

Herrmann, Roland; Schenck, Patricia; Wiebelt, Manfred

**Working Paper — Digitized Version**

## On the measurement of agricultural protection: how price uncertainty and limited substitution matter

Kiel Working Paper, No. 414

**Provided in Cooperation with:**

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

*Suggested Citation:* Herrmann, Roland; Schenck, Patricia; Wiebelt, Manfred (1990) : On the measurement of agricultural protection: how price uncertainty and limited substitution matter, Kiel Working Paper, No. 414, Kiel Institute of World Economics (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/527>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# Kieler Arbeitspapiere Kiel Working Papers

Working Paper No. 414

On the Measurement of Agricultural  
Protection: How Price Uncertainty and  
Limited Substitution Matter

by

Roland Herrmann\*  
Patricia Schenck\*  
Manfred Wiebelt\*\*

.273 /

Institut für Weltwirtschaft an der Universität Kiel  
The Kiel Institute of World Economics

ISSN 0342-0787

Kiel Institute of World Economics  
Department IV  
Duesternbrooker Weg 120, D-2300 Kiel 1

Working Paper No. 414

On the Measurement of Agricultural  
Protection: How Price Uncertainty and  
Limited Substitution Matter

by

Roland Herrmann\*  
Patricia Schenck\*  
Manfred Wiebelt\*\*

March 1990

AG 1373 / 90  
Weltwirtschaft  
Kiel

- A first version of this paper was submitted for presentation at the Sixth EAAE Congress on "European Agriculture in Search for New Strategies", The Hague, Netherlands, September 3-7, 1990. This study is part of the research project "Discrimination Against Agriculture in Developing Countries? Magnitude, Structure and the Role of Economic Policy" financed under grant number II/64 700 by Volkswagen-Stiftung. Helpful comments by Torsten Amelung, Gernot Klepper, Matthias Lücke, Jörg-Volker Schrader, and Volker Stüven are gratefully acknowledged. -

\* Institute of Agricultural Policy and Market Research, University of Gießen, Senckenbergstr. 3, D-6300 Gießen 1, FR Germany.

\*\* Kiel Institute of World Economics, Duesternbrooker Weg 120, D-2300 Kiel, FR Germany.

The authors themselves, not the Kiel Institute of World Economics, are responsible for the contents and distribution of Kiel Working Papers. Since the series involves manuscripts in a preliminary form, interested readers are requested to direct criticisms and suggestions directly to the authors and to clear any quotations with them.

## 1. Introduction

There is a growing interest in the measurement of the levels and the costs of agricultural protection. Levels of agricultural protection are measured and compared across countries in various recent studies by national ministries and international organizations [World Bank (1986), FAO (1987a), OECD (1987, 1988), USDA (1987, 1988)]. These comparisons may be used, e.g., in international negotiations on agricultural trade liberalization [Tangermann/Josling/Pearson (1987)]. In another branch of the literature, domestic and international prices are compared in order to evaluate national agricultural policies from a welfare-economic point of view or to study the implications of agricultural protection for world market prices and trade [Tyers/Anderson (1986), Valdés/Zietz (1980), Matthews (1985), Parikh/Fischer/Frohberg/Gulbrandsen (1988)].

It is well-known from this literature that the measurement of agricultural protection has important implications for policy evaluation. Despite this and the fact that nominal and effective rates of protection are widely used in the trade literature, protection levels in agriculture were often measured in a rather crude way. Consequently, policy conclusions were in many cases derived from studies using crude protection levels. Westlake (1987) argues that several studies on agricultural protection ignored transport and marketing costs. His empirical analyses suggest that these costs matter for the magnitude of the measured level of protection, especially in developing countries. Byerlee/Sain (1986) show that the measured subsidization of or discrimination against agriculture is strongly affected when overvalued exchange rates are taken into account. Furthermore, they argue that heavily fluctuating world prices distort the measured degree of protection and vote for the use of normal instead of actual world prices in the calculation of protection rates.

Our paper elaborates further how measurement issues are important when agricultural protection is analyzed. It reveals that policy conclusions vary due to the way agricultural protection is measured. We focus on two aspects which have been widely ignored in the literature: price uncertainty and limited substitution. In the first part, we start from the important findings of Byerlee/Sain (1986). These authors tried to cope with world price uncertainty and derived for the wheat sector the challenging and unexpected result that developing countries do not systematically discriminate against agriculture. We will show that this major finding is heavily dependent on the way price uncertainty is measured. When normal world prices are modelled on the basis of an econometric world wheat model rather than with trend analysis, the qualitative result changes. In the second part, we investigate how the modelling of substitution between agricultural products affects the calculated impacts of given levels of agricultural protection. The assumption of the law of one price, which is mostly used in agricultural economics, is dropped and imperfect substitutability of foreign and domestically produced products of the same category is allowed for within an Armington (1969) framework. Such a more realistic modelling of agricultural markets influences the effects of government interventions on trade and welfare significantly as an application to rice in Malaysia illustrates.

## 2. How Price Uncertainty Matters for the Measurement of Protection Levels in Agriculture

### 2.1 The Results of the Byerlee/Sain Study

For many years, agricultural economists have argued that developing countries often discriminate against agriculture in their economic and agricultural policies [Brown (1978); Lutz/Scandizzo (1980); Schultz (1978)]. The urban population is believed to be favoured at the direct expense of the rural population. The study of Byerlee/Sain (1986) tests this hypothesis within a cross-country analysis. Nominal protection coefficients are computed for the wheat sector in 1980-82 and consumer and producer prices

are distinguished. In three respects, the Byerlee/Sain approach goes beyond earlier quantitative studies:

1. Nominal protection coefficients are calculated at one point of the marketing chain. Transport costs are taken into account.
2. Nominal protection coefficients are not only computed with official exchange rates, but also with corrected exchange rates which are supposed to incorporate exchange-rate overvaluation in many developing countries.
3. Nominal protection coefficients are based on "normal" world prices. This is done in order to avoid a comparison of domestic prices with fluctuating world prices.

Major results of the Byerlee/Sain study confirm the conventional wisdom on consumer subsidies but challenge the traditional view on producers' incentives:

1. A widespread policy of subsidizing consumers is indicated by the results of Byerlee/Sain.
2. The authors find out that producer prices for wheat in developing countries approached long-run trend prices in the world wheat market during 1980-82 and showed no consistent evidence of price disincentives to wheat producers.

It is now analyzed whether this second finding depends on the particular methodology Byerlee/Sain used.

## 2.2 The Importance of Price Uncertainty for the Measurement of Producers' Incentives in Wheat

Byerlee/Sain calculate their nominal protection coefficient, which we call  $NPC_1$ , as follows:

$$(1) NPC_1 = p_D/p_w^*$$

$p_D$  is the domestic producer price of wheat in 1980-82 and  $p_w^*$  is a normal world wheat price in the same period, measured by a linear time-trend regression of world prices over the period 1960-82. Both prices are evaluated at the consumption points. This methodology differs from the usual procedure by introducing a normal world price rather than the actual world price ( $p_w$ ). One might argue with Byerlee/Sain that normal world prices are an indicator of expected world prices whereas actual world prices include a stochastic component  $u$ :

$$(2) p_w = p_w^* + u.$$

Hence, the approach of Byerlee/Sain can be interpreted as one which deals with price uncertainty whereas the traditional approach does not. The traditional nominal protection coefficient, which we call  $NPC_2$ , is defined as

$$(3) NPC_2 = p_D/p_w.$$

Appendix 2 shows in columns (1) and (2) the nominal protection coefficients  $NPC_1$  and  $NPC_2$  for the 31 selected developing countries.<sup>1</sup> Table 1 presents in columns (1) and (2) the respective frequency distributions of  $NPC_1$  and  $NPC_2$ .

From this, it can be derived how the countries' nominal protection coefficients were affected due to the Byerlee/Sain method. Column (1) in Table 1 describes nominal protection as measured by Byerlee/Sain and column (2) nominal protection as measured traditionally.

