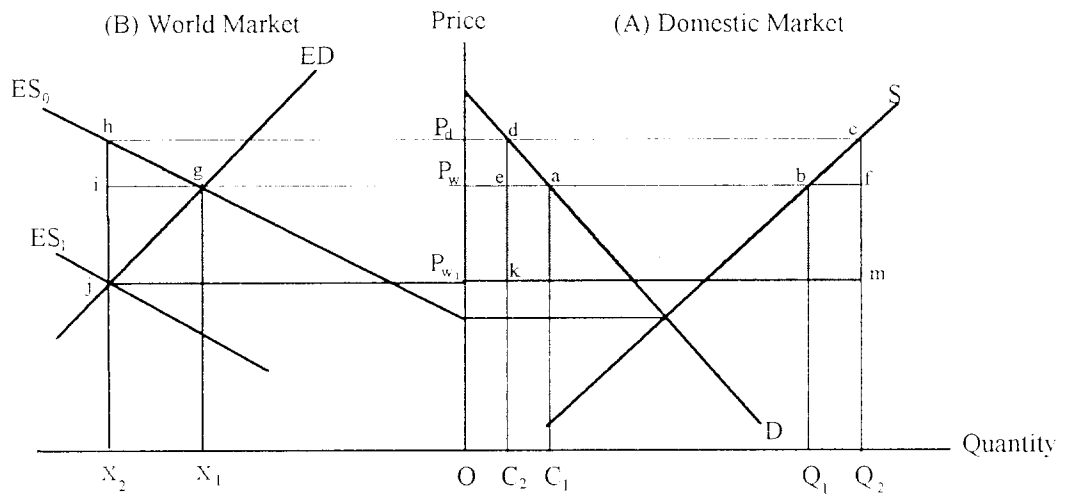


Figure 6. Measuring distortions in a large exporting country case

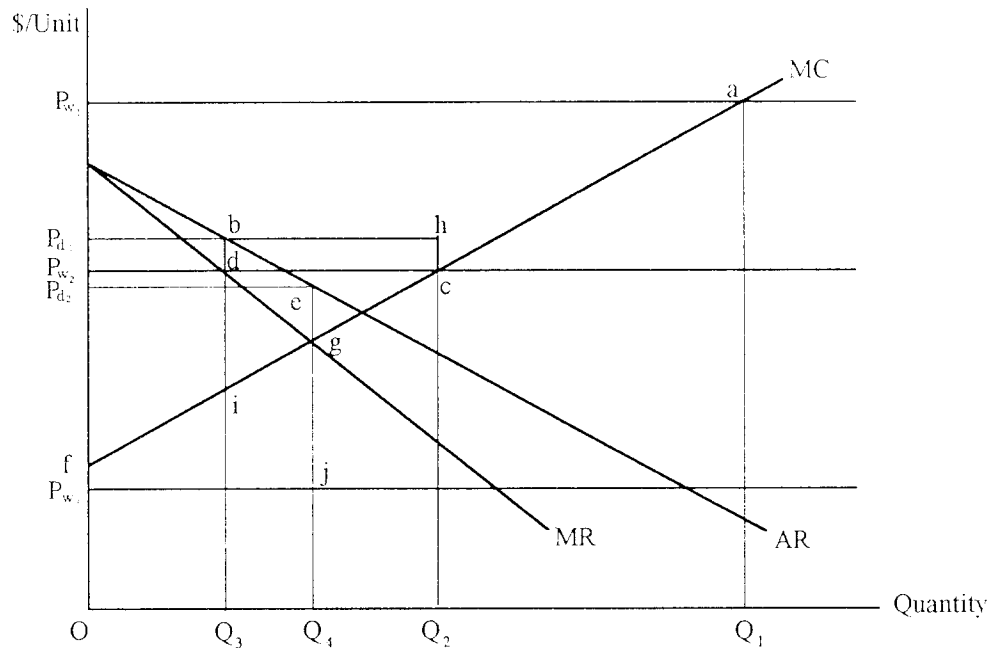


Figure 7. Comparison of measures of protection under price discrimination

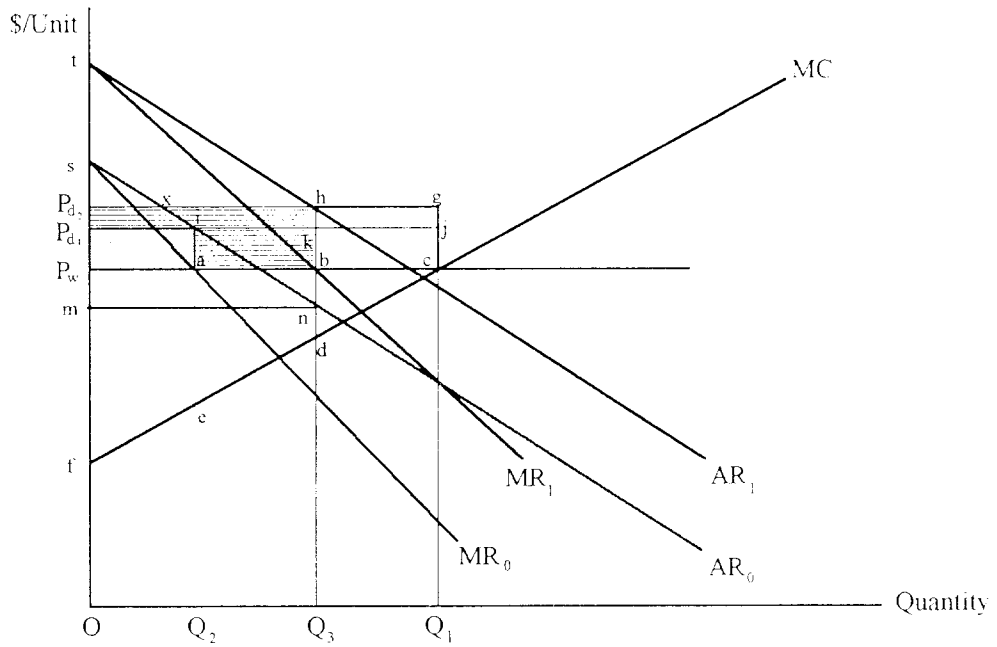


