THE EFFECTS OF EXPORT SUBSIDIES IN THE WORLD WHEAT MARKET

BY

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ABSTRACT

The Welfare Effects of Export Subsidies

The use of export subsidies in the world wheat market has caused substantial changes in the behaviour of both importing and exporting countries. To understand this behaviour more fully, a simulation model of the effects of targeted and general export subsidies within a partial equilibrium framework has been developed. The analysis uses three exporting countries and two importing countries. The exporting countries differ on the basis of their export policies: country A implements an export subsidy scheme; country B uses domestic subsidies to counteract the effects of country A's export subsidies; and country C matches the prices of country A, but does not use a formal export subsidy policy. These three policy orientations were chosen to roughly replicate the three general patterns of policy used by wheat exporters since the implementation of the Export Enhancement Program by the United States. The two importing countries differ on the basis of their eligibility to receive targeted export subsidies. From this, a base model is developed. The results indicate that all exporting countries lose welfare and all subsidized importing countries gain welfare when both targeted and general export subsidies are used. Non-targeted importers welfare remains constant when targeted export subsidies are used because they are ineligible for export subsidies.

Sensitivity analysis is used to evaluate the effects of changing several variables

including the elasticity of excess supply, the elasticity of net import demand, the generic subsidy value, and the percentage of generic certificates redeemed for wheat. The results indicate that prices, quantitites traded, and welfare vary when the elasticity of excess supply and import demand are altered. Only welfare varies when the generic subsidy value or the percentage of generic certificates redeemed for wheat varies because the shifts in excess supply or import demand from the use of export subsidies are mechanical.

Three functional forms are used in the analysis to determine if the prices, quantities traded, or welfare effects differ substantially depending on the functional form. Small changes do occur, but all functional forms are similar. Thus, the benefit of using alternative functional forms in this analysis is limited.

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INTRODUCTION:

Domestic agricultural policies often have direct, economic implications for international trade. During the 1980s, wheat producers were domestic subsidized by the United States and European Community, creating large, domestic surpluses of wheat. To eliminate these surpluses, the United States and European Community subsidized wheat exports through the use of export subsidies. To help understand the impacts of export subsidies, this study develops a simulation model to quantify the theoretical effects of export subsidies in the world wheat market using a partial equilibrium framework. Prices, quantities traded, and welfare changes are examined when export subsidies are not implemented, when targeted export subsidies are used, and when general export subsidies are incorporated. In doing so, this study shows that a simulation framework can reasonably model the world wheat market in terms of the theoretical effects of export subsidies. In addition, this study incorporates several alternative functional forms which reveal the effect functional form has on prices, quantities traded, and welfare changes.

To understand the world wheat market more clearly, it is useful to briefly examine how domestic agricultural policies used by both the United States and European Community have initiated the use of export subsidies. The agriculture policies under the Common Agricultural Policy (CAP) in the European Community allow for a relatively high internal market price for wheat. This ensures not only

increased wheat production, but also tends to limit domestic consumption (Coleman, 1988) which resulted in large wheat surpluses in the 1980s and 1990s. To eliminate these surpluses, the European Community has used export refunds under the CAP to export wheat at prices below the internal price. Under the CAP, export refunds are provided to exporters through a tender system when the internal European Community market price exceeds the world wheat price (Australian Bureau of Agricultural Economics, 1985). This ensures that wheat from the European Community remains competitive on the world wheat market with a relatively low cost to the European Community.

Under the structure of CAP, it is difficult to determine if export refunds are operating as targeted or general export subsidies for two reasons. First, various countries are eligible for varying degrees of subsidization depending on the location (Bureau of Agricultural Economics, 1985). This indicates that export refunds are not a straight, across the board subsidy program. Second, European Community disposal programs in the early 1980s included some elements of price discrimination (Coleman, 1988). The price discrimination factor reveals that export refunds may have some characteristics of a targeted export subsidy scheme. Thus, without a detailed analysis of export transactions, it is difficult to determine the specific nature of export refunds.

Concurrent to the European Community becoming a wheat exporter, wheat

exports from the United States were declining and producers in the United States were continuing to forfeit wheat to the Credit Commodity Corporation (CCC) under the Farmer-Owned Reserve and Non-Recourse Loan Programs. In addition, the European Community was using export refunds in several markets which were traditionally American. This caused Americans to believe that the European Community was using unfair trade practices to displace American wheat exports. Therefore, pressure in the United States grew to introduce a program to counteract the effects of subsidized wheat exports from the European Community.

On May 14, 1985, the Export Enhancement Program (EEP) was introduced. This program provided payment-in-kind bonuses to grain exporting companies selling wheat, wheat flour, barley, malted barley, and vegetable oil. Initially, the EEP was intended to operate as a targeted export subsidy program providing export subsidies to countries with relatively elastic import demand for United States wheat. Countries with relatively inelastic import demand would be ineligible for export subsidies and would pay the Gulf export price for wheat.

The main theoretical support for the EEP was provided by Abbott, Paarlberg, and Sharples (1987). They showed that if the United States subsidized countries with relatively elastic import demand while countries with relatively inelastic import demand paid the world price for wheat, the social welfare of the United States could moderately increase. However, this result only occurred if certain conditions were

met which included the assumption that other exporting countries did not retaliate.

Since the EEP was developed in retaliation to export subsidies used by the European Community, the objectives of the EEP were twofold: (1) to increase the competitiveness of United States exports, particularly in traditional American markets penetrated by European Community exports; and (2) to encourage the European Community to reduce its agricultural subsidies, specifically within the structure of General Agreement on Tariffs and Trade (GATT) (Coughlin and Carraro, 1988).

The EEP was designed as a targeted export subsidy program. However, there has been some changes to the program to indicate that it may also operate similar to a general export subsidy program: (1) The Interagency Trade Policy Review Group eliminated the administrative requirements of zero-budget impact, the additionality sales requirement, and the cost-effectiveness requirement (Paarlberg, 1990); (2) An increase in expenditures for the EEP occurred. For example, in the 1991 Fiscal Year, the Bush administration increased the EEP budget authority from $566 million to $900 million (Paarlberg, 1990); and (3) The United States began to target all countries perceived as using "unfair" trade practices. These changes have allowed the CCC to offer export subsidies to countries which were previously ineligible or who are supplied by countries using unfair trade practices. Thus, the changes caused increases in the number of countries eligible for export subsidies and the value of export subsidies under the EEP.

From the discussion above, there is some indication that the EEP in the United States has transformed from a targeted to a general export subsidy scheme. In addition, the uncertainty surrounding the nature of the export refund program used by the EEC, targeted or general, suggests that export subsidies should be modelled both as both targeted and general export subsidy programs. Thus, this study uses the information above to develop a simulation model which calculates the world wheat price, quantity of wheat traded, imports, exports, and the welfare changes of importing and exporting regions.

Incorporated into this analysis is several alternative functional forms of the import demand and excess supply curves. The types of functional forms used for the import demand and excess supply curves include the linear, semi-log, and reciprocal functional forms. This is done to examine the changes in the world wheat price, quantity traded, imports, exports, and welfare changes as the functional form changes.

Once a base model is established using each of the formulations, sensitivity analysis is incorporated into the model. This eliminates some of the uncertainty surrounding the elasticity of net import demand, the elasticity of excess supply, the generic subsidy value, and the percentage of generic certificates redeemed for wheat used in the analysis. From these scenarios, a range of world wheat prices, quantities traded, and welfare change estimates from export subsidies. Therefore, the sensitivity

of these variables on the world wheat price, the quantity traded, the net welfare changes can be determined.

Within this analysis, two other topics are discussed in detail: (1) the economic theory of welfare changes resulting from export subsidies; and (2) the implications of functional form when estimating welfare changes.

Four main assumptions are used within the partial equilibrium framework of this analysis: (1) wheat is treated as a homogeneous good. Thus, the differences in grade characteristics are not taken into consideration; (2) there are no trade barriers between regions. In other words, trade is assumed to proceed freely without tariff or quota limitations; (3) the domestic demand and supply schedules which make up the import demand and excess supply curves are assumed to be largely independent of each other (Chacholiades, 1981); (4) subsidies are assumed not to be passed on, but actually benefit those who are receiving the subsidies; and (5) ceteris paribus. In other words, all other factors not considered in this analysis remain constant.

The remainder of this study is divided into four chapters. Chapter two discusses the theoretical aspects of export subsidies and develops a conceptual framework of export subsidies. Chapter three outlines the formulations used to complete this analysis. Chapter four discusses the effects on the world wheat price, the quantity of wheat traded, and the net welfare changes shown by each of the

formulations. Chapter five addresses the limitations of the study and provides concluding remarks.

CHAPTER 2: CONCEPTUAL FRAMEWORK

This chapter conceptualizes the theoretical basis for the welfare analysis of export subsidies. Discussion includes theory relating to partial equilibrium analysis, welfare measurement, functional form, and export subsidies.

A. Partial Equilibrium Analysis

Partial equilibrium models are often used to analyse the world wheat market (Bailey and Houck 1990; Brooks, Devadoss, and Meyers 1990). This study extends their use to analyse the welfare changes from export subsidies. This method is chosen because farm sectors are relatively small and export subsidies do not affect the entire economy (Haley and Dixit 1988). In addition, partial equilibrium models are easily manipulated empirically. It should be noted, however, that partial equilibrium models do not consider all economic factors which could affect the world wheat market. Thus, factors such as income, changes in demand, prices of substitutes and compliments are not considered in this analysis.

B. Alternative Functional Forms

To determine the appropriate functional form of the import demand and excess supply curves, the utility function is often used in theory. In practice, the utility

function is unobservable. Thus, economists use other methods such as: (1) contrasting the characteristics of the chosen functional form to economic theory; and (2) using goodness-of-fit measures.

There are two main economic theories which import demand and excess supply curves should demonstrate: (1) diminishing marginal utility; and (2) the saturation principle. All functional forms are able to reflect diminishing marginal utilities with the exception of the linear functional form. In terms of the saturation principle, only the reciprocal functional form is appropriate. Thus, theoretically, only the reciprocal functional form is an adequate representation. However, using goodness-of-fit measures indicates that empirical studies often support the use of the semi-log functional form (Keith, 1989).

In contrast to conventional wisdom, Kling (1989) suggests that when price differences are small choosing the appropriate functional form may not be as crucial as previously thought. Therefore, in practice, choosing an incorrect functional form may not yield dramatic errors in welfare calculations.

C. Theoretical Welfare Measures

It is also necessary to determine an appropriate measure of welfare changes. Of the numerous methods available, consumer and producer surplus are the most

common. However, theoretically there are some theoretical problems when consumer surplus is used to measure welfare and when economic surpluses, in general, are used to measure welfare changes in international trade.

Under certain conditions, using consumer surplus to measure welfare changes causes ambiguous results (Just, Hueth, and Schmitz, 1986; Haley and Dixit, 1988). This ambiguity is a result of either: (1) path dependency problems when several prices or prices and income change simultaneously; or (2) utility measurement problems. To eliminate ambiguous results, two assumptions are incorporated: (1) The income effect of all goods must be zero; and (2) The marginal utility of income is constant with respect to all prices and income that change.

Unlike consumer surplus, producer surplus is considered an adequate measure of welfare. This is true when firms profit maximize such that owners or shareholders of a firm have no production preferences other than profit (Just, Hueth, and Schmitz, 1986). Thus, measurement of welfare changes using producer surplus is considered appropriate.

The use of economic surpluses in international trade also suggests that (Haley and Dixit 1988, p.14): "(1) the cross-country welfare comparisons require a global indifference curve, and (2) the demand curves need to be compensated Hicksian demand functions." As a result, several strong assumptions are incorporated into the

analysis: (1) preferences must be identical and homothetic; (2) the income effect of the good in question is near zero and the proportion of the budget spent on the good is small; (3) economic surpluses have a one-to-one distribution weight; (4) the competitive demand and supply price represent the actual value to the consumer and supplier respectively; and (5) the value of foreign exchange reflects the actual cost of foreign currency to a country. Further discussion is available in Haley and Dixit (1988).

Despite the theoretical concerns expressed above, consumer and producer surplus continue to be used in practice. Haley and Dixit (1988) cite two main reasons for this: (1) Marshallian measures of consumer and producer surplus can be obtained rather easily; and (2) under certain conditions, consumer surplus can approximate compensating and equivalent variations, the theoretically preferred measure of welfare. Corey, Gum, Martin, and Leigh (1981) also suggests the deviation between alternative welfare measures is small. Thus, consumer and producer surplus are appropriate estimators of welfare changes from export subsidies.

D. Export Subsidies

The welfare implications of export subsidies differ depending on the type of export subsidy program used. A general export subsidy scheme offers export subsidies to all importing countries which causes the price in the importing country to be

below the world price by the amount of the subsidy. A targeted export subsidy scheme offers subsidies to importing countries with relatively elastic import demand. Thus, targeted export subsidies are a form of price discrimination because they lower the effective price paid by targeted importers below the world price by the amount of the subsidy while non-targeted importers pay the world price for wheat (Paarlberg, Schmitz, and McCalla, 1986). Therefore, targeted export subsidies maximize exports by offering export subsidies to importing countries who are the most price responsive.

Export subsidies are interventions in the world wheat market by the country implementing the export subsidies. This causes changes in the welfare of groups of individuals such as consumers, producers, and taxpayers in both the country implementing the export subsidy and the countries participating in the world wheat market. Several studies have examined these welfare changes. Conventional wisdom suggests that general export subsidies are welfare reducing (Salathe and Langley, 1986; Paarlberg, 1984). In contrast, targeted export subsidies can increase the welfare of the exporting country under certain limiting conditions (Abbott, Paarlberg, and Sharples, 1987). Abbott, Paarlberg, and Sharples (1987) assume that other exporting nations do not retaliate, the targeted country is relatively price and income sensitive, and the exporting country uses small subsidies.

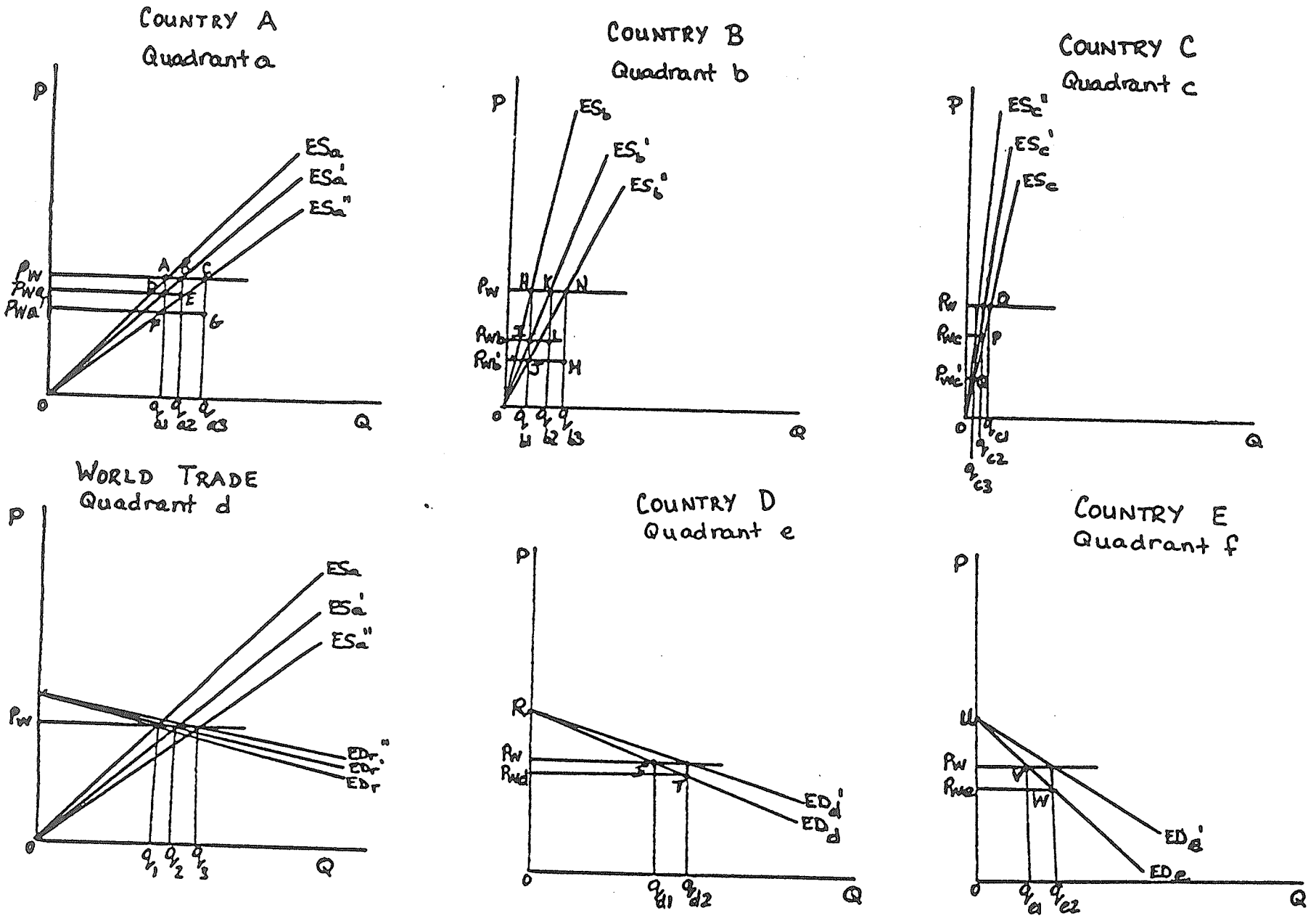
A partial equilibrium diagram can demonstrate the effects of targeted and

general export subsidies (Paarlberg, Schmitz, and McCalla, 1986; Bailey and Houck, 1990). In Figure 2.1[1], there are three exporters (A, B, and C) and two importers (D and E). Exporter A is the country which implements an export subsidy scheme for wheat. Under the assumption that the other exporting countries participating in the world wheat market will not match the subsidies used, country A believes that the export subsidy program will increase wheat exports. Exporter B is unwilling to give up its market share. Country B counteracts the effects of country A's export subsidy scheme with domestic subsidy programs that ensure producers a reasonable return and guarantee a high volume of wheat production. Exporter C attempts to retain some of its market share by matching the export price of country A, but does not implement a formal export subsidy program. Export supply curves for these three countries are given by ES_a, ES_b, and ES_c in Quadrants a, b, and c respectively. For simplicity, it is assumed that all world supply is represented by these three export supply curves.