Whereas the actual world wheat price was 202.17 \$/mt in 1980-82, the normal world price according to the Byerlee/Sain method was 182.11 \$/mt. This implies that the denominator of the nominal protection coefficient was reduced by 9.9% due to the Byerlee/Sain approach. As Table 1 shows, the qualitative results change when  $NPC_1$  and  $NPC_2$  are compared:

Table 1: The Influence of Price Uncertainty on the Frequency Distribution of Nominal Protection Coefficients for Wheat Producers in 31 Countries, 1980-82<sup>a</sup>

Indicator	Alternative Nominal Protection Coefficients		
	NPC <sub>1</sub>	NPC <sub>2</sub>	NPC <sub>3</sub>
	(1)	(2)	(3)
Distribution of countries according to the NPC in %:			
- Producers taxed (NPC < 0.85):	35	39	39
- No significant taxation or subsidization (0.85 < NPC < 1.15):	26	32	29
- Producers subsidized (NPC > 1.15):	39	29	32
- All Countries:	100	100	100
Average NPC:	1.13	1.02	1.07
Median NPC:	1.02	0.92	0.96

<sup>a</sup> For the definition of NPC<sub>1</sub> to NPC<sub>3</sub>, see Appendix 2 and the text.

Source: Own computations from Appendix 2 and the sources cited there.



1. On the basis of the Byerlee/Sain method, it has to be concluded that more developing countries subsidized wheat production than taxed it. A significant taxation in their study means that NPC is below 0.85 and a significant subsidization is indicated by a NPC above 1.15.<sup>2</sup> When the traditional methodology is applied, the reverse is true. The frequency distribution of NPC<sub>2</sub> shows that 39% of the developing countries taxed their wheat production whereas 29% subsidized it. On the basis of NPC<sub>2</sub>, however, we receive the conventional result saying that most developing countries tax their agricultural sectors.
2. The introduction of the normal rather than the actual wheat price has raised the average NPC from 1.02 to 1.13. As the NPCs are not normally distributed, the frequency distribution can be more adequately described by the median NPC. Again, the median NPC<sub>2</sub> shows with a value of 0.92 that the typical developing country taxed its wheat production. The median NPC<sub>1</sub>, however, had presented a slight subsidization of wheat production.

The results show that the introduction of price uncertainty into the calculation of world wheat prices raised nominal protection by a significant degree. Obviously, the policy-relevant conclusions on the subsidization or taxation of agriculture depend strongly on the methodology used.

### 2.3 How the Measurement of Producers' Incentives Depends on the Approach to Modelling Price Uncertainty

Suppose now that we agree with Byerlee/Sain that normal rather than actual world prices should be utilized in the calculation of nominal protection coefficients. Does then the economic result, that more countries subsidize wheat production than tax it, depend on the econometric model used to calculate the normal world price? Or, in terms of price uncertainty: Does the method which is used to eliminate the stochastic component affect the economic results? In order to answer this question, a reduced-

form econometric model of the world wheat market was estimated. The estimated world wheat price from this econometric model ( $p_w^{**}$ ) was introduced as normal price into the calculation of the nominal protection coefficients. The resulting nominal protection coefficient, which we call  $NPC_3$ , differs from the Byerlee/Sain approach by the way the normal world price is calculated:

$$(4) NPC_3 = p_D / p_w^{**}.$$

The econometric model is based on a stylized representation of import demand and export supply in the world wheat market. The export supply function is

$$(5) X_t = a + b p_{wt} + c PR_{Xt} + d PR_{Xt-1} + e POP_{Xt}$$

and the import demand function

$$(6) M_t = f + g p_{wt} + h p_{Rt} + i Y_{Mt} + j PR_{Mt} + k PR_{Mt-1} + l POP_{Mt}.$$

X is exports and M is imports of wheat.  $p_w$  stands for the world wheat price,  $p_R$  for the world rice price, PR for production of wheat<sup>3</sup> and POP for population. Y is an income variable. The subscript X indicates exporting and the subscript M importing countries. t and t-1 are the two periods considered. In an equilibrium situation, exports are equal to imports:

$$(7) X_t = M_t.$$

Introducing (5) and (6) into (7) yields the reduced form of the world wheat model:

$$(8) p_{wt} = f/(b-g) + h/(b-g) \cdot p_{Rt} + i/(b-g) \cdot Y_{Mt} + j/(b-g) \cdot PR_{Mt} \\ + k/(b-g) \cdot PR_{Mt-1} + l/(b-g) \cdot POP_{Mt} - a/(b-g) - \\ c/(b-g) \cdot PR_{Xt} - d/(b-g) \cdot PR_{Xt-1} - e/(b-g) \cdot POP_{Xt}.$$

Equation (8) was the starting point of the econometric model. In order to save degrees of freedom, however, the production and population variables of the exporting and importing countries were aggregated. This seemed acceptable since it was not the goal of this analysis to identify the underlying supply and demand functions (5) and (6). The following regression model performed best in the specification search:

$$\begin{aligned} (9) \ln p_{wt} = & 12.0621 + 0.7290 \ln p_{Rt} + 0.3045 \ln Y_{Mt-1} \\ & (2.90) \quad (5.61) \quad (1.26) \\ & - 1.3758 \ln PR_t - 1.3945 \ln PR_{t-1} \\ & (-2.41) \quad (-2.59) \\ & + 4.6636 \cdot 10^{-7} POP_t \\ & (2.50) \\ (\bar{R}^2 = & 0.94; F = 58.49; DW = 1.66) \end{aligned}$$

The values in parentheses are t-values.  $\bar{R}^2$  is the corrected coefficient of determination, F the F-value and DW the Durbin/Watson coefficient. The variables were measured as described in Appendix 1, and the data basis for 1960-82 is also presented there. The estimation period is the same as in the Byerlee/Sain study. Given the common test statistics, the overall performance of the econometric model is satisfactory. The coefficients of the independent variables had the expected signs and they were statistically different from zero in all cases except for the income variable. The world wheat price rises with an increasing world rice price, with a reduced world wheat production in the same year and in the previous year and with a rising world population. The sign of the income variable indicates also that the world wheat price is raised by a growing PPP-corrected gross domestic product in major wheat-importing countries. The coefficient of the production variable can be interpreted as price flexibility. An increase of world wheat production by 1% reduces the world wheat price by 1.38%.

Various measures of simulation errors show that the econometric model outperforms in each case the linear time-trend model as applied by Byerlee/Sain. This is illustrated in Table 2. The absolute simulation error, measured by the root-mean square simulation error (RMSE) or the mean absolute simulation error (MAE), is much lower for the econometric world wheat model than for the linear time-trend model. The same holds true for the relative simulation error as indicated by the mean absolute percentage error (MAPE): The MAPE value is higher than 20% for the trend model but only 8.1% for the econometric model. Theil's inequality coefficient GMTU compares the simulation errors of the competing models with a naive simulation on the basis of previous year's values. It shows that the time-trend model performs worse than a naive simulation whereas the econometric wheat model clearly outperforms the naive simulation.

The antilog of the  $\ln p_w$  values characterizes the normal world wheat price on the basis of the reduced-form world wheat model. Computing the antilog for 1980-82 yields the denominator of  $NPC_3$  as defined by equation (4).<sup>4</sup>

The results are given in Appendix 2 and Table 1. Column (3) of Appendix 2 shows  $NPC_3$  for the selected developing countries and column (3) of Table 1 indicates the frequency distribution of these nominal protection coefficients. In order to elaborate the influence of the methodology, which is used to eliminate world price uncertainty, we compare  $NPC_1$  with  $NPC_3$ :

1. Due to the better explanation of movements in world wheat prices, the normal price according to the structural model is closer to the actual world price than the linear-trend price.  $p_w^{**}$  is 193.79 \$/mt as opposed to  $p_w^*$  with 182.11 \$/mt. This means that  $NPC_3$  is by 6.0% lower than  $NPC_1$  for all countries. Table 1 shows that this makes a significant difference for the frequency distribution of the NPCs. Whereas more developing countries subsidized than taxed wheat production according to

Table 2 : Accuracy of Simulations of the Econometric World Wheat Price Model Compared with a Linear Time-Trend Model, 1960-82<sup>a</sup>

Simulation Error Measurement	Simulation Model	Linear Time-Trend Model	Econometric World Wheat Price Model
RMSE (\$/mt):		27.59	12.05
MAE (\$/mt):		23.90	9.12
MAPE (%):		21.21	8.09
Theil's inequality coefficient (GMTU):		1.20	0.53

<sup>a</sup> RMSE, the root-mean square simulation error, is defined as  $\sqrt{(1/n) \cdot \sum e_t^2}$ . The mean absolute simulation error, MAE, is  $(1/n) \cdot \sum |e_t|$ . The mean absolute percentage error, MAPE is defined as  $(100/n) \cdot \sum |e_t|/p_t$ . Theil's inequality coefficient is measured as  $\sqrt{\sum e_t^2 / \sum (p_t - p_{t-1})^2}$ . In each case, the simulation error is  $e_t = p_t - \hat{p}_t$ , where  $\hat{p}_t$  is the estimated and  $p_t$  the actual world wheat price in period  $t$ . The econometric model is shown in equation (9) in the text. In each definition, it is summed over all periods  $t$  with  $t = 1, \dots, n$ .