Figure 8: Comparison of measures of protection under price discrimination with consumer subsidies

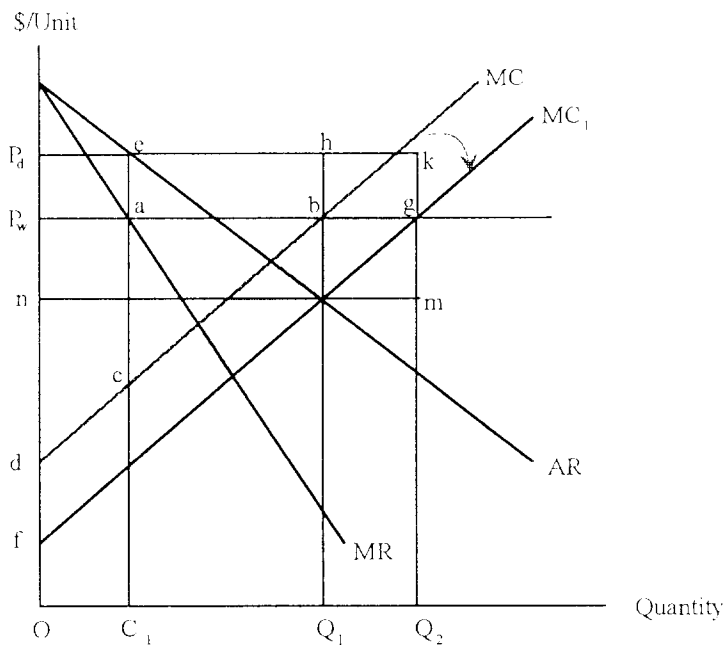


Figure 9. Measures of market distortion under price discrimination

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