In terms of importers, the world wheat market is made of two importing countries. Importer D has a relatively elastic import demand curve (ED_d) (Quadrant e) and is eligible for country A's export subsidies when both targeted and general export subsidy programs are used. Importer E has a relatively inelastic import demand curve (ED_e) (Quadrant f) and is not eligible for country A's export subsidies when a targeted export subsidy scheme is implemented. However, country E becomes

[1] For simplicity Figure 2.1 is drawn as an ad valorem export subsidy.

FIGURE 2.1
THE WELFARE EFFECTS OF EXPORT SUBSIDIES
WHEN THE WORLD WHEAT PRICE REMAINS CONSTANT



eligible for export subsidies when a general export subsidy program is used. It is assumed that all importing countries are represented by the import demand curves of these two countries. The net excess demand curve (ED_r) shown in Quadrant d is the sum of the excess demand curves of the importing nations D and E less the sum of the excess supply of exporting nations B and C (Anania, Bohman, and Carter, 1992). The world wheat price is determined by the intersection of the net world excess supply (ES_a) and the net world import demand (ED_r) in the world market (Quadrant d).

Suppose a targeted export bonus scheme is introduced by country A which provides export bonuses from government stocks in the form of generic certificates which can be redeemed for any commodity. This program targets wheat exports at the relatively elastic import demand of country D by applying an export subsidy to all sales made by country A to country D (assuming no arbitrage). This results in an "effective" import demand function (ED_d') (Quadrant e) which lies above ED_d by the amount of the generic subsidy (S_d) (Bailey and Houck, 1990). Note that ED_d' is a mechanical construct which does not actually shift the import demand outwards.

To determine the "effective" excess supply curve for exporter A, it is important to consider that when a government stock export bonus is used, generic certificates may be used to redeem any commodity. Thus, the "effective" excess supply curve

(ES_a') (Quadrant a) becomes (Brooks, Devadoss, and Meyers 1990):

$$ES_a' = ES_a + \sum_{i=1}^{n} Q_g * M * W \quad (1)$$

where Q_g is the quantity of government stocks required to fulfil the additional wheat imports, M is the market share of country A, and W is the proportion of generic certificates redeemed for wheat.

The use of equation (1) to determine the excess supply shifts implies that the shift in excess supply for country A is dependant on the percentage of generic certificates redeemed for wheat. Thus, the "effective" wheat subsidy may differ from the generic subsidy offered because generic certificates can be redeemed for any commodity. A simple example illustrates this point. If 100 percent of the generic certificates issues were redeemed for wheat using a generic subsidy of $50/tonne, the "effective" wheat subsidy would be $50/tonne. However, if only half of the generic certificates issued were redeemed for wheat, the "effective" wheat subsidy would be $25/tonne.

The response of other exporters is also necessary to determine the effects of export subsidies. Exporter B is assumed to use domestic agricultural programs such

that the "effective" excess supply curve of country B shifts to the right, similar to that of country A. Country C matches the export price used by country A in the targeted markets. Country C's average export price (P_{wc}) falls below the world price by:

$$P_{wc} = \sum_{i=1}^{n} k * S_i \qquad (2)$$

where k is the market share of country C in each of the targeted markets and S_i is the average wheat export subsidy used. The "effective" export supply curve (ES_c') (Quadrant c) to shift inwards from the excess supply curve by the value of S_c as resources used for wheat production shift to other uses.

Figure 2.1 shows that when a targeted export subsidy program is used, the quantities exported increase with the exception of exporter C. Total exports from country A increase from $0q_{a1}$ to $0q_{a2}$ (Quadrant a) with $q_{a1}q_{a2}$ being comprised of government stock export bonuses. Exporter B increases its exports from $0q_{b1}$ to $0q_{b2}$ (Quadrant b) and exports from exporter C decline from $0q_{c1}$ to $0q_{c2}$ (Quadrant c).

The quantity of imports increases in targeted countries. Country D's imports increase from $0q_{d1}$ to $0q_{d2}$ (Quadrant e). This increase in imports is supplied by countries A and B. However, the quantity of exports supplied by each country is dependent on the market shares of each exporter in the import market. For example, if country A and B have 40 and 50 percent of the market share in country D respect-

ively, they will export 44 and 56 percent of the additional exports respectively. Imports into non-targeted importers such as country E do not change because the world price remains constant when a mechanical shifts of import demand and excess supply are used.

Mechanical shifts in the excess supply and import demand curves also cause "effective" changes in export and import prices of wheat. The "effective" export prices fall when targeted export subsidies are used. The average export prices in countries A, B, and C fall from P_w to P_{wa} (Quadrant a), P_{wb} (Quadrant b), and P_{wc} (Quadrant c) respectively. The average import price of importer D falls from P_w to P_{wd} (Quadrant e) because the export subsidy lowers the importing price below the world wheat price by the subsidy value. The decline in the "effective" import price is determined by the subsidy offered and the market share of country D. For example, if country D imports a small portion of the total world wheat imports, the decline in the world wheat price and the subsidy offered is minimal. In contrast, if country D imports a large portion of the total world wheat imports, the world wheat price declines and the value of the subsidy offered increases. Therefore, the difference between P_w and the export or import price of each country is the effect of the subsidy and not an actual price decline.

Figure 2.1 also shows the effect of an evolution from a targeted to a general

export subsidy if country E, the relatively inelastic market, becomes eligible for country A's export subsidies. In the same fashion as country D, country E's "effective" excess demand curve shifts to ES_e' (Quadrant f). The "effective" excess supply curves of countries A and B shift to ES_a'' (Quadrant a) and ES_b'' (Quadrant b). Assuming country C continues to match the export price of country A, country C's "effective" excess supply curve shifts back to ES_c'' (Quadrant c). Thus, a new "effective" world excess demand curve (ED_r'') (Quadrant d) results.

The changes from a general export subsidy cause further "effective" price distortions because both importers D and E are now eligible for export subsidies. The import prices of countries D and E fall from P_w to P_{wd} (Quadrant e) and P_{we} (Quadrant f) respectively. The export prices of countries A, B, and C are driven down to P_{wa}' (Quadrant a), P_{wb}' (Quadrant b), and P_{wc}' (Quadrant c) respectively. Thus, the downward price pressure on the world wheat market increases causing the "effective" world wheat price to decline further and the export subsidy offered to increase.

The welfare implications of targeted and general export subsidies when the world price remains constant are shown in Figure 2.1 and Tables 2.1 and 2.2. As drawn in Figure 2.1, country A's producers do not gain welfare because the world

TABLE 2.1
THE WELFARE EFFECTS OF EXPORT SUBSIDIES
ON EXPORTING NATIONS

Welfare Changes	Exporter A	Exporter B	Exporter C
TARGETED EXPORT SUB-SIDY			
- Producer Surplus	-	HK0	$P_wP_{wc}PO$
- Taxpayer Cost	$q_{a1}q_{a2}BA$	$P_wP_{wb}LK$	-
- Bonus Revenue	$q_{a1}q_{a2}ED$	-	-
GENERAL EXPORT SUBSIDY			
- Producer Surplus	-	HN0	$P_wP_{wc}'QO$
- Taxpayer Cost	$q_{a1}q_{a3}CA$	$P_wP_{wb}'MN$	-
- Bonus Revenue	$q_{a1}q_{a3}GF$	-	-

- = no change

TABLE 2.2
THE WELFARE EFFECTS OF EXPORT SUBSIDIES
ON IMPORTING NATIONS

Welfare Changes	Importer D	Importer E
Targeted Export Subsidy		
- Consumer Surplus	$P_wP_{wd}TS$	-
General Export Subsidy		
- Consumer Surplus	$P_wP_{wd}TS$	$P_wP_{we}WV$

- = no change

wheat price does not change from "mechanical" shifts in excess supply and import demand and any additional exports from export subsidies are in the form of stocks. Consumers are not affected because the domestic price of wheat does not change. Government cost increases from area $q_{a1}q_{a2}BA$ with a targeted export subsidy to area $q_{a1}q_{a3}CA$ with a general export subsidy. The bonus revenue from sales under a targeted and general export subsidy scheme is area $q_{a1}q_{a2}ED$ and area $q_{a1}q_{a3}GF$ respectively.

Country B's change in producer surplus is represented by area HK0 and HN0 (Quadrant b) with targeted and general export subsidies respectively. Consumers are not affected because the domestic price of wheat remains constant. Country B remains competitive in the wheat market by paying direct subsidies from tax revenue to subsidize the cost of exports. This cost is reflected by area $P_wP_{wb}LK$ for a targeted export subsidy and area $P_wP_{wb}'MN$ for a general export subsidy.

Country C's change in producer surplus is represented by area $P_wP_{wc}PO$ when targeted export subsidies are used and area $P_wP_{wc}'QO$ when general export subsidies are used assuming the world wheat price remains constant. Consumers of the importing countries are also beneficiaries of export subsidies. Table 2.3 and Figure 2.1 show that when a targeted (or general) export subsidy scheme is implemented, importer D gains by area $P_wP_{wd}TS$. In the case of importer E, area $P_wP_{we}WV$ is gained when a general export subsidy scheme is used. Thus, importers receive

economic benefits from the use of export subsidies.

The analysis used above to examine the government cost of country A and B is substantially different. Thus, it is helpful to briefly compare the alternative methods of calculation of government cost for countries A and B. The subsidization of wheat exports by country A is equivalent to the additional wheat exported from the use of export subsidies times the world wheat price. This was previously shown in Figure 2.1 as area $q_{a1}q_{a2}BA$ and $q_{a1}q_{a3}CA$ for targeted and general export subsidies respectively. In contrast, the subsidization of wheat exports by country B is determined by examining the quantity of wheat exported times the subsidy offered on all wheat sales. This was also previously shown in Figure 2.1 as $P_wP_{wb}LK$ and $P_wP_{wb}'MN$ for targeted and general export subsidies respectively . This can lead to substantially different government costs for countries A and B depending on the quantity of wheat exported by each of the countries, the world wheat price, and the subsidy used by country B. For example, if country A exports substantially more wheat from export subsidies when the world wheat price is relatively high while country B exports a relatively small amount of wheat, the government cost incurred by country B could be relatively small. Thus, the size of government cost incurred by countries A and B is largely dependant on the circumstances in the world wheat market with regards to exports, the world wheat price, and the subsidies offered.

CHAPTER 3: THE METHODOLOGICAL APPROACH

To apply a mathematical representation of the theoretical analysis shown above, this study uses a simulation model with three alternative formulations. Each formulation differs by the functional form incorporated for the import demand and excess supply curves: (1) Formulation One uses inverse linear import demand and excess supply curves; (2) Formulation Two incorporates inverse semi-log import demand and excess supply curves; and (3) Formulation Three uses inverse reciprocal import demand and excess supply curves.

The baseline solutions in each of the formulations are calculated using a series of interlinking spreadsheets in Quattro Pro[2]. To solve for these solutions, four equations or values are simultaneously determined including: (1) the excess supply and import demand curves when export subsidies are not used, the "effective" excess supply and import demand curves when targeted export subsidies are used, and the "effective" excess supply and import demand curves when general export subsidies are implemented; (2) the quantity of wheat traded in the world wheat market; (3) the world wheat price[3]; and (4) the welfare changes from export subsidies. To determine the excess supply and import demand curves when export subsidies are not used,

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[2] Quattro Pro is a product of Borland International Inc., 1800 Green Hills Road, Scotts Valley, CA., copyright 1987, 1989, run on an IPC 386-40 System.

[3] The world wheat price refers to the average export price from a port before the export subsidy is applied.

importing and exporting countries are initially classified into categories. The average imports and exports from each of the countries, average world wheat price, and import demand and excess supply elasticities from previous studies (Duffy and Wohlgenant, 1991) are inserted into the price elasticity equation shown in equations 6, 11, 16, and 21 shown below. This action causes the simultaneous determination of the average world wheat price, quantity traded, and the intercepts of the import demand and excess supply equations to be determined.

As shown further below, when export subsidies (targeted or general) are used mechanical shifts occur in the excess supply and import demand equations. The difference between the excess supply and import demand curves without export subsidies and with export subsidies (targeted or general) is a shift in the excess supply of exporting countries who offer export subsidies or in the import demand of importers who receive export subsidies. Once the shifts are calculated, the excess supply and import demand equations when targeted or general export subsidies are used are determined. From this analysis, the quantity of wheat imported or exported from each of the countries and the "effective" export and import prices are calculated under the three export subsidy scenarios: (1) when export subsidies are not used; (2) when a targeted export subsidy scheme is implemented; and (3) when a general export subsidy program is used are calculated. Details of this procedure are provided in Appendix 1.

To calculate the welfare changes, integration calculates the area between the curves. Details of this procedure are provided below and in Appendix 1.

To analyse the uncertainty of several variables used in this formulation, sensitivity analysis is performed on the estimates of import demand elasticity, excess supply elasticity, the percentage of generic certificates redeemed for wheat, and the subsidy value (Babcock, Carter, and Schmitz, 1990). Sensitivity analysis is performed for two reasons: (1) the values of the percentage of generic certificates redeemed for wheat and the generic subsidy used vary from year to year; and (2) the value of export demand elasticity facing exporting countries is uncertain (Gardiner and Dixit, 1987). Issues relating to the measurement of the value of the export demand elasticities are numerous and are discussed in Abbott (1988). Further procedural issues are discussed below and in Appendix 1.

A. Classification of Importers and Exporters

Three exporters are represented in Figure 2.1. Country A is assumed to lead the market in terms of export subsidies. Country B is assumed to use domestic subsidy programs which encourage wheat production to counteract the subsidies used by country A. Country C matches the export price used by country A, but does not use a formal export subsidy program.

Importing countries are classified based on their eligibility to receive export subsidies under the EEP. Nation D (targeted) represents countries with relatively elastic import demand curves which are eligible for targeted export subsidies. Country E (non-targeted) aggregates the remaining importing countries which are eligible for export subsidies once a general export subsidy scheme is implemented.

B. Functional Form

The formulations of this study use several inverse functional forms including the linear, the semi-log, and reciprocal forms. These functional forms are often used in export demand literature (Chambers and Just, 1981; Brooks, Devadoss, and Meyers, 1990; Devadoss and Heady, 1984; Taylor and Talpaz, 1979; Johnson, 1981; Bailey and Houck, 1990; and Blandford, 1987). In addition, goodness-of-fit tests done in research often support the use of the semi-log functional form (Kling, 1989). The reciprocal functional form is also used because it is theoretically sound representing the theories of diminishing marginal utility and saturation adequately.