Source: Own computations with data from Appendix 1 and the sources cited there.

Byerlee/Sain, this is not true any more when world price uncertainty is eliminated with a different method. According to NPC<sub>3</sub>, 39% of the countries did significantly tax wheat production whereas only 32% subsidized it.

2. The median NPCs show a differential qualitative result, too. When normal prices are measured with the econometric model (9), the traditional qualitative result is confirmed. The typical developing country tends to discriminate against the wheat sector. The median NPC<sub>3</sub> is 0.96 compared with 1.02 for the Byerlee/Sain method.

These results show that it is not only the introduction of price uncertainty which matters for the measured protection levels. It is also the way how normal world prices are modelled, or, how price uncertainty is eliminated which affects the measured degree of agricultural protection.

### 3. How Limited Substitution Matters for the Measurement of Welfare Effects in Agriculture

In the following, it will be shown that methodology does not only matter for the measured degree of protection. Starting from an apparent degree of protection, as implied by the wedge between domestic prices and the border price, it can be derived that standard assumptions in agricultural market analyses are also crucial for the calculated impacts of government pricing policies. The homogeneity assumption is a case in point.

#### 3.1 Concepts for the Measurement of Welfare Effects

The analysis of agricultural incentives including calculations of producer and consumer surplus is often done market by market under the assumption of the "law of one price" [e.g. Scandizzo/Bruce (1980); Bale/Lutz (1981); Bale (1985)]. However, such an analysis will give the correct welfare effects only, if:

1. the commodity in question is not a substitute or complement for any other commodity, and if
2. there is perfect substitution between foreign and domestically produced varieties of that commodity.

The chances that such a good exists in agriculture are small and the errors of standard welfare analyses can be substantial. While intermarket connections are now widely recognized,<sup>5</sup> individual agricultural markets as those for wheat and rice are still mostly regarded as homogeneous markets where arbitrage quickly equates goods prices internationally at least under free trade. This hypothesis, however, "has probably been rejected more decisively by empirical evidence than any other hypothesis in the history of economics" [Williamson (1983), p. 201]]. In fact, cross hauling, which is ruled out by the law of one price can be found in agricultural trade statistics at the most disaggregated commodity level [e.g. FAO (a); IRRI (1988)]. Furthermore, empirical evidence from Asia [e.g. ADB (1988)] shows that even for such a narrowly defined market as that for rice, there exists a wide spectrum of domestic prices indicating limited substitution possibilities between different varieties. In a recent study [Ardeni (1989)], the law of one price is rejected quite uniformly for various agricultural markets.

There are two major reasons why agricultural products from foreign and domestic suppliers may not be perfect substitutes in domestic use. Differences in the technical characteristics may affect final demand. For example, processing diminishes the nutritive value of rice by reducing the protein and vitamin content. Imported and domestic rice of differing degrees of processing may therefore be imperfect substitutes. Market rigidities may also influence demand from competing supply. Commercial relationships, traditions and custom or simply imperfect information may limit the willingness of consumers to substitute perfectly among the products of competing suppliers. In this case, products which may be technically indistinguishable are differentiated by place of production.

Product differentials are sometimes considered in standard welfare analyses by correcting the border price, i.e. the standard against which to judge domestic intervention prices [e.g. ADB (1988)]. If for example, the nutrient content of domestic rice is lower, the border price is corrected downwards and vice versa if the nutritive value of domestic rice is higher. By this means, the price, quantity and welfare effects, e.g. of a floor price, are underestimated if the domestic variety is inferior and overestimated if it is superior. Underlying this procedure is the assumption of close substitutes in which case the price differentials remain constant during liberalization [Hiemenz/von Rabenau (1973), p. 83].

A different result is obtained if the products cannot be regarded as close substitutes because of consumer preferences. If the cross-price elasticity of the import substitute with respect to changes in the price of the imported product is relatively low - i.e. the quantity adjustment in the market for the domestic product is not sufficiently large to induce an equal change in the domestic price - the actual protection [Hiemenz/von Rabenau (1973), p. 83] and consequently the actual welfare effects are overestimated in the traditional model.

In the following we will first show how limited substitution can be introduced into a model of an agricultural market and then discuss how this influences the outcome of government-imposed distortions. We shall discuss these issues more specifically with reference to rice in Malaysia.

### 3.2 How Limited Substitution Affects Welfare

A convenient way of introducing limited substitution into an agricultural-market model is the use of the so-called Armington formulation [which includes perfect substitutability as a special case]. This treats similar products produced in different countries as qualitatively different, i.e. heterogeneous rather than homogeneous as in standard welfare analyses. In the context of rice, the Armington approach implies that domestic consumers



demand a composite commodity, C, which is a function of imported quantities, M, and domestically produced quantities, D:

$$(10) \quad C = C(M, D)$$

Since total expenditure on the composite commodity must equal expenditure on its imported and domestic components, we have the following budget constraint:

$$(11) \quad PC = P_M M + P_D D$$

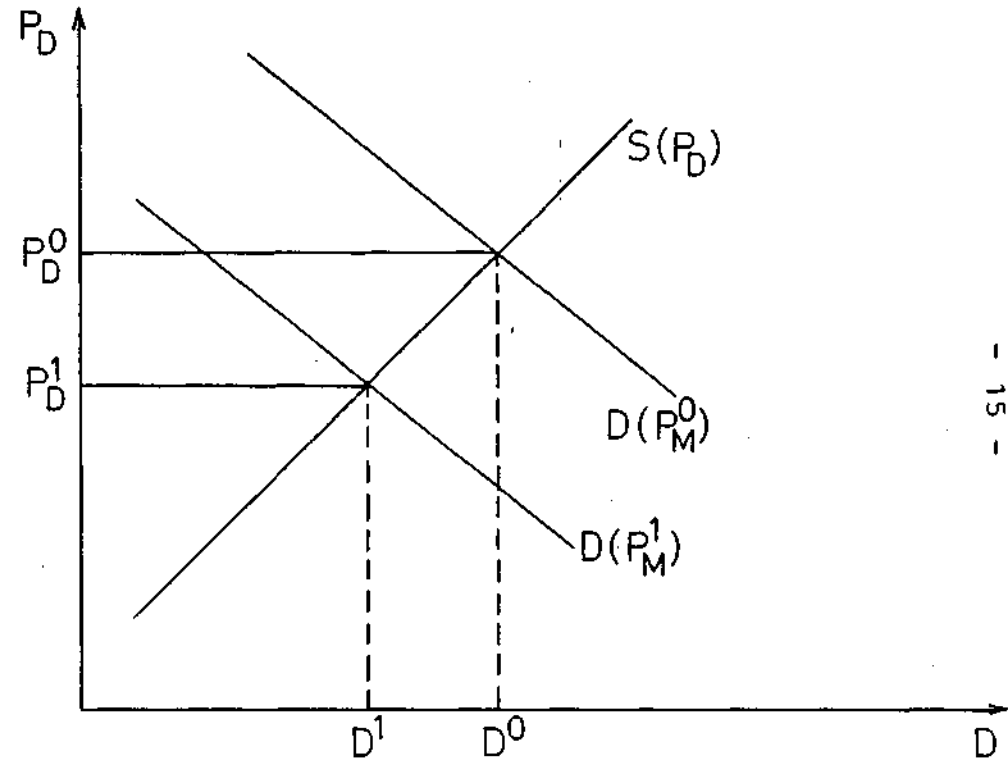
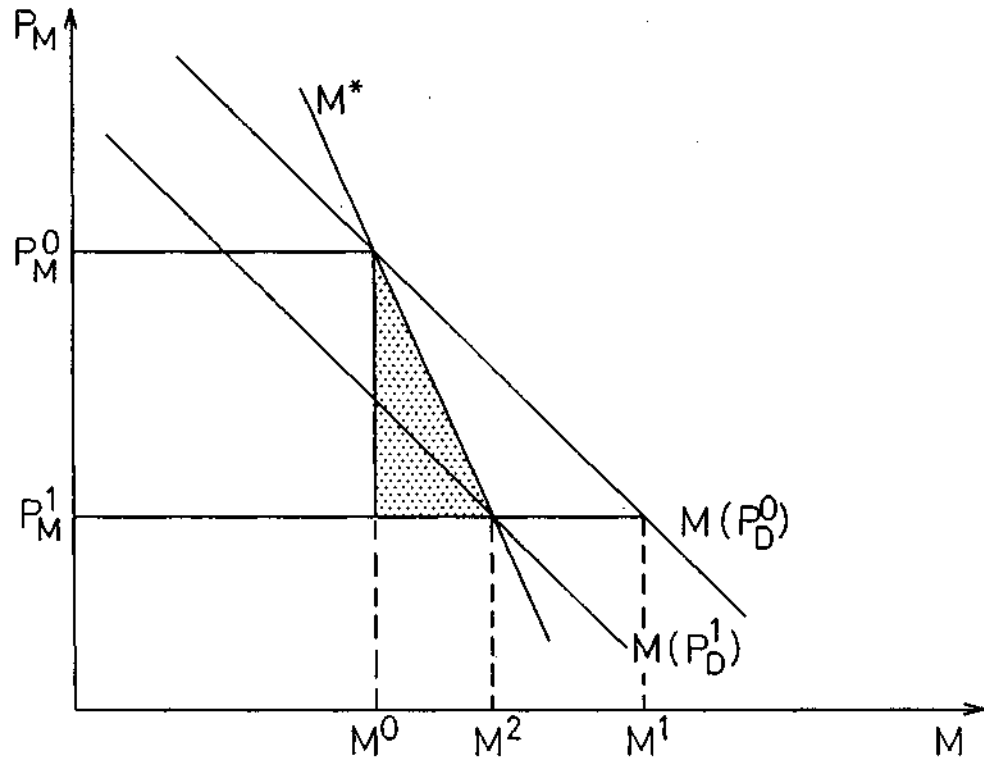
where P,  $P_M$  and  $P_D$  stand for the composite commodity price, the import price, and the price for the domestic import substitute respectively.

Assuming that consumers minimize the cost of purchasing a given amount of the composite good, the demand for imported and domestic rice will be functions of both, the domestic price and the import price. The supply, S, of domestic rice will be a function of its own price:

$$(12) \quad \begin{aligned} M &= M(P_M, P_D) \\ D &= D(P_D, P_M) \\ S &= S(P_D) \end{aligned}$$

Now consider two varieties of rice that are substitutes in demand. The supply of imported rice is perfectly elastic under the small-country assumption, while the supply of domestic rice is upward sloping. As a result of government-imposed distortions the domestic prices of both varieties are above the border price and the welfare gains of free trade are to be calculated. The situation is depicted in Figure 1. The demand curves for imported and domestic rice are each conditional on the other's price, i.e.  $M(P_D)$  and  $D(P_M)$ .<sup>6</sup> The demands are also conditional on income, but this income is assumed to be constant with respect to the policy change considered.

Figure 1: Welfare Effects of Liberalization



Now let the price for M decrease from  $P_M^0$  to  $P_M^1$  as a result of liberalization. Initially, consumers attempt to increase M from  $M^0$  to  $M^1$ , but because of substitution in demand the lower price for M causes a decrease in consumers' demand for D. This shift in demand for D from  $D(P_M^0)$  to  $D(P_M^1)$  causes a change in  $P_D$  from  $P_D^0$  to  $P_D^1$ , which, in turn, leads to a shift in demand for M from  $M(P_D^0)$  to  $M(P_D^1)$ . The new equilibrium finally occurs at price  $P_M^1$  and quantity  $M^2$ .

Thus, the demand relationship  $M^*$ , which takes account of adjustments in the market for domestic rice, is obtained and this relationship is less elastic than the movement along  $M(P_D^0)$ .

The total welfare gain generated by liberalization is the shaded triangle under  $M^*$ . As shown by Just/Hueth/Schmitz [1982], pp. 188-192], that triangle measures consumer gains in the import market net of the loss of government revenues as well as the gains to consumers and losses to producers in the market for the domestic substitute.

What then determines the price adjustment in the domestic market? Assuming a constant-elasticity-of-substitution (CES) function for equation (10) de Melo/Robinson (1985) derive an expression which relates percentage changes in the domestic price ( $\overset{\circ}{P}_D$ ) to percentage changes in the domestic price for imports ( $\overset{\circ}{P}_M$ ):

$$(13) \quad \overset{\circ}{P}_D = \frac{(\sigma - \delta) \Theta}{\varepsilon + \delta + (\sigma - \delta) \Theta} \overset{\circ}{P}_M$$

where  $\sigma$  is the elasticity of substitution between imports and domestically produced substitutes;  $\delta$  is the price elasticity of demand for the composite commodity;  $\Theta$  is the import share; and  $\varepsilon$  is the price elasticity of domestic supply.

As can be seen from equation (13), the price adjustment in the market for domestic rice depends crucially on the elasticity of substitution. Thus, the higher the elasticity of substitution the larger the price adjustment for domestic rice.

Furthermore, from equation (13), it can be seen that for any elasticity of substitution, the responsiveness of the domestic price depends on the import share. Thus, even if imported and domestic rice are close substitutes in demand, the response of the domestic price to a change in the import price will be small if the import share is low.

Finally, the derived nature of demand for domestic rice is shown by the presence of the supply elasticity in equation (13). Thus, the higher the elasticity of supply, the smaller the adjustment in the domestic price necessary to bring back equilibrium in the market. The same can be said of the role of the price elasticity of demand for the composite good.

### 3.3 Economic Effects of Rice Market Price Interventions in Malaysia

In this section, we investigate numerically the impact of government intervention on welfare in the case of perfect and limited substitution possibilities. In doing so, the basic premise is that government policies distort producer incentives and influence the efficiency of resource allocation. However, as will be shown, the welfare effects measured in the traditional model overestimate the negative impact of government intervention because they do not take account of limited substitution possibilities between different varieties of rice. The methodology involves the systematic elimination of distortions from existing price levels to obtain a picture of supply and demand conditions under a no-intervention scenario.

In order to do this, an Armington model featuring product differentiation in domestic demand [Dervis/de Melo/Robinson (1982), pp. 232-239] was calibrated for prices and quantities on the rice market for the period 1982-1986 given in Tamin/Meyanathan (1988) and solved for the no-intervention prices and quantities. The supply, demand and substitution elasticities were taken from Tamin/Meyanathan (1988) and Ahluwalia/Lysy (1983). Because the elasticity estimates differ widely from researcher to researcher

and because we wished to demonstrate the sensitivity of the results to changes in elasticities, the supply, demand and substitution elasticities presented in Table 3 and 4 are the point elasticities  $\pm 0.5$  times the point elasticities given by the sources.<sup>7</sup> Thus, the results are providing orders of magnitude, rather than exact measures.

The overall results of the partial equilibrium analyses are shown in Tables 3 and 4. The effects of the price interventions are evaluated in terms of: net social efficiency losses, the welfare trade-off between producers and consumers, and changes in government revenue and expenditure.

If imported and domestically produced rice are perfect substitutes, the welfare trade-off depends on the price elasticities of supply and demand and the difference between the intervention and border price of rice. Between 1982 and 1986 the domestic consumer and producer prices in Malaysia have always been above the border price. The nominal protection coefficients on production and consumption rose steadily from 1982 onwards to a maximum in 1985. In the high elasticity case (Table 4), producer gains are estimated at M\$ 623.6 million and government expenditure at M\$ 63.6 million in 1985. However, consumers suffered an overall loss of M\$ 670.2 million due to government intervention. Thus, the net social welfare loss (i.e. the deadweight efficiency loss) amounted to M\$ 110.2 million. Over the entire study period the accumulated total producer gain was estimated at M\$ 2430.0 million offset by a total consumer welfare loss of M\$ 2006.4 million. Accumulated total government expenditures are estimated at M\$ 727.6 million. Net total efficiency losses due to rice intervention in Malaysia tended to rise over the 1980s and summed up to M\$ 303.9 million over the study period. Comparing these results with those of the low elasticity case (Table 3) shows that the losses depend linearly on the assumed supply and demand elasticities.

Table 3: Sensitivity Analysis on the Price, Quantity and Welfare Effects of Rice Price Interventions, Malaysia 1982-1986<sup>a</sup> (Low Supply and Demand Elasticities)

	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986
Reference Solution	perfect substitutability					strong substitutability					weak substitutability				
Elasticity of Supply, $\pi$	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Elasticity of Demand, $\mu$	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Elasticity of Substitution, $\sigma$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	4.50	4.50	4.50	4.50	4.50	1.50	1.50	1.50	1.50	1.50
Production, X (000MT)	1225	1127	1022	1178	1121	1225	1127	1022	1178	1121	1225	1127	1022	1178	1121
Net Imports, M (000MT)	403	358	437	438	213	403	358	437	438	213	403	358	437	438	213
Consumption, C (000MT)	1628	1485	1459	1616	1334	1628	1485	1459	1616	1334	1628	1485	1459	1616	1334
World Price, PW (US\$/MT)	353	292	266	248	230	353	292	266	248	230	353	292	266	248	230
Exchange Rate (M\$/US\$)	2.34	2.32	2.34	2.08	2.58	2.34	2.32	2.34	2.08	2.58	2.34	2.32	2.34	2.08	2.58
Border Price, PB (M\$/MT)	841	692	637	531	608	841	692	637	531	608	841	692	637	531	608
Consumer Price, PC (M\$/MT)	916	914	915	910	910	916	914	915	910	910	916	914	915	910	910
Producer Price, PP (M\$/MT)	1104	1118	1131	1105	1158	1104	1118	1131	1105	1158	1104	1118	1131	1105	1158
Import Share,	0.25	0.24	0.30	0.27	0.16	0.25	0.24	0.30	0.27	0.16	0.25	0.24	0.30	0.27	0.16
NPC [PC/PB]	1.09	1.32	1.44	1.71	1.50	1.09	1.32	1.44	1.71	1.50	1.09	1.32	1.44	1.71	1.50
NPC [PP/PB]	1.31	1.61	1.77	2.08	1.90	1.31	1.61	1.77	2.08	1.90	1.31	1.61	1.77	2.08	1.90
Shift to no Intervention															
Decrease in Producer Price (%)	-23.8	-38.1	-43.6	-52.0	-47.5	-19.3	-30.7	-36.6	-42.9	-34.9	-13.6	-21.5	-27.0	-30.9	-22.0
Decrease in Consumer Price (%)	-8.2	-24.2	-30.3	-41.7	-33.1	-7.0	-20.7	-26.9	-36.4	-25.8	-5.5	-16.2	-22.2	-29.3	-18.2
Decrease in Output (000MT)	-29.2	-42.9	-44.6	-61.2	-53.2	-23.7	-34.6	-37.4	-50.5	-39.1	-16.7	-24.3	-27.6	-36.4	-24.6
Increase in Consumption (000MT)	20.0	54.0	66.4	101.0	66.3	17.2	46.1	58.9	88.1	51.6	13.6	36.2	48.6	71.1	36.4
No Intervention Outcomes															
Producer Price (M\$/MT)	841	692	637	531	608	890.6	774.4	716.9	631.3	753.9	953.6	877.3	826.0	763.9	903.5
Consumer Price (M\$/MT)	841	692	637	531	608	851.7	724.8	668.7	579.2	675.5	865.2	765.5	711.7	643.0	744.5
Supply (000MT)	1195.8	1084.1	977.4	1116.8	1067.8	1201.3	1092.4	984.6	1127.5	1081.9	1208.3	1102.7	994.4	1141.6	1096.4
Demand (000MT)	1648.0	1539.0	1525.4	1717.0	1400.3	1645.2	1531.1	1517.9	1704.1	1385.6	1641.6	1521.2	1507.6	1687.1	1370.4
Imports (000MT)	452.2	454.9	548.0	600.2	332.5	443.8	438.7	533.3	576.6	303.7	433.2	418.5	513.2	545.5	274.0
Welfare Results															
Producer Gain/Loss (M\$m)	318.3	470.5	493.4	658.8	601.5	253.9	369.4	400.0	522.2	429.3	180.5	262.5	299.1	383.2	275.9
Consumer Gain/Loss (M\$m)	-122.8	-335.0	-414.2	-631.9	-412.3	-105.3	-285.3	-366.5	-549.2	-318.9	-83.1	-223.2	-301.5	-440.9	-223.8
Government Revenue/Expenditure (M\$m)	-200.1	-150.6	-99.5	-63.6	-213.8	-151.6	-94.4	-48.4	0.5	-124.4	-99.0	-44.9	-6.7	42.0	-58.2
Total Deadweight Loss (M\$m)	4.6	15.1	20.2	36.7	24.6	3.1	10.3	15.0	26.5	14.0	1.6	5.6	9.1	15.7	6.1

<sup>a</sup> Data for the reference solution are taken from Tamin/Meyanathan (1988) except for the supply, demand, and substitution elasticities which are 1.5 times the point estimates given by Tamin/Meyanathan (1988) and Ahluwalia/Lysy (1983), respectively. The border price includes transport cost but was not corrected for quality differences [see Tamin/Meyanathan (1988), footnote 14].

Table 4: Sensitivity Analysis on the Price, Quantity and Welfare Effects of Rice Price Interventions, Malaysia 1982-1986<sup>a</sup> (High Supply and Demand Elasticities)