C. Parameters

To simulate the world wheat market, several of the parameters were taken from past studies done. Empirical estimates of the elasticity of export demand facing exporting countries in the world wheat market can differ greatly. This is consistent

with empirical estimated reviewed for the United States and the European Community (Gardiner and Dixit, 1987; Devadoss and Meyers, 1990; and Salathe and Langley, 1986) (Table 3.1). Gardiner and Dixit show the elasticity of export demand for United States wheat varying from -0.14 to -3.13 for short run elasticities and -0.23 to -6.72 for long run elasticities. Devadoss and Meyers reveal that the short run elasticity of export demand for United States wheat varies from -0.14 to -3.13. The review by Salathe and Langley express the export demand elasticity for wheat as ranging from -0.14 to -3.56.

Two other articles by Haley (1989) and Ahmadi-Esfahani (1989) estimate the elasticity of export demand for wheat facing the United States. Haley estimates the export demand elasticity for the United States is -5.18 while Ahmadi-Esfahani determines the elasticity of export demand facing North and Central America to range from -0.56 to -21.78 depending on the country. Evidently, no consensus exists for the empirical value of the elasticity of export demand for United States wheat.

For the European Community, few elasticity of export demand and excess supply elasticities exist. Kim (1989) estimates the excess supply and import demand elasticities of the European Community to be 2.2 and -0.2 respectively.

TABLE 3.1
A SUMMARY OF ELASTICITY OF
EXPORT DEMAND ESTIMATES

Reviewers or Authors	Long Run Elasticity	Short Run Elasticity
Gardiner and Dixit	-0.23 to -6.72	-0.14 to -3.13
Devadoss and Meyers	-	-0.14 to -3.13
Salathe and Langley	-	-0.14 to -3.56
Haley	-5.18	-
Ahmadi-Esfahani	-0.56 to -21.78	-

- = Not Given

To determine the values for sensitivity analysis, past literature is used (Duffy and Wohlgenant, 1991). The value of -2.0 is determined to be the value of the net import demand elasticity in the base model. A relatively more elastic and inelastic net import demand elasticity are used to indicate the sensitivity of the results. The values of -3.0 and -1.0 were chosen on the basis of past literature (Babcock, Carter, and Schmitz, 1990; Salathe and Langley, 1986; Devadoss and Meyers, 1990; and Gardiner and Dixit, 1988). In addition, the value of -1.0 is particularly important as a net import demand elasticity because this represents a fixed expenditure scenario. Conventional wisdom indicates that countries which receive food aid often operate within a fixed expenditure framework. Thus, by using the value of -1.0, this study shows the effects in the world wheat market if the importing countries operate under a fixed expenditure scenario.

The generic subsidy values of $26.60, $31.60, and $36.60 per tonne were also taken from the EEP. The 1985-1991 average generic EEP subsidy was $31.60 per tonne (Peter Szkraba, National Grains Bureau, February 11, 1992).

Other data including exporting prices and the average quantity of wheat exported from various countries are taken from the United States Department of Agriculture. The Canadian Wheat Board supplied the quantity of wheat imported for the importing countries. Importing prices are the weighted average of the exporting

prices.

(i) Excess Supply and Import Demand Equations

As discussed above, the excess supply and import demands under the three alternative subsidy scenarios: (1) when export subsidies (targeted or general) are not used; (2) when targeted export subsidies are implemented; and (3) when general export subsidies are used are calculated. Initially, the slopes and intercepts of each of the curves are calculated from the price elasticity equation. Several steps are taken to calculate the slopes of the import demand and excess supply curves from the price elasticity equation. These steps are shown below for the linear, semi-log, and reciprocal formulations:

Linear Formulation

$$P=\alpha+B*Q \tag{3}$$

$$\frac{dP}{dQ}=B \tag{4}$$

$$\frac{dQ}{dP} = \frac{1}{B} \tag{5}$$

$$E = \frac{dQ}{dP} * \frac{P}{Q} = \frac{1}{B} * \frac{P}{Q} \tag{6}$$

$$B = \frac{1}{E} * \frac{P}{Q} \tag{7}$$

Semi-log Formulation

$$P = \alpha + B * \ln(Q) \tag{8}$$

$$\frac{dP}{dQ} = \frac{B}{Q} \tag{9}$$

$$\frac{dQ}{dP} = \frac{Q}{B} \tag{10}$$

$$E=\frac{dQ}{dP}*\frac{P}{Q}=\frac{Q}{B}*\frac{P}{Q}=\frac{P}{B} \tag{11}$$

$$B=\frac{P}{E} \tag{12}$$

Reciprocal Formulation

$$P=\alpha+\frac{B}{Q} \tag{13}$$

$$\frac{dP}{dQ}=-\frac{B}{Q^2} \tag{14}$$

$$\frac{dQ}{dP}=-\frac{Q^2}{B} \tag{15}$$

$$E=\frac{dQ}{dP}*\frac{P}{Q}=-\frac{Q^2}{B}*\frac{P}{Q}=-\frac{Q*P}{B} \tag{16}$$

$$B=-\frac{(Q*P)}{E} \tag{17}$$

where α is the intercept of the excess supply or import demand equation, P is the average world wheat price, E is the elasticity of excess supply or import demand, B is the slope of the curve, and Q is the average quantity of wheat exported or imported by a nation.

The intercepts of the import demand and excess supply equations are solved by substituting the slopes, average prices, and average quantities into transformations of each formulation's functional form. The steps to determine the intercept of the excess demand (α_d) are:

Linear Formulation

$$P=\alpha_d-B*Q \tag{18}$$

$$\alpha_d=P+B*Q \tag{19}$$

Semi-log Formulation

$$P=\alpha_d-B*\ln(Q) \tag{20}$$

$$\alpha_d = P + B * \ln(Q) \tag{21}$$

Reciprocal Formulation

$$P = \alpha_d - (-B) * \frac{1}{Q} \tag{22}$$

$$\alpha_d = P + (-B) * \frac{1}{Q} \tag{23}$$

where P is the average price of wheat, Q is the average quantity imported or exported by a nation, and B is the slope of the excess supply or import demand equations.

The intercepts of excess supply (α_s) are determined by the following steps:

Linear Formulation

$$P = \alpha_s + B * Q \tag{24}$$

$$\alpha_s = P - B * Q \tag{25}$$

Semi-log Formulation

$$P = \alpha_s + B * \ln(Q) \tag{26}$$

$$\alpha_s = P - B * \ln(Q) \tag{27}$$

Reciprocal Formulation

$$P = \alpha_s + (-B) * \frac{1}{Q} \tag{28}$$

$$\alpha_s = P - (-B) * \frac{1}{Q} \tag{29}$$

where P is the average world wheat price, Q is the average quantity of wheat imported or exported, and B is the slope of the excess supply curve.

From these curves, the net import demand curve of the rest-of-the world is determined using a curve fitting process. First, the net import demand is calculated by summing the quantity demanded from countries D and E less the quantity supplied from exporters B and C. Second, ordinary least squares is used to calculate the intercepts and slopes of the net import demand curve. The world wheat price and quantity traded without export subsidies is then determined by equating the excess supply curve of country A and the net import demand curve of the rest-of-the-world. This process is used to incorporate kinks in the net import demand curve. The exact import demand curve could be used in this type of analysis, however, this would not allow this analysis to be used as a simulation model. Thus, to incorporate the changes in the net import demand curve from the kinks and the idea of a simulation model, a fitted curve is used as an approximation to the exact net import demand curve.

The "effective" shift in excess supply resulting from export subsidies (targeted or general) for country A (SH_a) is calculated by the formula:

$$SH_a = \sum_{i=1}^{n} k_a * S_i * G \tag{30}$$

where k_a is the market share of country A in each of the targeted markets, S_i is the generic subsidy offered in each of the i markets, and G is the percentage of generic

certificates redeemed for wheat.

The "effective" shift in excess supply of country B is considered equivalent to that of country A because country B has developed domestic agricultural programs to counteract the effects of export subsidies used by country A for wheat. Thus, country B's domestic subsidies cause a shift similar to that used by country A. Note that previous research has assumed that other exporters match the export price used by country A which would cause the excess supply curve of country B to shift to the left (Brooks, Devadoss, and Meyers 1990; Bailey and Houck 1990). However, country B's domestic programs cause the excess supply curve of country B to shift outwards when the world wheat price is below the historical wheat price.

Countries such as country C are assumed to match the export price of country A to retain their market share. Producers in country C receive a lower price for wheat causing a downward movement along their excess supply curve. This movement is calculated by having the excess supply curve of country C shift back by:

$$SH_c = S_i * k \tag{31}$$

where SH_c is the shift of country C, S_i is the average subsidy used in each of the targeted markets, and k_c is the market share of country C in the targeted markets.

To determine the "effective" excess supply curve when targeted or general export subsidies are implemented, the shift in the excess supply curve is subtracted from the intercept when export subsidies are not used. For example, if the value of the intercept when export subsidies is not used is 10 and the shift in the excess supply curve is 2, the intercept when export subsidies are used is 10 minus 2 is 8.

For the importing countries, the shift in excess demand will be equal to the generic subsidy offered to that particular country. Thus, the "effective" import demand curve for the each of the importing countries when export subsidies (targeted or general) are used is determined by adding the value of the subsidy to the intercept of the import demand curve when export subsidies are not offered.

Calculation of the world wheat price and quantity traded when export subsidies are implemented (targeted or general) is done by equating the "effective" excess supply curve of country A and the "effective" net import demand curve of the rest-of-the-world (summed in the same manner as above) when export subsidies (targeted or general) are used.

(ii) Welfare Calculations

Welfare calculations are completed with the use of integration or geometrical areas. Producer and consumer surplus are calculated by integrating the functional forms and substituting in the quantities imported or exported under the three alternative export subsidy scenarios. The government cost and bonus revenue of the linear, semi-log, and reciprocal formulations are calculated using geometrical areas. From this, the welfare changes from targeted and general export subsidies are determined. Further details of this procedure are outlined in Appendix 1.

CHAPTER 4: RESULTS

This section summarizes the empirical results of the base model and the sensitivity analysis scenarios. The sensitivity analysis scenarios alter the values used for the elasticity of excess supply, the elasticity of net import demand of the rest-of-the-world, the generic subsidy, and the percentage of generic certificates redeemed for wheat. This section also examines the changes in country B's wheat exports when export subsidy programs are implemented.

The welfare analysis used compares changes in producer surplus, consumer surplus, government cost, and bonus revenue when export subsidies are used relative to when export subsidies are not used. Thus, the use of export subsidies within different time periods is not examined. For example, comparisons between 1985/86 and 1990/91 are not made. In addition, when examining the changes in export subsidies, the effect of other domestic programs such as deficiency payments in the United States is assumed to be constant. As a result, the interpretation of the results is limited to include the effects of export subsidies only and does not take into consideration domestic programs not explicitly outlined in this analysis.

A. The Base Model

The variables used in the base model are shown in Table 4.1. The values used for the elasticity of excess supply are estimated by Kim (1989). The value of the elasticity of net import demand for the rest-of-the-world is determined by examining elasticity estimate reviews completed by Devadoss and Meyers (1990) and Gardiner and Dixit (1987). The subsidy value is the weighted average generic subsidy used by the EEP between 1985 and 1991. The percentage of wheat redeemed for all United States commodity programs is used as a proxy for the percentage of generic certificates redeemed for wheat.

i) Variation Between Imports and Exports

As was explained in the methodological section, regression analysis is not an exact measure of the net import demand curve, but rather a curve-fitting process which often causes slight differences between exports supplied by country A and imports demanded by the rest-of-the-world. Average differences between exports and imports in the base model range from 0 per cent in the linear formulation to 9.13 percent in the reciprocal formulation (Table 4.2). In this analysis, exports are generally less in magnitude than imports. Thus, by showing the variations as a percentage of exports, a larger difference occurs than if the variations were shown as a percentage of imports. Therefore, the variations between exports and imports

TABLE 4.1
VALUES OF BASE MODEL VARIABLES

Variable:	Value Used:
Export subsidy value	$31.60
Elasticity of excess supply of country A	1.2
Elasticity of excess supply of country B	0.2
Elasticity of excess supply of country C	0.2
Elasticity of import demand of country D	-1.6
Elasticity of import demand of country E	-0.1
Elasticity of net import demand	-2.0
Market share of country A	66.0%
Market share of country B	19.3%
Market share of country C	18.4%
Percentage of generic certificates redeemed for wheat	10.0%

TABLE 4.2
VARIATION BETWEEN EXPORTS AND IMPORTS

	Functional form		
Variation between exports and imports as a percentage of exports (1)	Linear	Semi-log	Reciprocal
Without export subsidies	0.00	7.02	5.17
Targeted export subsidies	0.00	3.53	10.31
General export subsidies	0.00	3.67	11.93
Average	0.00	4.74	9.13

(1) Absolute value.

shown are conservative.

ii) World Wheat Price

The world wheat price is determined by equating the equations for quantity supplied from country A to quantity demanded for the rest-of-the-world. In this analysis, the world wheat price does not change when export subsidies are introduced because the shifts in the excess supply and import demand curves are mechanical. Here, the world wheat price represents the market clearing price when commercial trade (not surplus stocks) is put onto the world wheat market. Thus, the world wheat price for the linear, semi-log, and reciprocal formulations are $131.38, $128.45, and $129.25 per tonne respectively (Table 4.3).

In recent years, however, the world wheat price has declined from a high of approximately $161 per tonne in 1980 to a low of approximately $123 per tonne in 1987[4]. This phenomena is explained by the "effective" world wheat price which is the average export price when exporting subsidies are used. Thus, the "effective" world wheat price represents the market clearing price when both commercial trade and surplus stocks are put onto the market. The "effective" world wheat price for targeted export subsidies is $128.10, $125.31, and $125.65 for the linear, semi-log, and reciprocal formulations respectively (Table 4.4). The "effective" world wheat price for

[4] The world wheat price is considered to be the weighted average of export prices.

TABLE 4.3
WORLD WHEAT PRICE, Dollars per Tonne

	Functional form		
	Linear	Semi-log	Reciprocal
World Wheat Price	131.38	128.45	129.25

TABLE 4.4
AVERAGE "EFFECTIVE" WORLD WHEAT PRICE
Dollars per Tonne

Export price	Functional form		
	Linear	Semi-log	Reciprocal
Targeted export subsidies	128.10	125.31	125.65
General export subsidies	116.81	113.96	114.21

general export subsidies is $116.81, $113.96, and $114.21 per tonne for the linear, semi-log, and reciprocal formulations respectively. Thus, the "effective" world wheat prices pattern the decline in the world wheat price seen in the world wheat market. However, factors other than export subsidies may also have contributed to this decline.

iii) Quantity of Wheat Traded

The quantity of wheat traded for the world wheat market is calculated by equating the excess supply of country A to the net import demand of the rest-of-the-world. This value represents the quantity of wheat traded in the world wheat market whether export subsidies are used or not because the shifts in the excess supply and import demand curves are mechanical. The quantity of wheat traded in the world wheat market is 53.74, 52.39, and 52.81 million tonnes for the linear, semi-log, and reciprocal formulations respectively (Table 4.5).

The theoretical prices and quantities traded shown in this model (Tables 4.3 and 4.5) underestimate the actual prices and quantities traded in the world wheat market. Assuming the world wheat price can be approximated by a weighted average of export prices, the average world wheat price since 1985 has been approximately $154 per tonne. Thus, all formulations underestimate the world wheat price. However, the "effective" world wheat price may show a closer approximation to the

TABLE 4.5
QUANTITY TRADED IN THE WORLD WHEAT MARKET
Millions of Tonnes

	Functional form		
	Linear	Semi-log	Reciprocal
Quantity of wheat traded	53.74	52.39	52.81

world wheat price when stocks are supplied to the market. Exports from major wheat exporters have averaged approximately 88.1 million tonnes of wheat annually. Again, the model underestimates the volume of wheat traded. The linear formulation is highest with approximately 53.74 million tonnes of wheat traded annually.

iv) Quantities Imported and Exported

In addition to the quantity traded in the world wheat market and the world wheat price, the model also determines the quantity of wheat imported and exported from the various countries. These are shown in Tables 4.6 to 4.8.

Export subsidies cause exports of wheat from countries A and B to increase (Tables 4.6 to 4.8). For example, as shown by the linear formulation (Table 4.6), exports from country A increase from 53.74 million tonnes without export subsidies to 59.00 and 64.25 million tonnes with targeted and general export subsidies respectively. Similar increases occur for country B as exports increase from 17.50 million tonnes without export subsidies to 17.75 and 18.00 million tonnes with targeted and general export subsidies respectively.

Exports from country C decline as export subsidies are implemented by country A (Tables 4.6 to 4.8). Country C export approximately 17.50 million tonnes when export subsidies are not used, 17.36 million tonnes when targeted export

TABLE 4.6
QUANTITIES IMPORTED AND EXPORTED IN THE WORLD WHEAT MARKET, Linear Formulation, Millions of Tonnes

Region	Quantity exported or imported		
	Without export subsidies	With targeted export subsidies	With general export subsidies
Country A	53.74	59.00	64.25
Country B	17.50	17.75	18.00
Country C	17.50	17.36	17.23
Country D	59.87	81.45	81.45
Country E	28.86	28.86	29.54

TABLE 4.7
QUANTITIES IMPORTED AND EXPORTED IN THE WORLD WHEAT MARKET, Semi-Log Formulation, Millions of Tonnes

Region	Quantity exported or imported		
	Without export subsidies	With targeted export subsidies	With general export subsidies
Country A	52.38	58.09	64.42
Country B	17.45	17.69	17.93
Country C	17.43	17.30	17.16
Country D	62.02	90.11	90.11
Country E	28.92	28.92	29.61

TABLE 4.8
QUANTITIES IMPORTED AND EXPORTED IN THE WORLD WHEAT MARKET, Reciprocal Formulation, Millions of Tonnes

Region	Quantity exported or imported		
	Without export subsidies	With targeted export subsidies	With general export subsidies
Country A	52.81	59.17	67.26
Country B	17.48	17.71	17.95
Country C	17.45	17.32	17.18
Country D	61.56	102.30	102.30
Country E	28.90	28.90	29.60

subsidies are implemented, and 17.23 million tonnes when general export subsidies are used. This result occurs because the "effective" excess supply curve of country C shifts left when export subsidies are offered by other exporting countries.

For importing countries, increased imports are dependant on a subsidy being offered (Tables 4.6 to 4.8). Countries eligible for export subsidies increase the quantity of wheat imported when export subsidies are used. This is shown in the semi-log formulation (Table 4.7) as country D increases their wheat imports from 62.02 million tonnes when export subsidies are not offered to 90.11 million tonnes when targeted and general export subsidies are implemented. Targeted importers, such as country D, do not further increase the quantity of wheat imported when general export subsidies are implemented because they receive the same export subsidy for both targeted and general export subsidies. For country E, non-targeted importers, the quantity of wheat imported remains constant when targeted export subsidies are offered because the world wheat price does not change. When general export subsidies are used, however, the semi-log formulation suggests imports increase from 28.92 million tonnes without export subsidies to 29.61 million tonnes with general export subsidies.

v) Welfare Changes

The sign attached to the change in producer surplus varies in each of the

exporting countries (Table 4.9). The change in producer surplus of country A is 0 for all formulations. This result occurs because the additional exports from the use of export subsidies are in the form of stocks. The change in country B's producer surplus is positive at approximately $29.29 million tonnes for targeted export subsidies and approximately $58.93 million for general export subsidies. This result occurs because country B exports a higher volume of wheat when export subsidies are used. For country C, the change in producer surplus is negative, averaging losses of $16.05 and $32.17 million tonnes for targeted and general export subsidies respectively. This occurs because when export subsidies are used, the excess supply curve of country C shifts back, causing exports to decline.

The base model also shows that the change in producer surplus from export subsidies is generally dependant on the functional form used with the exception of country A (Table 4.9). For example, when a targeted export subsidy is implemented, country B's producer surplus change ranges from approximately $26.22 (reciprocal) to $32.92 million (linear). When general export subsidies are used, the change in producer surplus varies from $53.10 (reciprocal) to $65.83 million (linear). The change in producer surplus for country C ranges from losses of approximately $14.47 (reciprocal) to $17.81 million (linear) and $29.28 (reciprocal) to $35.67 million (linear) for targeted and general export subsidy schemes respectively. For country A, the change in producer surplus is constant at 0 for all three formulations. This result occurs because in the additional wheat exported from the use of export subsidies in

TABLE 4.9
CHANGES IN PRODUCER SURPLUS WHEN EXPORT SUBSIDIES ARE USED, Millions Of Dollars

	Functional form		
Changes in producer surplus	Linear	Semi-log	Reciprocal
TARGETED EXPORT SUBSIDIES			
Country A	0.00	0.00	0.00
Country B	32.92	28.72	26.22
Country C	-17.81	-15.87	-14.47
GENERAL EXPORT SUBSIDIES			
Country A	0.00	0.00	0.00
Country B	65.83	57.85	53.10
Country C	-35.62	-31.62	-29.28

country A is in the form of stocks. Changes in consumer surplus for country D is positive at $2,329.97 million for both targeted and general export subsidy schemes (Table 4.10). The change in consumer surplus for country D is similar for both targeted and general export subsidy schemes. This occurs because targeted importers do not incur further subsidies from the use of a general export subsidy program. The change in consumer surplus for country E is 0 for targeted export subsidies because these non-targeted importers continue to pay the world wheat price. When general export subsidies are offered, however, the changes in consumer surplus average approximately $923.89 million.

Calculation of consumer surplus is also dependant on the functional form used (Table 4.10). When a targeted or general export subsidy scheme is implemented, the change in the consumer surplus for country D ranges from approximately $2,232.90 (linear) to $2,480.97 million (reciprocal). The change in consumer surplus of country E remains constant at 0 for all formulations when targeted export subsidies are used. However, the change in consumer surplus ranges from approximately $922.61 (linear) to $924.73 million (semi-log) when general export subsidies are implemented. Thus, functional form does cause some changes in consumer surplus, but the differences are relatively small.

Changes in government cost for the countries A and B and the bonus revenue of country A are substantial (Table 4.11). The average government cost of country

TABLE 4.10
CHANGES IN CONSUMER SURPLUS WHEN EXPORT SUBSIDIES ARE USED, Millions Of Dollars

	Functional form		
Changes in consumer surplus	Linear	Semi-log	Reciprocal
TARGETED EXPORT SUBSIDIES			
Country D	2,232.90	2,276.05	2,480.97
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D	2,232.90	2,376.05	2,480.97
Country E	922.61	924.73	924.32

TABLE 4.11
CHANGES IN GOVERNMENT COST AND BONUS REVENUE OF COUNTRIES A AND B, Millions Of Dollars

	Functional form		
Changes in government cost and bonus revenue	Linear	Semi-log	Reciprocal
TARGETED EXPORT SUBSIDIES			
Government cost of country A	690.46	733.00	821.52
Government cost of country B	374.19	372.96	373.47
Bonus revenue of country A	631.88	669.39	750.67
GENERAL EXPORT SUBSIDIES			
Government cost of country A	1,380.93	1,545.86	1,867.86
Government cost of country B	570.85	568.66	567.57
Bonus revenue of country A	1,146.58	1,277.55	1,545.66

A for targeted and general export subsidies is approximately $748.33 and $1,598.22 million respectively. The bonus revenue of country A which is the additional revenue received from the use of export subsidies by country A averages approximately $683.98 and $1,323.26 million for targeted and general export subsidies schemes respectively. The average cost of country B's domestic policies is $374.54 million for targeted export subsidies and $569.03 million for general export subsidies.

From the analysis above, the "effective" net cost of export subsidies to country A can be determined by subtracting the bonus revenue received from export subsidies from the government cost of export subsidies (Table 4.11). This figure is not meant to represent that "actual" cost of export subsidies to taxpayers of country A, but to represent a net loss to country A as a whole because of the bonus revenue from additional sales of wheat. This analysis shows that the net cost of export subsidies averages approximately $64.35 and $274.46 million for targeted and general export subsidies respectively. Thus, the net cost to country A for export subsidies is substantially less than the cost to country B discussed above.

The ranges of government cost and bonus revenue incurred by countries A and B also vary according to the functional form incorporated (Table 4.11). Targeted export subsidies cause the government cost of country A to range from approximately $690.46 (linear) to $821.52 million (reciprocal) while the bonus revenue received varies from $631.88 (linear) to $750.67 million (reciprocal). The government cost of

country B ranges from approximately $374.19 (linear) to $372.96 million (semi-log). When a general export subsidy program is implemented, the government cost of country A ranges from approximately $1,380.93 (linear) to $1,867.86 million (reciprocal). The bonus revenue received varies from $1,146.58 (linear) to $1,545.66 million (reciprocal). For general export subsidies, the government cost of country B ranges from $567.57 (reciprocal) to $570.85 million (linear). Thus, functional form does induce some relatively small changes in government cost and bonus revenue of countries A and B.

To summarize the welfare changes of the base model, it is helpful to examine the results in terms of net welfare changes for each of the country groupings (Table 4.12). For country A, the welfare losses average $64.35 and $274.95 million for targeted and general export subsidies respectively. The welfare losses of country B average approximately $344.26 million for targeted export subsidies and $508.60 million for general export subsidies. In contrast to country B, the welfare losses of country C are relatively small, averaging $16.05 million for targeted export subsidies and $32.17 million for general export subsidies. This result occurs because country C does not use export subsidies. Thus, they do not incur large government costs, similar to that of country B.

In comparison to exporting countries, the welfare gains for importing countries are relatively large (Table 4.12). Country D's welfare gains average $2,363.31 million

TABLE 4.12
NET WELFARE CHANGES, Millions of Dollars

	Functional form used in formulation		
Net welfare changes	Linear	Semi-log	Reciprocal
TARGETED EXPORT SUBSIDIES			
Country A	-58.59	-63.61	-70.85
Country B	-341.28	-344.24	-347.26
Country C	-17.81	-15.87	-14.47
Country D	2,232.90	2,376.05	2,480.97
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country A	-234.35	-268.31	-322.20
Country B	-502.83	-508.81	-514.17
Country C	-35.62	-31.62	-29.28
Country D	2,232.90	2,376.05	2,480.97
Country E	922.61	924.73	924.32

for both targeted and general export subsidies. For country E, non-targeted importers, the welfare gains average 0 for targeted export subsidies and $923.89 million for general export subsidies.

As with previous analyses of the base model, the welfare ranges between alternative functional forms differ slightly (Table 4.12). For country A, the welfare losses range from $58.59 to $70.85 million for targeted export subsidies and from $234.35 (linear) to $322.20 (reciprocal) million for general export subsidies. The welfare losses of country B range from approximately $341.28 (linear) to $347.26 (reciprocal) million and from $502.83 (linear) to $514.17 (reciprocal) million for targeted and general export subsidies respectively. The welfare losses of country C vary from $17.81 (linear) to $14.47 (reciprocal) million for targeted export subsidies and from $35.62 (linear) to $29.28 (reciprocal) million for general export subsidies.

The welfare ranges of importing countries are slightly larger than the welfare ranges of exporting countries (Table 4.12). For country D, the welfare gains of range from $2,232.90 (linear) to $2,480.97 million (reciprocal) for both targeted and general export subsidies. For country E welfare does not change for targeted export subsidies. For general export subsidies, however, the welfare gains range from approximately $922.61 (linear) to $924.73 million (semi-log).

The welfare ranges discussed above reveal that the changes in welfare from

using alternative functional forms is relatively small. Thus, the benefit of using alternative functional forms in the analysis is limited. This result was previously observed by Kling (1989) who suggested that when small price changes were used, the benefit of using alternative functional forms was relatively small.

B. Sensitivity Analysis

Several variables used in this analysis have values which are uncertain. Sensitivity analysis overcomes some of this uncertainty by evaluating the estimates of the excess supply elasticity of country A, the elasticity of net import demand of the rest-of-the-world, the generic subsidy value, and the percentage of generic certificates redeemed for wheat. Within this framework, changes in the world wheat price, the quantity traded, and welfare are discussed. Again note that the welfare change estimates are relative to the no-subsidy scenario. For clarity, the changes in welfare are shown using net welfare changes. A further breakdown is available in Appendix Two.

In the previous section, changes in price, quantity traded, and welfare were discussed relative to the functional form used. The results differed between functional forms slightly. Therefore, using any one functional form for the remainder of this discussion does not limit the analysis. Thus, the remainder of this analysis is discussed using the linear formulation. The welfare changes of all formulations are shown in

detail in Appendix 2.

To avoid confusion in this chapter, a summary table (Table 4.13) has been devised which describes the direction of trends in the world wheat price, the quantity traded, and net welfare as the variables used in the sensitivity analysis scenarios change. However, no detailed discussion of the results occurs as further explanation of these changes will be provided later in the chapter.

Sensitivity analysis of the elasticity of excess supply of country A reveals that the world wheat price declines and the quantity of wheat traded increases as the excess supply elasticity of country A becomes relatively more elastic (Table 4.13). This result occurs because the excess supply curve of country A shifts out, rotating clockwise as the excess supply elasticity increases relatively. The net welfare losses of country A increase because of increasing government cost associated with offering export subsidies. For countries B and C, the net welfare losses decline slightly because of reduced exports and a declining world wheat price. Countries D and E increase their welfare gains with the exception of country E when targeted export subsidies are offered. In this case, no welfare change occurs because the world wheat price does not change. When the net import demand elasticity of the rest-of-the-world becomes relatively more elastic, the world wheat price and the quantity of wheat traded increase. This result occurs because as the elasticity of the net import

TABLE 4.13
SUMMARY OF TRENDS IN NET WELFARE
FROM SENSITIVITY ANALYSIS

Variable used	Trends in price, quantity traded, and welfare as the variable used becomes relatively more elastic or increases in magnitude		
	Price	Quantity traded	Welfare changes
Elasticity of excess supply of country A	declines	increases	-welfare losses of country A increase -welfare losses of other exporters increase slightly -welfare gains of importing countries increase or remains constant
Elasticity of net import demand of the rest-of-the-world	increases	increases	-welfare losses of country A remain constant or decline slightly -welfare losses of other exporters increase slightly -welfare gains of importing countries increase or remain constant
Generic subsidy value	-	-	-welfare losses of all exporting countries increase -welfare gains of importing countries increase or remain constant
Percentage of generic certificates redeemed for wheat	-	-	-welfare losses of country A increase -welfare losses of country B decline -welfare losses of country C remain constant -welfare gains of importing countries remain constant

demand curve of the rest-of-the-world becomes relatively more elastic, the net import demand curve shifts outwards, counter-clockwise. In this scenario, the net welfare losses of country A remain constant or decline slightly. For other exporting countries, the welfare losses increase just slightly. Similar to the excess supply scenario, the net welfare gains of countries D and E increase or remain constant as the net import demand elasticity of the rest-of-the-world becomes relatively more elastic.

The sensitivity analysis of the generic subsidy value does not alter the world wheat price or the quantity traded because the shifts occurring as a result of the generic subsidy value are mechanical. The welfare losses of all exporting countries decline as the generic subsidy value increases relatively. This result occurs because of increases in government costs or declines in exports. For importing countries, their welfare gains generally increase. When targeted export subsidies are used, however, country E's welfare does not change because they continue to pay the world wheat price.

Similar to the generic subsidy value, the world wheat price and the quantity traded do not change when the percentage of generic certificates redeemed for wheat increases relatively. The welfare losses of country A increase as the percentage of generic certificates redeemed for wheat increases. This occurs because the government cost of export subsidies increases. The welfare losses of country B decline when the certificate redemption rate increases relatively because increases

in producer surplus are greater than increases in government cost. No welfare changes occur for countries C, D, and E because an increase in the redemption rate affects the mechanical shifts in excess supply of countries A and B, but does not affect the world wheat price.