	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986	1982	1983	1984	1985	1986
Reference Solution	perfect substitutability					strong substitutability					weak substitutability				
Elasticity of Supply, $\pi$	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Elasticity of Demand, $\mu$	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Elasticity of Substitution, $\sigma$	$\infty$	$\infty$	$\infty$	$\infty$	$\infty$	4.50	4.50	4.50	4.50	4.50	1.50	1.50	1.50	1.50	1.50
Production, X (000MT)	1225	1127	1022	1178	1121	1225	1127	1022	1178	1121	1225	1127	1022	1178	1121
Net Imports, M (000MT)	403	358	437	438	213	403	358	437	438	213	403	358	437	438	213
Consumption, C (000MT)	1628	1485	1459	1616	1334	1628	1485	1459	1616	1334	1628	1485	1459	1616	1334
World Price, PW (US\$/MT)	353	292	266	248	230	353	292	266	248	230	353	292	266	248	230
Exchange Rate (M\$/US\$)	2.34	2.32	2.34	2.08	2.58	2.34	2.32	2.34	2.08	2.58	2.34	2.32	2.34	2.08	2.58
Border Price, PB (M\$/MT)	841	692	637	531	608	841	692	637	531	608	841	692	637	531	608
Consumer Price, PC (M\$/MT)	916	914	915	910	910	916	914	915	910	910	916	914	915	910	910
Producer Price, PP (M\$/MT)	1104	1118	1131	1105	1158	1104	1118	1131	1105	1158	1104	1118	1131	1105	1158
Import Share,	0.25	0.24	0.30	0.27	0.16	0.25	0.24	0.30	0.27	0.16	0.25	0.24	0.30	0.27	0.16
NPC [PC/PB]	1.09	1.32	1.44	1.71	1.50	1.09	1.32	1.44	1.71	1.50	1.09	1.32	1.44	1.71	1.50
NPC [PP/PB]	1.31	1.61	1.77	2.08	1.90	1.31	1.61	1.77	2.08	1.90	1.31	1.61	1.77	2.08	1.90
Shift to no Intervention															
Decrease in Producer Price (%)	-23.8	-38.1	-43.6	-52.0	-47.5	-13.6	-21.5	-27.0	-30.9	-22.0	-6.1	-9.6	-12.9	-14.3	-8.7
Decrease in Consumer Price (%)	-8.2	-24.2	-30.3	-41.7	-33.1	-5.5	-16.2	-22.2	-29.3	-18.2	-3.6	-10.5	-15.4	-19.6	-10.4
Decrease in Output (000MT)	-87.5	-128.7	-133.8	-183.6	-159.6	-50.1	-72.8	-82.7	-109.1	-73.9	-22.5	-32.5	-39.5	-50.5	-29.2
Increase in Consumption (000MT)	60.0	162.0	199.2	303.0	199.0	40.7	108.6	145.9	213.3	109.2	26.5	70.1	100.9	142.9	62.3
No Intervention Outcomes															
Producer Price (M\$/MT)	841	692	637	531	608	953.6	877.3	826.0	763.9	903.5	1036.3	1010.6	985.2	947.1	1057.6
Consumer Price (M\$/MT)	841	692	637	531	608	865.2	765.5	711.7	643.0	744.5	882.9	818.2	774.4	731.2	815.5
Supply (000MT)	1137.5	998.3	888.2	994.4	961.4	1174.9	1054.2	939.3	1068.9	1047.1	1202.5	1094.5	982.5	1127.5	1091.8
Demand (000MT)	1688.0	1647.0	1658.2	1919.0	1533.0	1668.7	1593.6	1604.9	1829.3	1443.2	1654.5	1555.1	1559.9	1758.9	1396.3
Imports (000MT)	550.5	648.7	770.0	924.6	571.6	493.7	539.4	665.5	760.4	396.1	452.0	460.5	577.4	631.4	304.5
Welfare Results															
Producer Gain/Loss (M\$m)	310.6	452.2	471.4	623.6	572.2	173.0	245.0	273.9	346.0	257.1	80.6	115.8	140.4	174.1	108.2
Consumer Gain/Loss (M\$m)	-124.3	-347.0	-432.6	-670.2	-432.3	-83.8	-228.6	-311.4	-459.9	-229.8	-54.3	-145.7	-212.2	-301.7	-129.0
Government Revenue/Expenditure (M\$m)	-200.1	-150.6	-99.5	-63.6	-213.8	-94.0	-33.2	10.1	66.8	-45.7	-27.5	24.8	61.8	110.9	16.4
Total Deadweight Loss (M\$m)	13.8	45.3	60.7	110.2	73.9	4.8	16.8	27.4	47.1	18.4	1.2	5.1	10.0	16.8	4.4

<sup>a</sup> Data for the reference solution are taken from Tamin/Meyanathan (1988) except for the supply, demand, and substitution elasticities which are 0.5 times the point estimates given by Tamin/Meyanathan (1988) and Ahluwalia/Lysy (1983), respectively. The border price includes transport cost but was not corrected for quality differences [see Tamin/Meyanathan (1988), footnote 14].

If imported and domestically produced rice are not perfectly substitutable in consumption, the no-intervention outcomes change drastically. As a result of product differentiation in demand, the fall in domestic rice prices will be smaller than in the case of perfect substitutability and will never equal border prices. As can be seen from Tables 3 and 4, domestic consumer and producer prices in the free-trade situation are always above the border price with consumer prices being a consumption-share weighted average of the border and producer prices. As a result, the welfare effects are much lower than in the case of perfect substitutability.

This is best illustrated by comparing the previous results with those calculated under the assumption of weak substitutability (Table 4). In this case, producers realize a welfare gain of only M\$ 174.1 million in 1985, which is only one fourth of producers' surplus estimated under the assumption of perfect substitutability. This result is intuitively clear because with weak substitutability domestic producers would benefit from "natural protection" even in a free-trade situation. Furthermore, consumers suffer a loss of M\$ 301.7 million which is below 50 percent of the previous case. These consumer losses are mainly attributable to the implicit tax on imports. As a result, government expenditure for producer subsidies are relatively low and revenues from imports are relatively high leaving net government revenues of M\$ 110.9 million as compared to net expenditures of M\$ 63.9 million with perfect substitutability. Thus, the deadweight losses amount to only M\$ 16.8 million in 1985. Over the entire study period, the accumulated total producer gain is estimated at M\$ 619.1 million which is offset by a total consumer loss of M\$ 842.9 million and government revenues of M\$ 186.4 million.

Our results indicate that limited substitution possibilities can play an important role in determining the final welfare effects of government intervention in the Malaysian rice market. Assuming stronger substitutability ( $\sigma = 4.5$ ) changes only the quantitative results leaving the qualitative conclusions from the comparison



of the two extreme cases unaffected. In any case, limited substitution drives a wedge between domestic prices and border prices, the extent of which depends on the degree of substitutability on the consumer side, the share of imports in total domestic supply, and the supply and demand conditions in the domestic market.

Some other observations which can be made from Tables 3 and 4 are summarized in Table 5. There, the mean and the coefficient of variation (C.V.) of selected variables over 1982 to 1986 in the free-trade situation and for various elasticity assumptions are confronted with those in the distorted situation. The results can be summarized as follows:

1. In terms of magnitude, the supply mean is raised (though not substantially), with intervention while demand is reduced compared to intervention. Imports, on the other hand, were in fact reduced over the period.
2. The changes in quantities increase with increasing substitutability and increasing supply and demand elasticities. The same holds true for producer and consumer prices. Thus, limited substitutability diminishes the need to support producer prices in order to increase producer income.
3. Limited substitution in connection with high supply and demand elasticities has a stabilizing effect on both producer and consumer prices. This result also suggests that there is less need for intervention if substitution possibilities are limited.

Although the above welfare calculations are not based on an econometric estimation of the substitution elasticity for rice in Malaysia, they have nevertheless generated some useful insights into the impact of agricultural pricing policies. Perhaps the most important result which emerges from our findings is the importance of the import share in determining domestic price changes. Standard trade theory would predict that, even for a large market such as the rice market in Asian countries, price

Table 5: Mean and Variation With and Without Intervention, Malaysia 1982-1986<sup>a</sup>

Low Supply and Demand Elasticities								
With Intervention			Without Intervention					
			Perfect Substitutability		Strong Substitutability		Weak Substitutability	
	Mean	C.V.%	Mean	C.V.%	Mean	C.V.%	Mean	C.V.%
Production	1135	5.97	1088	6.51	1098	6.40	1109	6.28
Consumption	1504	7.23	1566	6.96	1557	7.10	1546	7.20
Imports	370	22.62	478	19.24	459	20.45	437	21.59
Border Price			662	15.65	662	15.65	662	15.65
Consumer Price	913	0.28	662	15.65	700	12.74	746	9.73
Producer Price	1123	1.78	662	15.65	753	11.18	865	7.53

High Supply and Demand Elasticities								
With Intervention			Without Intervention					
			Perfect Substitutability		Strong Substitutability		Weak Substitutability	
	Mean	C.V.%	Mean	C.V.%	Mean	C.V.%	Mean	C.V.%
Production	1135	5.97	996	8.14	1057	7.08	1100	6.45
Consumption	1504	7.23	1689	7.49	1628	7.68	1585	7.58
Imports	370	22.62	693	20.05	571	22.48	485	23.36
Border Price			662	15.65	662	15.65	662	15.65
Consumer Price	913	0.28	662	15.65	746	9.73	804	6.27
Producer Price	1123	1.78	662	15.65	865	7.53	1007	3.84

<sup>a</sup> Production, consumption and imports in 1000 tons. Prices in M\$/ton. C.V. is the coefficient of variation. It is equal to the standard deviation of the respective variable divided by the mean of the variable, times 100. Mean is the arithmetic mean.

liberalization would exert strong pressure on domestic prices. On the contrary, the Armington-specification implies that a large market with a low import share has substantial price autonomy. From the government point of view another interesting result is the fact that expenditures to support the guaranteed minimum price would need to be much lower than is predicted under traditional assumptions.