The analysis above indicates that the world wheat price and quantity traded are affected by the elasticity of excess supply and net import demand. However, welfare changes occur in all scenarios. Further explanation of these results is provided below.

i) The Elasticity of Excess Supply

Three values are used for the excess supply elasticity of country A: 0.2, 1.2, and 2.2. The value of 1.2 is estimated by Kim (1989) for the United States who is generally thought to be one of the market leaders in the world wheat market. When the excess supply elasticity of country A varies, several trends in the world wheat price, quantity traded, and welfare are evident. Each of these changes and their implications will be discussed below.

a) World Wheat Price

The world wheat price declines as the excess supply elasticity of country A becomes relatively more elastic (Figure 4.1 and Table 4.14). The linear formulation shows the world wheat price declines from $134.45 per tonne with an excess supply elasticity of 0.2 to $131.38 and to $129.84 per tonne when the excess supply elasticity of country A increases to 1.2 and 2.2 respectively. Thus, the relatively more responsive excess supply is to price relatively, the lower the world wheat price.

b) Quantity of Wheat Traded

The quantity of wheat traded in the world wheat market increases as the excess supply elasticity of country A becomes relatively more elastic (Figure 4.2 and Table 4.15). In the linear formulation, the quantity of wheat traded in the world wheat market increases from approximately 51.44 million tonnes with an excess supply elasticity of 0.2 to approximately 53.74 and 54.89 million tonnes with excess supply elasticities of 1.2 and 2.2 respectively. Thus, the more relatively elastic the excess supply elasticity is, the greater quantity of wheat traded in the world wheat market.

FIGURE 4.1
PRICES IN THE WORLD WHEAT MARKET AS THE EXCESS SUPPLY ELASTICITY OF COUNTRY A VARIES, Linear Formulation

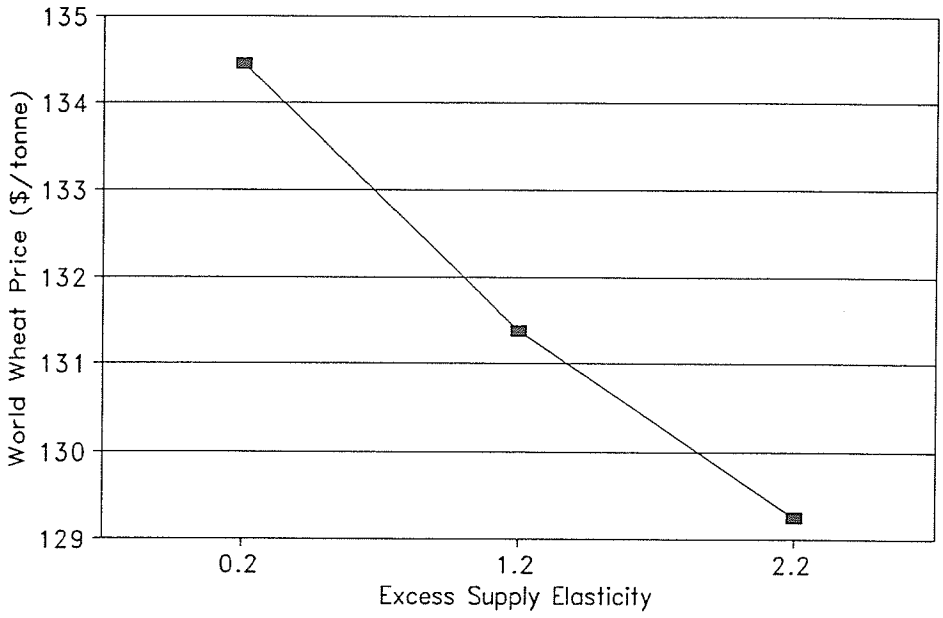

TABLE 4.14
PRICES IN THE WORLD WHEAT MARKET AS THE EXCESS SUPPLY ELASTICITY OF COUNTRY A VARIES, Linear Formulation
Dollars per Tonne

	Elasticity of excess supply of country A		
	0.2	1.2	2.2
World wheat price	134.45	131.38	129.84

FIGURE 4.2
QUANTITY TRADED IN THE WORLD WHEAT MARKET AS THE EXCESS SUPPLY ELASTICITY OF COUNTRY A VARIES, Linear Formulation

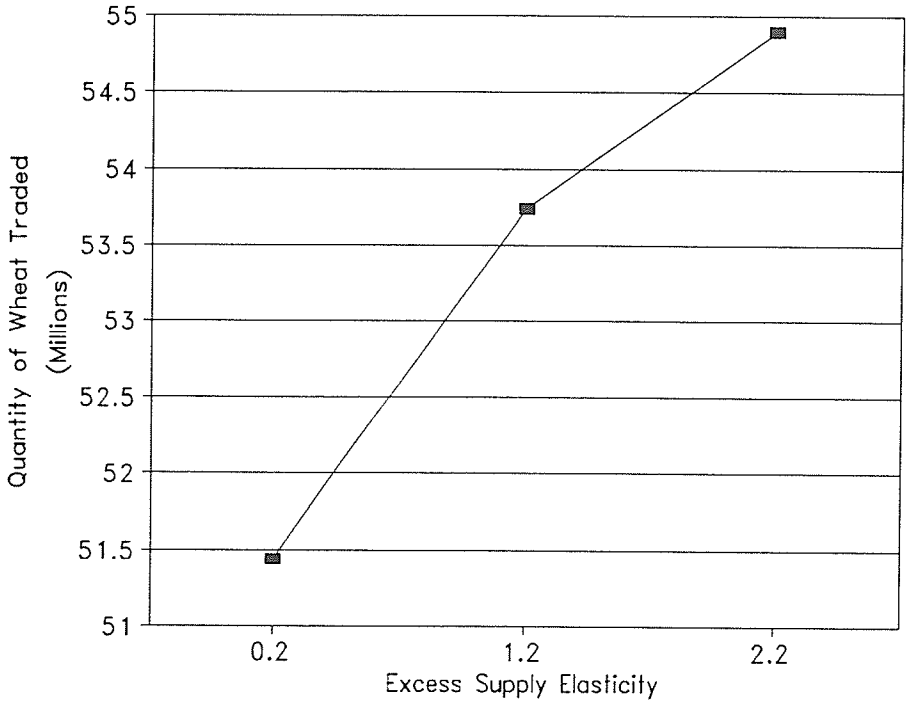

TABLE 4.15
QUANTITY TRADED IN THE WORLD WHEAT MARKET AS THE EXCESS SUPPLY ELASTICITY OF COUNTRY A VARIES
Linear Formulation, Millions of Tonnes

	Elasticity of excess supply of country A		
	0.2	1.2	2.2
Quantity traded in the world wheat market	51.44	53.74	54.89

c) Welfare Changes

With the analysis of the sensitivity of excess supply, several trends in net welfare also become evident (Table 4.16 and Tables A4.1a to A4.3b in Appendix 2). First, as the excess supply elasticity of country A becomes relatively more elastic, the net welfare losses from export subsidies in country A increase. In the linear formulation, net welfare losses of country A increase from approximately $8.14 to $109.04 million for targeted export subsidies and from losses of $32.55 to $436.15 million for general export subsidies as the excess supply elasticity of country A becomes relatively more elastic. This result occurs because country A increase their wheat exports as their excess supply elasticity increases. In doing so, they also increase their net cost[5] of export subsidies.

Country B's net welfare losses decline slightly as the excess supply elasticity of country A increase relatively. In the linear formulation (Table 4.16), the welfare losses of country B range from approximately $341.96 to $340.93 million for targeted export subsidies and from $503.47 to $502.51 million for general export subsidies as the excess supply elasticity of country A becomes relatively more elastic. This result occurs because exports from country B and the world wheat price decline as the excess supply elasticity of country A becomes relatively more elastic. As a result, both

[5] The net cost of export subsidies for the United States and European Community refers to the difference between government cost and bonus revenue.

TABLE 4.16
NET WELFARE CHANGES AS EXCESS SUPPLY ELASTICITY
OF COUNTRY A VARIES, Linear Formulation
Millions of Dollars

Net welfare changes	Elasticity of excess supply of country A		
TARGETED EXPORT SUBSIDIES	0.2	1.2	2.2
Country A	-8.14	-58.59	-109.04
Country B	-341.96	-341.28	-340.93
Country C	-18.23	-17.81	-17.60
Country D	2,166.62	2,232.90	2,266.11
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country A	-32.55	-234.35	-436.15
Country B	-503.47	-502.83	-502.51
Country C	-36.45	-35.62	-35.20
Country D	2,166.62	2,232.90	2,266.11
Country E	920.53	922.61	923.65

changes in producer surplus and government cost decline relatively. However, the relative decline in government cost is slightly more than the relative decline in producer surplus which causes the net welfare losses to decline slightly from export subsidies.

The welfare losses of country C decline as the excess supply elasticity of country A becomes relatively more elastic. In the linear formulation (Table 4.16), the net welfare losses of country C decline slightly from approximately $18.23 to $17.60 million for targeted export subsidies and from $36.45 to $35.20 million for general export subsidies. As the excess supply elasticity of country A becomes relatively more elastic, the world wheat price and exports from country C decline. Thus, the welfare losses of country C decline as the excess supply elasticity of country A becomes relatively more elastic.

The net welfare gains of targeted importing countries increase as the excess supply elasticity of country A becomes relatively more elastic (Table 4.16). The net welfare gains of targeted importers range from approximately $2,166.62 to $2,266.11 million for targeted export subsidies and general export subsidies. This result occurs because as the excess supply elasticity of country A increases, the quantity of wheat imported by targeted importers increases.

Non-targeted importers do not incur welfare changes when targeted export

subsidies are offered because they continue paying the world wheat price for imports (Table 4.16). When general export subsidies are offered, however, non-targeted importers gain welfare which ranges from $920.53 to $923.65 million for general export subsidies in the linear formulation. Thus, non-targeted importers gain substantial welfare benefits once they become eligible for export subsidies.

The results discussed above show that the policies used by exporting countries determine the increase or decrease in welfare losses as the excess supply elasticity of country A becomes relatively more elastic. The welfare losses increase for country A and decline just slightly for countries B and C as the excess supply elasticity of country A increases relatively. The welfare of importing countries D and E increases or does not change as the excess supply elasticity of country A becomes relatively more elastic. Again, however, these results do not consider domestic programs not explicitly modelled in this analysis.

ii) The Elasticity of Import Demand

The net import demand elasticity of the rest-of-the-world is also central to the effects that export subsidies have in the world wheat market. This analysis varies the elasticities of import demand of countries D and E. The values of net world import demand elasticities for the rest-of-the-world are 0.8, 1.4, and 2.0. The value of 2.0 is the average weighted net import demand elasticity used in the base model. The

values of 0.8 and 1.4 were used to evaluate welfare changes with a relatively inelastic net import demand. To accomplish this task, the values of 0.08 and 0.06 were used for the import demand elasticity of country E and the values of 1.07 and 0.55 were used for the import demand elasticity of country D.

a) World Wheat Price

As the net import demand elasticity of the rest-of-the-world becomes relatively more elastic, the world wheat price increases (Figures 4.3 and Table 4.17). In the linear formulation, the world wheat price increases from $129.53 per tonne with a net import demand elasticity of 0.8 to $130.66 and $131.38 per tonne with net import demand elasticities of 1.4 and 2.0 respectively. Thus, as the excess demand in the world wheat market becomes relatively more price responsive, the world wheat price increases.

b) Quantity of Wheat Traded

The quantity of wheat traded increases when the net import demand elasticity for the rest-of-the-world increases relatively (Figure 4.4 and Table 4.18). The linear formulation shows that the quantity of wheat traded increases from 52.87 million tonnes with an import demand elasticity of 0.8 to 53.40 and 53.74 million tonnes with an import demand elasticity of 1.4 and 2.0 respectively. Thus, as the excess demand

FIGURE 4.3
PRICES IN THE WORLD WHEAT MARKET AS THE NET IMPORT DEMAND ELASTICITY OF THE REST-OF-THE-WORLD VARIES
Linear Formulation, Dollars per Tonne

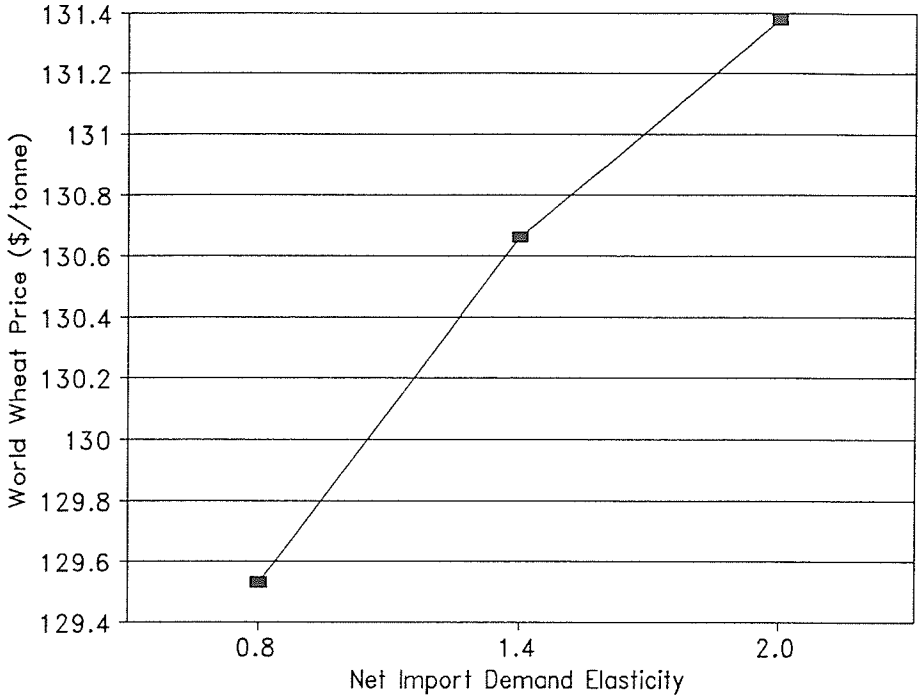

TABLE 4.17
PRICES IN THE WORLD WHEAT MARKET AS THE NET WORLD IMPORT DEMAND ELASTICITY OF THE REST-OF-THE-WORLD VARIES, Linear Formulation, Dollars per Tonne

	Elasticity of net import demand for the rest-of-the-world		
	0.8	1.4	2.0
Prices in the world wheat market	129.53	130.66	131.38

FIGURE 4.4
QUANTITY TRADED IN THE WORLD WHEAT MARKET AS THE NET IMPORT DEMAND ELASTICITY OF THE REST-OF-THE-WORLD VARIES, Linear Formulation, Millions of Dollars

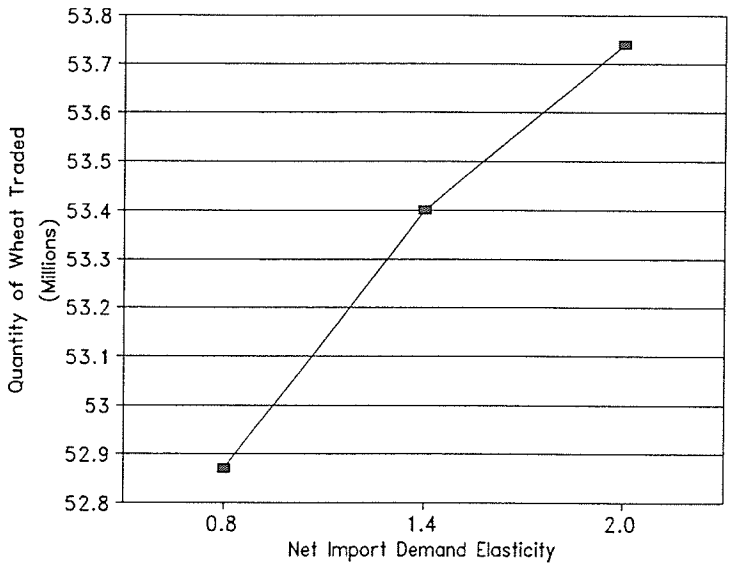

TABLE 4.18
QUANTITY TRADED IN THE WORLD WHEAT MARKET AS THE NET IMPORT DEMAND ELASTICITY OF THE REST-OF-THE-WORLD VARIES, Linear Formulation, Millions of Tonnes

	Elasticity of net import demand for the rest-of-the-world		
	0.8	1.4	2.0
Quantities traded in the world wheat market	52.87	53.40	53.74

of the rest-of-the-world becomes relatively more price responsive, the quantity traded in the world wheat market increases.

c) Welfare Changes

The net welfare losses of all exporting countries remain constant or increase when the net import demand elasticity of the rest-of-the-world increases relatively (Table 4.19 and Tables 4.4a to 4.6b in Appendix 2). The net welfare losses of country A remain constant at $58.59 million for targeted export subsidies and $234.35 million for general export subsidies as the net import demand elasticity of the rest-of-the-world becomes relatively more elastic. This result occurs because the changes in the export price and the world wheat price are small as the net import demand elasticity becomes relatively more elastic. Thus, the divergence between government cost and bonus revenue is extremely small, causing the net welfare losses of country A to remain constant. In the semi-log and reciprocal formulations, however, exports increase by a greater amount which causes the net welfare losses of country A to increases just slightly (shown in Appendix 2).

The net welfare losses of country B decline slightly as the net import demand elasticity of the rest-of-the-world increases relatively (Table 4.19). Country B's net

TABLE 4.19
NET WELFARE CHANGES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF-THE-WORLD VARIES
Linear Formulation, Millions of Dollars

Net welfare changes	Elasticity of net world import demand		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country A	-58.59	-58.59	-58.59
Country B	-340.87	-341.12	-341.28
Country C	-17.56	-17.71	-17.81
Country D	1,979.84	2,109.81	2,232.90
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country A	-234.35	-234.35	-234.35
Country B	-502.45	-502.68	-502.83
Country C	-35.12	-35.43	-35.62
Country D	1,979.84	2,109.81	2,232.90
Country E	918.24	920.44	922.61

welfare losses increase from $340.87 to $341.28 million for targeted export subsidies and from $502.45 to $502.83 million for general export subsidies as the net import demand elasticity of the rest-of-the-world increases relatively. This result occurs because the increases in government cost are larger than the increases in producer surplus, causing the net welfare loss of country B to increase.

As the net import demand elasticity of the rest-of-the-world increases relatively, the welfare losses of country C also increase slightly (Table 4.19). The losses increase from $17.56 to $17.81 million for targeted export subsidies and from $35.12 to $35.62 million for general export subsidies as the net import demand elasticity of the rest-of-the-world becomes relatively more elastic. This result occurs because the world wheat price increases as the net import demand elasticity increases relatively. Thus, producer surplus declines by a greater amount with a relatively elastic net import demand elasticity than with a relatively inelastic net import demand elasticity.

The net welfare gains of country D increases as the elasticity of net import demand of the rest-of-the-world becomes relatively more elastic (Table 4.19). In the linear formulation, the net welfare gains for country D ranges from approximately $1,979.84 to $2,232.90 million for both targeted and general export subsidies. This result occurs because as the net import demand elasticity increases, imports by targeted importing countries increase relatively.

For country E, no welfare changes occur when targeted export subsidies are used as the net import demand elasticity of the rest-of-the-world increases relatively (Table 4.19). This occurs because country E continues to pay the world wheat price. When general export subsidies are offered, however, welfare gains in the linear formulation vary from $918.24 to $922.61 million as the net import demand elasticity of the rest-of-the-world increases relatively. This result occurs because as with country D, country E imports a greater quantity of wheat when import demand is relatively elastic than when import demand is relatively inelastic.

The welfare change results discussed above reveal that the welfare losses of exporting countries remain constant or increase slightly as the net import demand elasticity of the rest-of-the-world becomes relatively more elastic. In contrast, the welfare of importing countries remain constant or increases as the net import demand elasticity of the rest-of-the-world increases. These results show that in terms of export subsidies only, a direct welfare transfer from exporting countries to importing countries occurs when export subsidies are used.

iii) The Generic Subsidy Value

To determine the sensitivity of the generic subsidy value, the values of $26.60, $31.60, and $36.60 per tonne were used. The value of $31.60 is the average weighted generic subsidy used by the EEP during the 1985-1991 crop years. The values of

$26.60 and $36.60 per tonne were used to evaluate a relatively higher and lower generic subsidy values.

a) World Wheat Price and Quantity Traded

Sensitivity analysis of the generic subsidy value is slightly different from previous sensitivity analysis scenarios in that changes in the subsidy value do not impact the world wheat price or the quantity traded of commercial wheat. This result occurs because the shifts in excess supply and import demand from the use of export subsidies are mechanical. However, this does not preclude stocks from being supplied to the world wheat market to fulfil additional demand from the use of export subsidies. For this reason, the world wheat price and quantity of commercially traded wheat remains constant at $131.38 per tonne and 53.74 million tonnes respectively.

b) Welfare Changes

When the value of export subsidies increases relatively, all exporting countries welfare losses increase (Table 4.20 and Tables A4.7a to A4.9b in Appendix 2). The welfare losses of country A increase from $41.51 to $78.59 million for targeted export subsidies and from $166.06 to $314.38 million for general export subsidies as the subsidy value increases relatively. Country B's welfare losses range from $286.57 to $396.25 million and from $421.16 to $585.30 million for targeted and general export

subsidies respectively as the generic subsidy value increases from a low of $26.60 per tonne to a high of $36.60 per tonne. For country C, the welfare losses range from approximately $14.99 to $20.63 million for targeted export subsidies and from $29.98 to $41.25 million for general export subsidies as the generic subsidy value increases relatively. These results occur in countries A and B because the government cost increases as the generic subsidy value increases. For country C, these results occur because the "effective" excess supply curve shifts further left when the generic subsidy value becomes relatively larger.

For country D, the welfare gains increase when the generic subsidy value increases relatively (Table 4.20). The welfare gains increase from approximately $1,834.19 to $2,648.68 million for targeted and general export subsidies. Again, note the welfare of country D does not increase further when general export subsidies are used because targeted importers do not incur further subsidization.

The welfare of country E does not change when targeted export subsidies are used because they continue to pay the world price for wheat. When general export subsidies are offered, however, their welfare gains increase from approximately $775.20 to $1,070.55 million as the generic subsidy value increases relatively.

The results above show that as the generic subsidy value increases relatively, the welfare losses of exporting countries increase, particularly when general export

TABLE 4.20
NET WELFARE CHANGES AS THE GENERIC SUBSIDY VALUE VARIES
Linear Formulation, Millions of Dollars

Net welfare changes	Subsidy value ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country A	-41.51	-58.59	-78.59
Country B	-286.57	-341.28	-396.28
Country C	-14.99	-17.81	-20.63
Country D	1,834.19	2,232.90	2,648.68
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country A	-166.06	-234.35	-314.38
Country B	-421.16	-502.83	-585.30
Country C	-29.98	-35.62	-41.25
Country D	1,834.19	2,232.90	2,648.68
Country E	775.20	922.61	1,070.55

subsidies are used. The welfare of importing countries increases or remain constant depending on their eligibility for export subsidies as the generic subsidy value increases relatively. Thus, as the generic subsidy value increases, the welfare transfer from exporting countries to importing countries increases.

4. Percentage of Generic Certificates Redeemed for Wheat

This section analyses the sensitivity of the percentage of generic certificates redeemed for wheat by incorporating estimates of 10, 20, and 30 percent as the certificate redemption rate. The estimate of 10 percent is used in the base model, but is considered low because the percentage of generic certificates redeemed for wheat each year is highly variable and is often above the 10 percent level. Thus, the estimates 20 and 30 percent were incorporated into the model on the assumption that the percentage of generic certificates redeemed for wheat could be substantially higher in any given year.

a) World Wheat Price and Quantity Traded

As with the sensitivity of the generic subsidy value, the percentage of generic certificates redeemed for wheat does not directly influence the world wheat price or the quantity of wheat traded. Thus, the world wheat price and quantity traded remain constant at $131.38 per tonne and 53.74 million tonnes traded in the linear

formulation.

b) Welfare Changes

As the percentage of generic certificates redeemed for wheat becomes relatively higher, the directional change of net welfare losses of exporting countries depends on the specific country's policies (Table 4.21). In country A, the net welfare losses increase from $58.59 to $83.49 million for targeted export subsidies and from $234.35 to $333.94 million for general export subsidies as the percentage of generic certificates redeemed for wheat increases relatively. The policy of using generic certificates redeemable for any commodity causes the net government cost[6] for wheat subsidies to increase when the certificate redemption rate increases relatively.

Country B's policies of using domestic subsidies to encourage production cause the net welfare losses of country B to decline slightly as the percentage of generic certificates redeemed for wheat increases relatively (Table 4.21). In the linear formulation, the welfare losses range from approximately $341.28 to $335.92 million for targeted export subsidies and from $502.83 to $493.15 million for general export subsidies as the percentage of generic certificates redeemed for wheat increases relatively. This result occurs because the shift in the "effective" excess supply curve

[6] Net government cost refers to the difference between government cost and bonus revenue.

TABLE 4.21
NET WELFARE CHANGES AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES,
Linear Formulation, Millions of Dollars

Net welfare changes	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country A	-58.59	-70.49	-83.49
Country B	-341.28	-338.60	-335.92
Country C	-17.81	-17.81	-17.81
Country D	2,232.90	2,232.90	2,232.90
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country A	-234.35	-281.95	-333.94
Country B	-502.83	-497.99	-493.15
Country C	-35.62	-35.62	-35.62
Country D	2,232.90	2,232.90	2,232.90
Country E	922.68	922.68	922.68

causes larger changes in producer surplus than in government cost as the percentage of generic certificates redeemed for wheat increases relatively.

The welfare losses of country C remain do not change when the percentage of generic certificates redeemed for wheat increases relatively (Table 4.21). For targeted export subsidies, the welfare losses of country C in the linear formulation remain constant at $17.81 million. For general export subsidies, the welfare losses remain constant at $35.62 million. This result occurs because increases in the certificate redemption rate do not affect the world wheat price.

The welfare of countries D and E does not change when the certificate redemption rate for wheat increases relatively (Table 4.21). For country D, the welfare gains remain constant at $2,232.90 million for both targeted and general export subsidies. For country E, the welfare changes remain constant at 0 or increase to $922.68 million for targeted and general export subsidies respectively as the percentage of generic certificates redeemed for wheat increases relatively. Again, this result occurs because changes in the percentage of generic certificates redeemed for wheat does not affect the world wheat price. Thus, importing countries welfare does not change.

The results discussed above show that the welfare of exporting countries depends on the policies used as the percentage of generic certificates redeemed for

wheat increases. For country A, the welfare losses increase as the certificate redemption rate increases relatively. The welfare losses of country B decline and the welfare losses of country C remain constant as the certificate redemption rate increases relatively. Importing countries, like country C, do not incur any welfare changes as the percentage of generic certificates redeemed for wheat increases because the world wheat price does not change. Thus, as the percentage of generic certificates increases, the welfare losses of country A increase while other exporters and importers benefit or their welfare does not change.In summary, the results indicate that variations in the excess supply elasticity of country A, the net import demand elasticity of the rest-of-the-world, the generic subsidy value, and the percentage of generic certificates redeemed for wheat cause different welfare changes depending on the values used. However, it is clear that when the effects of other domestic programs are held constant, importing countries receive a direct welfare transfer from exporting countries when export subsidies are used. Thus, when analysing only the welfare effects export subsidies (and not the domestic consequences), their economic benefits in terms of welfare can be questioned.

Exports from Country B

To fully analyse the export policies of country B, it is also necessary to understand the sensitivity of exports. This section expands the use of sensitivity analysis to include country B exports. Similar to the sensitivity analysis section, this

section varies the excess supply elasticity of country A, the net import demand of the rest-of-the-world, the generic subsidy value, and the percentage of generic certificates redeemed for wheat. From this analysis, it is then possible to determine to what extent Canadian wheat exports are affected as these variables change. This analysis shows only the effects of only the linear formulation because changes in functional form do not affect the analysis greatly.

Three values for the excess supply elasticity of country A are used, 0.2, 1.2, and 2.2 (Figure 4.5 and Table 4.22). The results of the linear formulation indicate that as the excess supply elasticity of country A becomes relatively more elastic, the quantity of wheat exported by country B declines. This is shown using targeted export subsidies as the quantity of wheat exported declines from approximately 17.81 million tonnes using an elasticity of 0.2 to 17.75 and 17.71 million tonnes using elasticities of 1.2 and 2.2 respectively. This result occurs because as the excess supply elasticity of the rest-of-the-world becomes relatively more elastic, the world wheat price declines.

As the net import demand elasticity of the rest-of-the-world becomes relatively more elastic, the quantity of wheat exported by country B increases (Figure 4.6 and Table 4.23). When general export subsidies are used in the linear formulation, the quantity of wheat exported by country B increases from 17.95 million tonnes with a net import demand elasticity of 0.8 to 17.98 and 18.00 million tonnes with net import

FIGURE 4.5
COUNTRY B'S WHEAT EXPORTS AS THE EXCESS SUPPLY ELASTICITY OF COUNTRY A VARIES, Linear Formulation, Millions of Tonnes

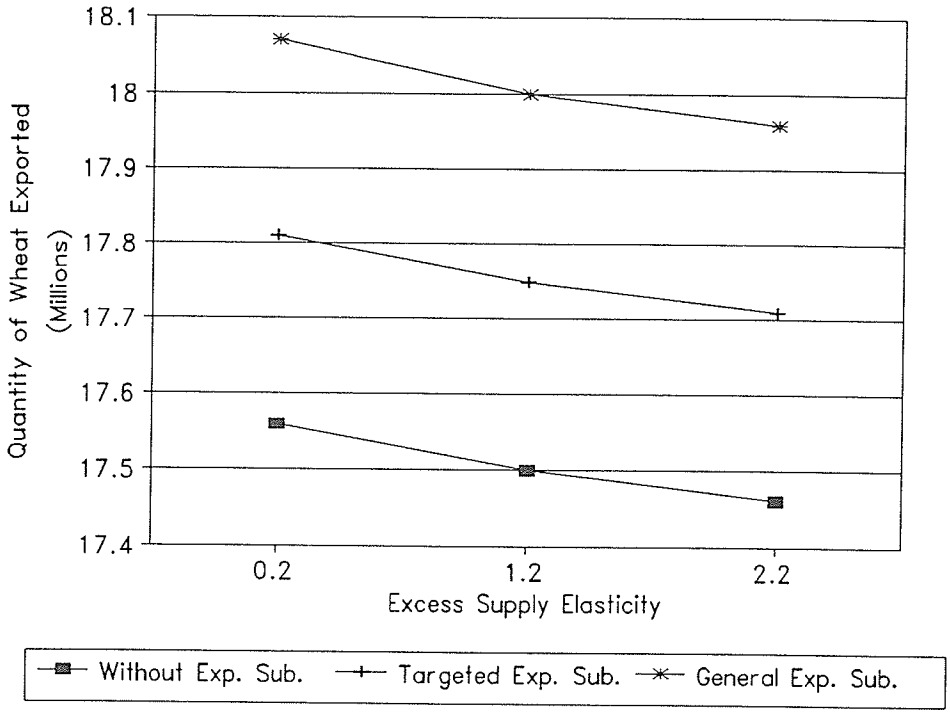

TABLE 4.22
COUNTRY B'S WHEAT EXPORTS AS THE EXCESS SUPPLY ELASTICITY OF COUNTRY A VARIES, Linear Formulation, Millions of Tonnes

	Elasticity of excess supply of country A		
Quantity exported	0.2	1.2	2.2
Without export subsidies	17.56	17.50	17.46
Targeted export subsidies	17.81	17.75	17.71
General export subsidies	18.07	18.00	17.96

FIGURE 4.6
COUNTRY B'S WHEAT EXPORTS AS THE NET IMPORT DEMAND ELASTICITY OF THE REST-OF-THE-WORLD VARIES
Linear Formulation, Millions of Tonnes

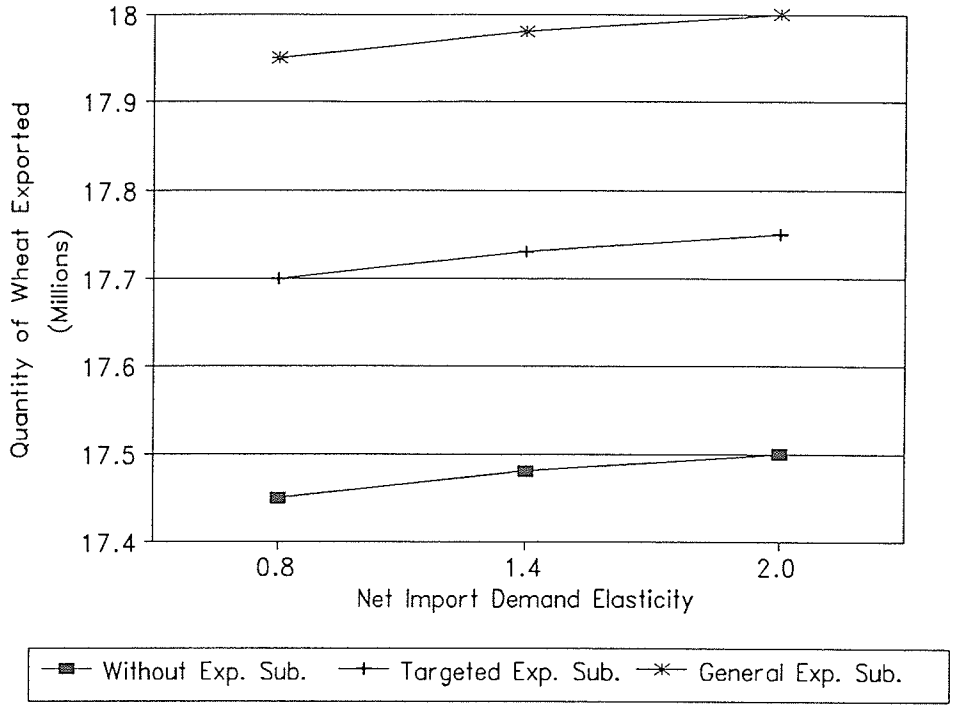

TABLE 4.23
COUNTRY B'S WHEAT EXPORTS AS THE NET IMPORT DEMAND ELASTICITY OF THE REST-OF-THE-WORLD VARIES,
Linear Formulation, Millions of Tonnes

	Net import demand elasticity of the rest-of-the-world		
Quantity exported	0.8	1.4	2.0
Without export subsidies	17.45	17.48	17.50
Targeted export subsidies	17.70	17.73	17.75
General export subsidies	17.95	17.98	18.00

demand elasticities of 1.4 and 2.0 respectively. This result occurs because as the net import demand elasticity of the rest-of-the-world increases, the world wheat price increases. Thus, as the net import demand elasticity becomes relatively more elastic, the quantity exported by country B increases.