The question remains whether the assumptions of product differentiation at the micro level is reasonable. There may be disagreement on the correct specification of the substitution elasticity, but one certainly does not observe the degree of substitutability found in standard trade theory.

#### 4. Conclusions

It was investigated in this paper how measurement issues are important when agricultural protection is analyzed. The focus was on price uncertainty and limited substitution, two aspects which are often neglected in studies on agricultural protection. The following major findings can be summarized:

1. When uncertainty is introduced into the measurement of protection, e.g. by using normal rather than actual world prices in nominal protection coefficients, the computed protection levels are strongly affected. Additionally, it matters, how normal world prices are calculated, i.e. how uncertainty in world prices is excluded in the empirical analysis. The analysis started from the important findings of Byerlee/Sain who had denied a clear pattern of discrimination against wheat producers in developing countries. This basic result was shown to depend heavily on the introduction of normal rather than actual world prices and on the way normal world prices are modelled. When an econometric model rather than trend analysis is utilized to model world prices, the qualitative result changes and a discrimination against agriculture occurs in most countries.

2. The analysis on limited substitution in agricultural markets showed that the economic impacts of a given level of agricultural protection are crucially affected by the homogeneity assumption. The application of an Armington framework to rice policy in Malaysia shows that the welfare effects of liberalization are overestimated when perfect substitution between domestic and imported rice is assumed. When the more realistic framework of imperfect substitution is considered, welfare gains of liberalization become smaller. In cases with a low substitution elasticity between domestic and imported goods, the differentials in calculated welfare impacts are significant.

Footnotes

- 1 As the raw data were not published, it was not possible to replicate exactly the domestic price and the actual and normal world prices Byerlee/Sain used. We measured the actual and normal world prices on the basis of the data shown in Appendix 1. A linear time-trend analysis was utilized to compute the normal price as in the Byerlee/Sain study. From this, we calculated a correction factor  $C = (p_w^*/p_w)$  which we multiplied by  $NPC_1$  in the Byerlee/Sain study to identify  $NPC_2$ . This procedure assumes that the introduction of the normal world price rather than the actual world price affected the nominal protection coefficient by the same percentage in the Byerlee/Sain study as on the basis of the data of Appendix 1.
- 2 Note that the limits of 0.85 and 1.15 contain an element of arbitrariness. No economic interpretation can be given for these values.
- 3 The formulation of equations (5) and (6) implies that production does not respond to changes in world prices within the same period.
- 4 Again, a correction factor  $(p_w^*/p_w^{**})$  was computed on the basis of the two alternative modelling approaches and the data basis of Appendix 1. This correction factor was multiplied by  $NPC_1$ , as measured in the Byerlee/Sain study, to derive  $NPC_3$ .
- 5 See Just/Hueth/Schmitz (1982) for an excellent treatment of welfare measurement in related markets and Thurman/Wohlgenant (1989) on estimation procedures. Many recent empirical studies have tried to deal with such intermarket connections either by estimating complex indicators [e.g. Krueger/Schiff/Valdés (1988); Bautista (1987)] or by using multi-market [e.g. Braverman/Hammer/Gron (1987)] and computable general equilibrium models [e.g. de Janvry/Sadoulet (1987)].

- 6 Without loss of generality the two products can be measured in units such that they exchange at a price ratio of one for one in the initial situation. In Figure 1, the demand curves are drawn as straight lines for geometrical convenience; they may be regarded as approximations to curvilinear curves.
  
- 7 There is little consensus on estimates of the substitution elasticity for rice. The estimates reported in the literature [e.g. Gardiner/Dixit (1986); Carter/Gardiner (1988)] vary widely from very inelastic (less than 1) to very elastic (greater than 1) in both the short-run (1 year) and the long-run (more than 1 year). Literature estimates for rice in Malaysia are not available. Ahluwalia/Lysy (1983) report a substitution elasticity of 3.0 for food crops and this is used here as a central tendency parameter for rice.

Appendix 1: Data Basis for the Econometric World Wheat Price Model

Year	World Market Price for Wheat <sup>a</sup> (p <sub>w</sub> ) (1)	World Market Price for Rice <sup>b</sup> (p <sub>R</sub> ) (2)	Real GDP of Major Wheat Importers <sup>c</sup> (Y) (3)	World Wheat Production (1000 mt) (PR) (4)	World Population (1000) (POP) (5)
1959	- <sup>d</sup>	- <sup>d</sup>	169487.77	241716	- <sup>d</sup>
1960	65.79	145.2	178956.64	243856	3023223
1961	67.21	151.2	217411.69	226333	3082581
1962	68.67	158.2	225523.17	254635	3143104
1963	70.17	146.7	284001.15	236418	3204871
1964	73.26	148.5	344790.83	273432	3270106
1965	65.53	148.4	347362.23	267208	3334685
1966	67.76	160.5	376497.87	309970	3403699
1967	71.13	194.8	319630.70	299027	3474140
1968	67.18	213.8	349224.99	332257	3546040
1969	65.94	196.6	346258.59	313345	3619428
1970	66.11	196.6	428811.85	316584	3694334
1971	68.01	197.5	463527.87	353829	3767863
1972	83.32	187.5	596495.07	348121	3842855
1973	144.96	436.2	684033.67	376080	3919339
1974	188.67	564.0	559977.31	364138	3997346
1975	167.26	425.9	604762.36	359902	4076906
1976	142.52	301.1	589782.39	425429	4148845
1977	112.37	360.0	738990.60	387289	4222053
1978	145.22	444.1	835246.74	451195	4296553
1979	184.85	435.7	889996.93	428524	4372368
1980	213.47	497.9	968960.25	446351	4449520
1981	208.00	555.9	1029442.80	455697	4524497
1982	185.04	415.4	- <sup>d</sup>	482626	4600738

<sup>a</sup> Price of American Red Hardwinter 2, cif Rotterdam, in \$/mt. - <sup>b</sup> Price of American Long Corn Rice, cif Northsea ports in \$/mt. - <sup>c</sup> Weighted real gross domestic product of the five major wheat-importing countries - China, USSR, Japan, United Kingdom and India - in mill.\$.. The real gross domestic product is PPP-corrected according to the International Comparison Project and in 1975 prices. The countries' shares in wheat imports were used as weights. - <sup>d</sup> Not included as the data were irrelevant for the econometric model.

Sources: Columns (1) and (2): Statistisches Bundesamt, various years; column (3): calculated with income data from Summers/Heston (1984) and Summers/Heston (1988) and the countries' shares in wheat imports taken from FAO (a) various years; column (4): FAO (1987 b); column (5): FAO (b), various years.

Appendix 2: The Influence of Price Uncertainty on the Measured Nominal Protection Coefficients for Wheat Producers in 31 Countries, 1980-82<sup>a</sup>

Country	Alternative Nominal Protection Coefficients		
	NPC <sub>1</sub>	NPC <sub>2</sub>	NPC <sub>3</sub>
	(1)	(2)	(3)
Nigeria	2.60	2.34	2.44
Sudan	2.37	2.13	2.23
Burma	2.05	1.85	1.93
Colombia	1.67	1.50	1.57
Jordan	1.66	1.50	1.56
Algeria	1.50	1.35	1.41
Brazil	1.35	1.22	1.27
Morocco	1.35	1.22	1.27
Ethiopia	1.32	1.19	1.24
Ecuador	1.24	1.12	1.17
Bolivia	1.21	1.09	1.14
Cameroon	1.19	1.07	1.12
Paraguay	1.08	0.97	1.01
Chile	1.07	0.96	1.01
China	1.06	0.95	1.00
Lesotho	1.02	0.92	0.96
Syria	1.00	0.90	0.94
Bangladesh	1.00	0.90	0.94
Argentina	1.00	0.90	0.94
Kenya	0.89	0.80	0.84
Tunisia	0.84	0.76	0.79
Uruguay	0.80	0.72	0.75
Nepal	0.79	0.71	0.74
Mexico	0.76	0.68	0.71
Tanzania	0.73	0.66	0.69
Pakistan	0.71	0.64	0.67
Afghanistan	0.68	0.61	0.64
India	0.66	0.59	0.62
Turkey	0.65	0.59	0.61
Peru	0.51	0.46	0.48
Egypt	0.41	0.37	0.39

<sup>a</sup> NPC<sub>1</sub> is the nominal protection coefficient used by Byerlee/Sain. It utilizes the normal world market price in the denominator, measured as the value of a linear trend function on the basis of world prices for the period 1960-82. NPC<sub>2</sub> is based on the actual world prices rather than on the normal world price. NPC<sub>3</sub> is again based on a normal world price which is, however, calculated with an econometric world market model. For the exact measurement of NPC<sub>1</sub> to NPC<sub>3</sub>, see the text.