As the generic subsidy value increases relatively, the quantity of wheat exported also increases (Figures 4.7 and Table 4.24). Using targeted export subsidies, country B's wheat exports increase from 17.71 million tonnes using a generic subsidy value of $26.60 per tonne to 17.75 and 17.79 million tonnes with generic subsidy values of $31.60 and $36.60 respectively. Thus, in terms of exports, country B benefits from the use of higher export subsidies.

When sensitivity analysis is used on the percentage of generic certificates redeemed for wheat, the results indicate that wheat exports increase slightly (Figure 4.8 and Table 4.25). The linear model shows that when targeted export subsidies are implemented, wheat exports from country B increase from 18.04 million tonnes using a 10 percent redemption rate to 18.06 and 18.07 million tonnes with 20 and 30 percent redemption rates respectively. Thus, country B's producers also benefit from increases in the percentage of generic certificates redeemed for wheat.

FIGURE 4.7
COUNTRY B'S WHEAT EXPORTS AS THE GENERIC SUBSIDY VALUE VARIES, Linear Formulation, Millions of Tonnes

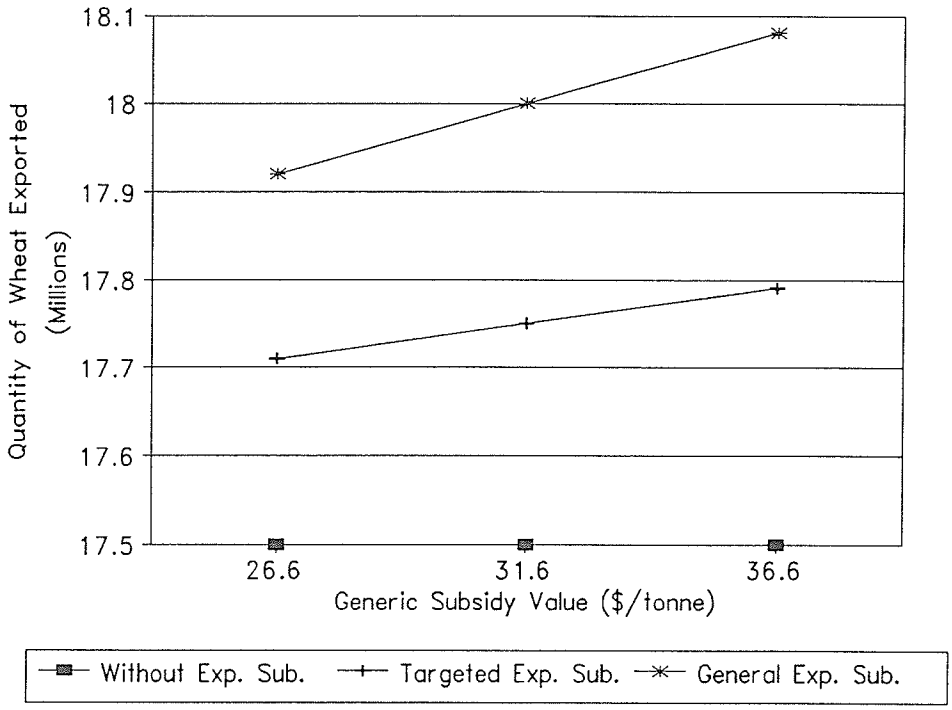

TABLE 4.24
COUNTRY B'S WHEAT EXPORTS AS THE GENERIC SUBSIDY VALUE VARIES, Linear Formulation, Millions of Tonnes

	Generic subsidy value ($/tonne)		
Quantity exported	26.60	31.60	36.60
Without export subsidies	17.50	17.71	17.92
Targeted export subsidies	17.50	17.75	18.00
General export subsidies	17.50	17.79	18.08

FIGURE 4.8
COUNTRY B'S WHEAT EXPORTS AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES
Linear Formulation, Millions of Tonnes

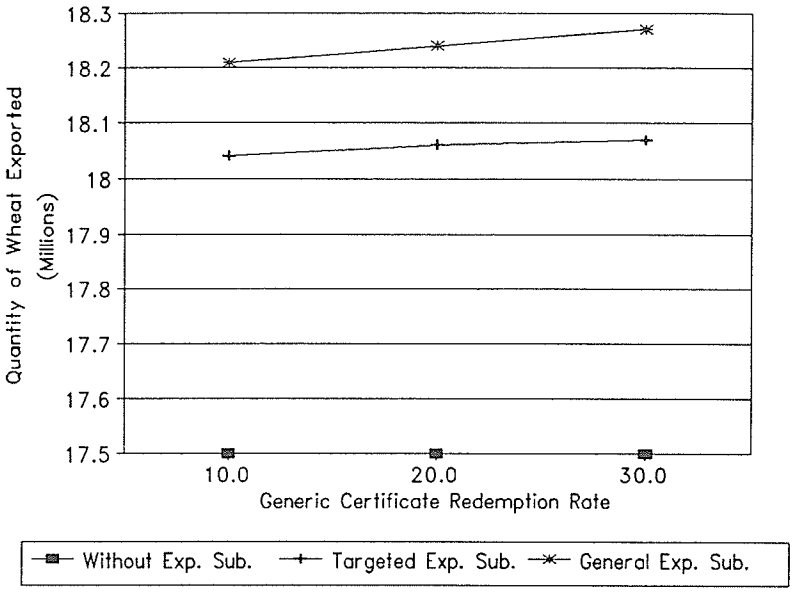

TABLE 4.25
COUNTRY B'S WHEAT EXPORTS AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES
Linear Formulation, Millions of Tonnes

	Percentage of generic certificates redeemed for wheat		
Quantity exported	10	20	30
Without export subsidies	17.50	17.50	17.50
Targeted export subsidies	17.75	17.77	17.79
General export subsidies	18.00	18.04	18.09

The results provided in this analysis show that the quantity of wheat exported from country B declines relatively when the elasticity of excess supply of country A is relatively more elastic. However, country B's exports increase relatively when the net import demand elasticity of the rest-of-the-world becomes relatively more elastic, the more the generic subsidy used increases relatively, or the percentage of generic certificates redeemed for wheat increase relatively. Without analysing the effect of other domestic programs, the analysis in terms of exports suggests that the export subsidy policy followed by country A increases the quantity of wheat exported by country B.

Exports from the use of export subsidies cause additionality of approximately 1.4 and 2.9 percent for targeted and general export subsidies respectively. These results seem rather low. However, country B's additionality would not be as high as previous empirical studies have indicated for countries such as the United States and the European Community because the world wheat price does not change. It is likely that if greater analysis of domestic programs was taken into consideration, the additionality factor would incrase. Thus, given the type of analysis completed in this study, a relatively low additionality factor is acceptable.

CONCLUSION:

This study analyses the effects of export subsidies in the world wheat market using a simulation model. The simulation model uses a partial equilibrium analysis which incorporates alternative functional forms to replicate the excess supply and import demand curves. A base model is developed and sensitivity analysis is used to examine the sensitivity of the results. This chapter summarizes these results in terms of the world wheat price, the quantity traded, and welfare changes. This chapter also discusses the implications for the world wheat market and highlights areas of further research.

Prior to examining the results, however, there are several limitations to this analysis which must be examined. First, elasticities used for import demand and excess supply are taken from previous studies. Thus, different time periods and assumptions are used. However, the controversy over estimating elasticities in the world wheat market justify this method. It is also used by Duffy and Wohlgenant to examine the United States cotton industry (1990). Second, integration is used to determine the equations for import demand and excess supply. This method ignores the integration constant. Thus, some bias may be introduced. Third, this study uses a partial equilibrium analysis to analyse the world wheat market. Partial equilibrium analysis does not consider factors other than price. Thus, the changes in factors such as income are not considered. Finally, this study assumes that the effects of other

domestic subsidy programs not explicitly outlined in this analysis remain constant. Thus, the analysis discussed below reveals the effects of only export subsidies in the present context of the world wheat market.

A. Summary

The base model was run using three functional forms, three exporting regions, and two importing regions. The functional forms include the linear, semi-log, and reciprocal. The three exporting regions include: (1) country A which leads the market in terms of export subsidies; (2) country B which uses domestic subsidies to counteract the effects of country A; and (3) country C which matches the export price of country A. The two importing regions include: (1) country D which represents targeted importers; and (2) country E which represents non-targeted importers.

When export subsidies are incorporated into the base model, the world wheat price remains constant because the shifts in the excess supply and import demand curves are mechanical. However, the "effective" world wheat price which is the average, weighted export price when export subsidies are used declines when targeted and general export subsidies are used. This result occurs because the average "effective" export prices decline when export subsidies are used.

The quantity of wheat traded commercially also remains constant in the base

model. However, additional stocks are supplied to the market when export subsidies are used. Thus, the quantities imported and exported from countries A and B increases when export subsidies are used. The quantity of wheat exported from country C declines when export subsidies are used. This result occurs because country C do not use an explicit export subsidy program to maintain their market share.

Net welfare has four components producer surplus, consumer surplus, government cost, and bonus revenue. Producer surplus in country A does not change because producers in country A have previously received the benefit of the additional exports through domestic subsidization programs. Country B gains producer surplus because country B exports a larger quantity of wheat when export subsidies are used. Producer surplus in country C declines because their exports decline when export subsidies are used. Thus, the gains or losses in producer surplus are largely dependant on the policies used by each of the exporting countries.

Consumer surplus of country D increases when offered both targeted and general export subsidies. Consumer surplus of country E does not change when targeted export subsidies are used because the world wheat price does not change. When general export subsidies are implemented, however, consumer surplus of country E increases because non-targeted importers become eligible for export subsidies.

The net cost of export subsidies to country B was substantially more than the net cost[7] of export subsidies to country A. This result occurs because country A receive bonus revenue for the additional wheat exported while country B does not. Thus, the domestic programs used by country B ensure a large wheat production at the expense of a large government cost.

In summary, the net welfare changes show that all exporting countries lose welfare when export subsidies, both targeted and general, are used. These results are supported by conventional wisdom which says that targeted export subsidies can be welfare increasing, but are not necessarily and general export subsidies are always welfare reducing (Salathe and Langley, 1986; Paarlberg, 1984). The base model also indicated that the welfare losses to country B from export subsidies are substantially higher than any other exporting country, particularly than country C. This result occurs because country C do not incur the large government cost similar to country B.

The welfare changes determined in the base model also show that alternative functional forms cause slight differences in the welfare changes estimated. Thus, the benefit of using alternative functional forms is limited. This is supported by Kling's

[7] The net cost of export subsidies for the United States and the European Community is calculated by subtracting bonus revenue from government cost.

(1989) conclusion that with small price changes, using the appropriate functional form may not be as relevant as previously presumed.

Sensitivity analysis was used to determine the sensitivity of the elasticity of excess supply of country A, the elasticity of net import demand of the rest-of-the-world, the generic subsidy value, and the percentage of generic certificates redeemed for wheat. When the excess supply elasticity of country A becomes relatively more elastic, the excess supply curve shifts out, clockwise, causing the world wheat price to decline and the quantity of wheat traded commercially to increase. These results cause the net welfare losses of exporting countries to increase and the net welfare gains of country D and country E when general export subsidies are used to increase as the excess supply elasticity of country A increases relatively. Country E does not incur any welfare changes when targeted export subsidies are used because the world wheat price remains constant.

As the net import demand elasticity of the rest-of-the-world became relatively more elastic, the world wheat price and the quantity of wheat traded increases because the net import demand curve shifts out, counter-clockwise. This causes the net welfare losses of country A to remain constant or decline slightly as the net import demand elasticity becomes relatively more elastic. The welfare losses of other exporters increases slightly as the net import demand elasticity becomes relatively more elastic. The welfare gains of country D and country E when general export

subsidies are used increase as the import demand elasticity of the rest-of-the-world increases relatively.

When the generic subsidy value increases relatively, the world wheat price and the quantity of commercial wheat traded does not change although additional wheat may be supplied to the market in the form of stocks. This result occurs because the shifts in the excess supply and import demand curves are mechanical. In this scenario, the welfare losses of all exporting countries and the welfare gains of all importing countries increase as the generic subsidy value increases relatively. The exception to this is country E when targeted export subsidies are offered. In this case, the welfare of non-targeted importers does not change.

As with the generic subsidy value, the world wheat price and quantity of commercial wheat traded in the world wheat market does not change when the certificate redemption rate for wheat increases relatively. Again, this occurs because the shifts in the excess supply and import demand curves are mechanical. In this scenario, the welfare losses of country A increase relatively as the certificate redemption rate increases. Country B's welfare losses decline as the percentage of generic certificates redeemed for wheat increases relatively. The welfare losses of countries C, D, and E remain constant because changes in the certificate redemption rate do not affect the world wheat price.

Sensitivity analysis is also used to analyse the changes in country B's exports as the excess supply elasticity of country A, net import demand elasticity of the rest-of-the-world, the generic subsidy value, and the percentage of generic certificates redeemed for wheat increase relatively. When the excess supply elasticity of country A increases relatively, country B's exports decline. This result occurs because the world wheat price declines as the excess supply elasticity of country A becomes relatively more elastic. Country B's exports increase when the net import demand elasticity became relatively more elastic, the generic subsidy value increases relatively, or the percentage of generic certificates redeemed for wheat increases relatively. In the case of the net import demand elasticity of the rest-of-the-world, these results occur because the world wheat price increases as the net import demand elasticity becomes relatively more elastic. Thus, this analysis indicates that if the excess supply elasticity of country A is relatively inelastic, the net import demand elasticity of the rest-of-the-world is relatively elastic, the generic subsidy value is high, or the percentage of generic certificates redeemed for wheat is large, exports would increase from the use of export subsidies. Therefore, the policies used by country B may be reasonable, if the goal is to increase wheat exports from country B.

B. Implications for the World Wheat Market and Further Research

Since the export subsidies have been introduced, research involving the world wheat market has concentrated on the specific conjectural variation necessary to model exporting countries. Three main conjectures have been used: (1) other exporters did not respond to export subsidies (Abbott, Paarlberg, and Sharples 1987); (2) selected exporting countries have responded to export subsidies (Haley 1988; Bailey 1988, 1989); and (3) all exporters respond competitively to export subsidies (Brooks, Devadoss, and Meyers 1990; Bailey and Houck 1990). This study has also uses a scenario where exporting countries respond to export subsidies used by country A. However, this study assumes that all exporters do not necessarily respond in the same way. The results indicate that theoretically, the world wheat price remains constant although the "effective" world wheat price declines from the use of export subsidies. Given present market conditions, this leads to the conclusion that the conjectures used to explain the behaviour of exporting countries does not fully explain the recent market conditions in the world wheat market.