Sources: Own computations with data from Byerlee/Sain (1986), Table A-1 and the sources cited in Appendix 1.



## References

- Ahluwalia, M.S. and F.J. Lysy (1983), Creating a Consistent Data Base. In: Ahluwalia, M.S. and F.J. Lysy, The Workings of Computable General Equilibrium Models: With Special Reference to a Model on Malaysia.
- Ardeni, P.G. (1989), Does the Law of one Price Really Hold for Commodity Prices? "American Journal of Agricultural Economics", Vol. 71, No. 3, pp. 661-669.
- Armington, P. (1969), A Theory of Demand for Products Distinguished by Place of Production. IMF Staff Papers, Vol. 16, pp. 159-178.
- Asian Development Bank (ADB) (1988), Evaluating Rice Market Intervention Policies. Manila.
- Bale, M. (1985), Agricultural Trade and Food Policy: The Experience of Five Developing Countries. World Bank Staff Working Paper No. 724, Washington, D.C.
- Bale, M. and E. Lutz (1981), "Price Distortions in Agriculture and Their Effects: An International Comparison". American Journal of Agricultural Economics, Vol. 63, pp. 8-22.
- Bautista, R.M. (1987), Production Incentives in Philippine Agriculture: Effects of Trade and Exchange Rate Policies. International Food Policy Research Institute Research Report 59, Washington, D.C.
- Braverman, A., J.S. Hammer and A. Gron (1987), "Multimarket Analysis of Agricultural Price Policies in an Operational Context: The Case of Cyprus". The World Bank Economic Review, Vol. 1, No. 2, pp. 337-356.
- Brown, G.T. (1978), Agricultural Pricing Policies in Developing Countries. In: Schultz, T.W. (ed.), Distortions of Agricultural Incentives. Bloomington, London, pp. 84-113.
- Byerlee, D. and G. Sain (1986), Food Pricing Policy in Developing Countries: Bias against Agriculture or for Urban Consumers? "American Journal of Agricultural Economics", Vol. 68, pp. 961-969.
- Carter, C.A. and W.H. Gardiner (eds.) (1988), Elasticities in International Agricultural Trade. Boulder and London.
- de Janvry, A. and E. Sadoulet (1987), "Agricultural Price Policy in General Equilibrium Models: Results and Comparisons". American Journal of Agricultural Economics, Vol. 69, No. 2, pp. 230-246.

- de Melo, J. and S. Robinson (1985), Product Differentiation and Trade Dependence of the Domestic Price System in Computable General Equilibrium Trade Models. Report No. DRD127, Development Research Department, Economics and Research Staff, World Bank, Washington, D.C.
- Dervis, K., J. de Melo and S. Robinson (1982), General Equilibrium Models for Development Policy. Washington, D.C.
- FAO (a), Trade Yearbook. Rome, various years.
- FAO (b) Production Yearbook. Rome, various years.
- FAO (1987a), Agricultural Price Policies. Issues and Proposals. Rome.
- FAO (1987b), World Crop and Livestock Statistics 1948-85. Rome.
- Gardiner, W.H. and P.M. Dixit (1986), Price Elasticity of Export Demand: Concepts and Estimates. USDA, Washington, D.C.
- Hiemenz, U. and K. von Rabenau (1973), Effektive Protektion: Theorie und empirische Berechnung für die westdeutsche Industrie. Tübingen.
- International Rice Research Institute (IRRI) (1988), World Rice Statistics 1987. Manila.
- Just, R.E., D.L. Hueth and A. Schmitz (1982), Applied Welfare Economics and Public Policy. Englewood Cliffs.
- Krueger, A., M. Schiff and A. Valdés (1988), "Agricultural Incentives in Developing Countries: Measuring the Effect of Sectoral and Economywide Policies". The World Bank Economic Review, Vol. 2, No. 3, pp. 255-271.
- Lutz, E. and P.L. Scandizzo (1980), Price Distortions in Developing Countries: A Bias against Agriculture. "European Review of Agricultural Economics", Vol. 7, pp. 5-27.
- Matthews, A. (1985), The Common Agricultural Policy and the Less Developed Countries. Dublin.
- OECD (1987), National Policies and Agricultural Trade. Paris.
- OECD (1988), Agricultural Policies, Markets and Trade. Monitoring and Outlook 1988. Paris.
- Parikh, K.S., G. Fischer, K. Froberg and O. Gulbrandsen (1988), Towards Free Trade in Agriculture. Dordrecht, Boston, Lancaster.
- Scandizzo, P.L. and C. Bruce (1980), Methodologies for Measuring Agricultural Price Intervention Effects. World Bank Staff Working Paper No. 394, Washington, D.C.

- Schultz, T.W. (1978), On Economics and Politics of Agriculture. In: Schultz, T.W. (ed.), Distortions of Agricultural Incentives. Bloomington, London, pp. 3-23.
- Statistisches Bundesamt, Reihe 5: Preise und Preisindizes im Ausland. Wiesbaden, various years.
- Summers, R. and A. Heston (1984), Improved International Comparisons of Real Product and its Composition: 1950-1980. "The Review of Income and Wealth", Vol. 30, pp. 207-262.
- Summers, R. and A. Heston (1988), A New Set of International Comparisons of Real Product and Price Levels, Estimates for 130 Countries 1950-1985. "The Review of Income and Wealth", Vol. 34, pp. 1-25.
- Tamin, M. and S. Meyanathan (1988), Rice Market Intervention System in Malaysia: Scope, Effects and the Need for Reform. In: Adb (ed.), Evaluating Rice Model Market Intervention Policies, Manila.
- Tangermann, S., T. Josling and S. Pearson (1987), Multilateral Negotiations of Farm Support Levels: The Role of PSEs. "World Economy", Vol. 10, pp. 265-281.
- Thurman, W.N. and M.K. Wohlgenant (1989), "Consistent Estimation of General Equilibrium Welfare Effects". American Journal of Agricultural Economics, Vol. 71, No. 4, pp. 1041-1045.
- Timmer, C.P. (1988), Analyzing Rice Market Interventions in Asia: Principles, Issues, Themes and Lessons. In: Adb (ed.), Evaluating Rice Market Intervention Policies, Manila.
- Tyers, R. and K. Anderson (1986), The Price, Trade and Welfare Effects of Agricultural Protection. In: Anderson, K. und Y. Hayami (eds.), The Political Economy of Agricultural Protection. Sydney, London, Boston, pp. 50-62.
- United States Department of Agriculture (USDA) (1987), Government Intervention in Agriculture. Measurement, Evaluation and Implications for Trade Negotiations. (Economic Research Service, FAER-229), Washington, D.C.
- United States Department of Agriculture (USDA) (1988), Estimates of Producer and Consumer Subsidy Equivalents: Government Intervention in Agriculture, 1982-86. (Agriculture and Trade Analysis Division, Economic Research Service, U.S.D.A., ERS Staff Report No. AGES 880127), Washington, D.C.
- Valdés, A. and J. Zietz (1980), Agricultural Protection in OECD Countries: Its Cost to Less-Developed Countries. (Research Report No. 21, International Food Policy Research Institute), Washington, D.C.
- Westlake, M.J. (1987), The Measurement of Agricultural Price Distortion in Developing Countries. "The Journal of Development Studies", Vol. 23, pp. 367-381.

Williamson, J. (1983), *The Open Economy and the World Economy*.  
New York.

World Bank (1986), *World Development Report 1986*. Washington, D.C.