This phenomena may be explained by assuming importing countries as opposed to exporting countries have the market power in the world wheat market. This hypothesis was tested in a paper written by Carter and Schmitz (1979) using Japan and the European Community as the two major importers in the world wheat market. This study shows that it would be possible for importing countries to use an

optimal tariffs to control imports in the world wheat market. Since that paper was written, the European Community has become a major exporting nation in the world wheat market. This would likely enhance the ability of importers to use this or a similar strategy to maintain (or obtain) market power. In addition, the European Community and United States have been in a trade war over market share in recent years which would likely limit any market power exporting countries did have.

Paarlberg (1990) also points out that importing countries may be using strategic positioning when making grain purchases from the United States. He suggests three reasons for this: (1) importing nations do not purchase grain from the United States until the subsidies used and volume of grain available under the EEP are known; (2) the EEP has discriminated against a few reliable importers who were not made eligible for export subsidies such as Japan and Korea; and (3) foreign customers may import grain from the European Community to maintain their eligibility under the EEP for their normal grain purchases. These strategies may suggest that importing countries are maintaining market power by ensuring they receive the maximum subsidies possible.

This discussion leads to the conclusion that recent literature has not accounted for the conjectures of importers appropriately. Thus, to fully reflect the world wheat market, these conjectures must be taken into consideration when doing economic

analysis with regards to the world wheat market.

In addition to the conjecture issue, it should be noted that the use of export subsidies by country A is a sub-optimal strategy in terms of welfare. Country A is assumed to be a relatively large exporting country in the world wheat market and should theoretical implement an export tax to increase welfare. In addition, an export tax may be more politically acceptable with other exporting countries and domestic consumers and taxpayers.

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APPENDIX 1
EXPANDED METHODOLOGY

The steps taken to calculate the excess supply and import demand curves, world wheat price, and quantity traded commerically were shown in Chapter 3. This section describes how to calculate the "effective" world wheat price, quantities imported and exported, and the changes in welfare. The linear formulation is discussed below. However, the semi-log and reciprocal formulations would follow the same steps except that the natural logarithm of Q would replace Q for the semi-log formulation and 1/Q would replace Q in the reciprocal formulation.

A. Linear Formulation

Each of the formulations requires determining the "effective" world wheat prices and the quantities imported or exported from each country under the three alternative subsidy scenarios: (1) without export subsidies; (2) with targeted export subsidies; and (3) with general export subsidies. These are shown below.

(i) Quantities Imported and Exported

The quantity of wheat exported is determined using a transformations of the functional form. A generic form of the steps to determine the quantity exported is shown below for the linear formulation:

$$P=\alpha_s+B*Q \tag{32}$$

$$Q=\frac{(P-\alpha_s)}{B} \tag{33}$$

where P is the average world wheat price, Q is the average exports for the country, α_s is the intercept of the excess supply curve, and B is the slope of the excess supply curve.

Each of the quantity exported equations shown below follow a similar procedure:

$$Q_{j1}=\frac{(P_w-\alpha_s)}{B} \tag{34}$$

$$Q_{j2}=\frac{(P_w-\alpha_{st})}{B} \tag{35}$$

$$Q_{j3}=\frac{(P_w-\alpha_{sg})}{B} \tag{36}$$

where Q_{j1} is the quantity of wheat exported when export subsidies are not used; Q_{j2} is the quantity of wheat exported when targeted export subsidies are used; and Q_{j3} is the quantity of wheat exported when general export subsidies are used; P_w is the world wheat price; α_s, α_{st}, α_{sg} are the intercepts of the excess supply curve when export subsidies are not offered, when a targeted export subsidy scheme is used, and when a general export subsidy program is implemented respectively; and B is the slope of the excess supply curve.

The imports for countries D and E are determined using a similar procedure:

$$P=\alpha_d-B*Q \tag{37}$$

$$Q=\frac{(\alpha_d-P)}{B} \tag{38}$$

where P is the average world wheat price, Q is the average imports for the country, α is the intercept of the import demand curve, and B is the slope of the import demand curve.

Each of the quanity imported equations shown below follow a similar pattern:

$$Q_{i1}=\frac{(\alpha_d-P_w)}{B} \tag{39}$$

$$Q_{i2}=\frac{(\alpha_{dt}-P_w)}{B} \tag{40}$$

$$Q_{i3}=\frac{(\alpha_{dg}-P_w)}{B} \tag{41}$$

where Q_{i1} is the quantity of imported exported when export subsidies are not used; Q_{i2} is the quantity of wheat imported when targeted export subsidies are used; and Q_{i3} is the quantity of wheat imported when general export subsidies are used; P_w is the world wheat price; α_d, α_{dt}, α_{dg} are the intercepts of the import demand curve when export subsidies are not offered, when a targeted export subsidy scheme is used, and when a general export subsidy program is implemented respectively; and B is the slope of the excess supply curve.

(i) "Effective" Exporting and Importing Prices

The "effective" export price of countries A and B is calculated by substituting the quantity exported without export subsidies into the excess supply equations when

targeted or general export subsidies are used. The export price for country C is calculated by substituting the quantity exported when export subsidies (targeted or general) are used into the excess supply equation when export subsidies are not used. When a targeted export subsidy program is used, the export price (P_{wj}) for countries A and B and the export price for country C (P_{wc}) becomes:

$$P_{wj}=\alpha_{st}+B*Q_{j1} \tag{42}$$

$$P_{wc}=\alpha_{s}+B*Q_{c2} \tag{43}$$

α_s is the intercept of the excess supply curve when export subsidies are not used; α_{st} is the intercept of excess supply when targeted export subsidies are used; B is the slope of the excess supply curves; Q_{j1} is the quantity exported when export subsidies are not used; and Q_{c2} is the quantity exported by country C when targeted export subsidies are used.

For a general export subsidy, the exporting price (P_{wj}') for countries A and B and the export price for country C (P_{wc}') becomes:

$$P'_{wj}=\alpha_{sg}+B*Q_{j1} \tag{44}$$

$$P'_{wc}=\alpha_{s}+B*Q_{c3} \tag{45}$$

α_s is the intercept of the excess supply curve when export subsidies are not used; α_{sg} is the intercept of excess supply when general export subsidies are used; B is the slope of the excess supply curve; Q_{j1} is the quantity exported when export subsidies are not used; and Q_{c3} is the quantity exported by country C when general export subsidies are use.

To calculate the import price for importing countries, the quantity imported under the three alternative subsidy scenarios: (1) without export subsidies; (2) with targeted export subsidies; and (3) with general export subsidies is substituted into the import demand equation when export subsidies are not used. The "effective" import price of wheat when targeted export subsidies are used (P_{wi}) becomes:

$$P_{wi}=\alpha_{d}-B*Q_{i2} \tag{46}$$

respectively where α_d is the intercept of the import demand curve when export

subsidies are not used; and Q_{i2} is the quantity imported when targeted export subsidies are in effect.

For a general export subsidy, and the importing price (P_{wi}') for importing countries becomes:

$$P'_{wi}=\alpha_d-B*Q_{i3} \tag{47}$$

where α_d refers to the intercept of the import demand when export subsidies are not used; B refers to the slope of the "effective" import demand curve; Q_{i2} is the quantity imported when targeted export subsidies are implemented; and Q_{i2} refers to the quantity imported when general export subsidies are used.

(iii) Welfare Changes

Once the importing and exporting prices and the quantities imported and exported are calculated, the welfare changes are determined by integration. Changes in producer surplus is calculated using three steps: (1) The excess supply equation is integrated:

$$P=\alpha_s+B*Q \tag{48}$$

$$P=\alpha_s*Q+0.5*B*Q^2 \tag{49}$$

where α_s is the intercept of the excess supply curve; B is the slope of the excess supply equation; P is the average world wheat price; and Q is the average exports for the nation; (2) The equations for producer surplus are then developed by calculating producer surplus for when export subsidies are not used, when targeted export subsidies are implemented, and when general export subsidies are incorporated:

$$PS=P*Q_s-[(\alpha_s*Q_s+0.5*B*(Q_s^2)] \tag{50}$$

$$PS_t=P*Q_{st}-[\alpha_{st}*Q_{st}+0.5*B*Q_{st}^2)] \tag{51}$$

$$PS_g=P*Q_{sg}-[\alpha_{sg}*Q_{sg}+0.5*B*(Q_{sg}^2)] \tag{52}$$

where α_s refers to the intercept of the excess supply curve when export subsidies are

not used; α_{st} refers to the intercept of the excess supply curve when targeted export subsidies are used; α_{sg} is the intercept of the excess supply curve when general export subsidies are used; Q_s is the average exports from a nation when export subsidies are not used; Q_{st} is the average exports from a nation when targeted export subsidies are used; Q_{sg} is the average exports when general export subsidies are used; and P is the world wheat price when export subsidies are not used; Note, however, that using this method ignores the constant which is usually added to the end of the integration equation; and (3) Producer surplus without export subsidies is subtracted from producer surplus when targeted or general export subsidy schemes are used to determine the change in producer surplus.

Consumer surplus for importing countries is calculated in a manner similar to that of producer surplus: (1) the import demand equation is integrated:

$$P=\alpha_d - B*Q \tag{53}$$

$$P=\alpha_d * Q - 0.5*B*Q^2 \tag{54}$$

where α_d is the intercept of the import demand curve; B is the slope of the import demand equation; P is the average world wheat price; and Q is the average imports

for the nation; (2) The equations for consumer surplus are developed for the three subsidy scenarios, without export subsidies, with targeted export subsidies, and with general export subsidies:

$$CS=[\alpha_d * Q_d - 0.5 * B * Q_d^2] - P * Q_d \tag{55}$$

$$CS=[\alpha_{dt} * Q_{dt} - 0.5 * B * Q_{dt}^2] - P * Q_{dt} \tag{56}$$

$$CS=[\alpha_{dg} * Q_{dg} - 0.5 * B * Q_{dg}^2] - P * Q_{dg} \tag{57}$$

where α_d refers to the intercept of the import demand curve when export subsidies are not used; α_{dt} refers to the intercept of the import demand curve when targeted export subsidies are used; α_{dg} refers to the intercept of the import demand curve when general export subsidies are used; Q_d is the average imports from a nation when export subsidies are not used; Q_{dt} is the average imports from a nation when targeted export subsidies are used; Q_{dg} is the average imports from a nation when general export subsidies are used; P is the world wheat price when export subsidies are not used; and (3) The consumer surplus with export subsidies are not used is then subtracted from consumer surplus with targeted and general export subsidies to

determine the changes in consumer surplus. Note, however, that using this method ignores the constant.

Additional impacts on country A from export subsidies include the taxpayer cost of using export subsidies and the bonus revenue received from additional wheat sold. The bonus revenue using a targeted (BR_t) and general export subsidy (BR_g) is calculated by:

$$BR_t = P_{wa} * (Q_{a2} - Q_{a1}) \tag{58}$$

$$BR_g = P'_{wa} * (Q_{a3} - Q_{a1}) \tag{59}$$

where P_{wa} and P_{wa}' refer to the export prices of country A with targeted and general export subsidies respectively; the difference between Q_{a2} and Q_{a1} is the additional wheat exports resulting from a targeted export subsidy; and the difference between Q_{a3} and Q_{a1} is the additional wheat exported because of a general export subsidy.

The government cost of targeted and general export subsidies for country A is calculated from the wheat price before export subsidies were used and the additional wheat exports resulting from the use of export subsidies. Thus, the cost of

targeted (GC_t) and general export subsidies (GC_g) is calculated by:

$$GC_t = P_w * (Q_{a2} - Q_{a1}) \tag{60}$$

$$GC_g = P_w * (Q_{a3} - Q_{a1}) \tag{61}$$

where P_w is the world wheat price before export subsidies are used; Q_{j2} is the quantity of wheat exported when targeted export subsidies; Q_{j3} is the quantity of wheat exported when a general export subsidy scheme is used.

The government cost of country B's export subsidies differ from those of country A because country B is only able to maintain its market share with the use of taxpayers money and receives no bonus revenue from additional wheat sales. Thus, the calculations for the government cost of export subsidies is based solely on the additional wheat exported. The calculations for taxpayer cost of targeted (GC_t) and general (GC_g) export subsidies are:

$$GC_t = S_{dt} * M_{dt} * Q_t + S_{et} * M_{et} * Q_t \tag{62}$$

$$GC_t = S_{dg} * M_{dg} * Q_g + S_{eg} * M_{eg} * Q_g \quad (63)$$

where S_{dt} and S_{et} are the subsidies used in markets d and e when targeted export subsidies are used; M_{dt} and M_{dg} are the market share of country D when targeted and general export subsidies are used respectively; M_{et} and M_{eg} are the market share of country e when targeted and general export subsidise are implemented respectively; and Q_t and Q_g are the quantity of wheat exported by the nation when targeted and general export subsidies are used.

APPENDIX 2

WELFARE CHANGE TABLES

TABLE A4.1a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE ELASTICITY OF EXCESS SUPPLY OF COUNTRY A VARIES
Linear Formulation, Millions Of Dollars

Welfare changes of exporting countries	Elasticity of excess supply of country A		
TARGETED EXPORT SUBSIDIES	0.2	1.2	2.2
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	98.15	690.46	1,269.96
-Bonus revenue	90.02	631.88	1,160.92
-Net welfare change	-8.14	-58.59	-109.04
Country B			
-Producer surplus	33.69	32.92	32.53
-Government cost	375.65	374.19	373.46
-Net welfare change	-341.96	-341.28	-340.93
Country C			
-Producer surplus	-18.23	-17.81	-17.30
-Net welfare change	-18.23	-17.81	-17.30
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	196.31	1,380.93	2,539.92
-Bonus revenue	163.76	1,146.58	2,103.78
-Net welfare change	-32.55	-234.35	-436.15
Country B			
-Producer surplus	67.37	65.83	65.06
-Government cost	570.85	568.66	567.57
-Net welfare change	-503.47	-502.83	-502.51
Country C			
-Producer surplus	-36.45	-35.62	-35.20
-Net welfare change	-36.45	-35.62	-35.20

TABLE A4.1b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE ELASTICITY OF EXCESS SUPPLY OF COUNTRY A VARIES
Linear Formulation, Millions Of Dollars

Welfare changes of importing countries	Elasticity of excess supply of country A		
TARGETED EXPORT SUBSIDIES	0.2	1.2	2.2
Country D	2,166.62	2,232.90	2,266.11
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D	2166.62	2,232.90	2,266.11
Country E	920.53	922.61	923.65

TABLE A4.2a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE ELASTICITY OF EXCESS SUPPLY OF COUNTRY A VARIES
Semi-log Formulation, Millions Of Dollars

Welfare changes of exporting countries	Elasticity of excess supply of country A		
TARGETED EXPORT SUBSIDIES	0.2	1.2	2.2
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	96.32	733.00	1,435.18
-Bonus revenue	88.07	669.39	1,309.82
-Net welfare change	-8.25	-63.61	-125.36
Country B			
-Producer surplus	24.19	28.72	28.52
-Government cost	373.75	372.96	372.58
-Net welfare change	-344.61	-344.24	-344.06
Country C			
-Producer surplus	-16.10	-15.87	-15.76
-Net welfare change	-16.10	-15.87	-15.76
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	194.03	1,545.86	3,174.89
-Bonus revenue	160.79	1,277.55	2,620.26
-Net welfare change	-33.24	-268.31	-554.63
Country B			
-Producer surplus	58.68	57.85	57.44
-Government cost	567.84	566.65	566.07
-Net welfare change	-509.17	-508.81	-508.63
Country C			
-Producer surplus	-32.07	-31.62	-31.40
-Net welfare change	-32.07	-31.62	-31.40

TABLE A4.2b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE ELASTICITY OF EXCESS SUPPLY OF COUNTRY A VARIES
Semi-log Formulation, Millions Of Dollars

Welfare changes of importing countries	Elasticity of excess supply elasticity of country A		
TARGETED EXPORT SUBSIDIES	0.2	1.2	2.2
Country D	2,328.76	2,376.05	2,399.51
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D	2,328.76	2,376.05	2,399.51
Country E	923.56	924.73	925.30

TABLE A4.3a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE ELASTICITY OF EXCESS SUPPLY OF COUNTRY A VARIES
Reciprocal Formulation, Millions Of Dollars

Welfare changes of exporting countries	Elasticity of excess supply of country A		
TARGETED EXPORT SUBSIDIES	0.2	1.2	2.2
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	99.17	821.52	1,745.24
-Bonus revenue	90.77	750.67	1,593.42
-Net welfare change	-8.40	-70.85	-151.81
Country B			
-Producer surplus	26.78	26.22	25.96
-Government cost	374.55	373.47	372.98
-Net welfare changes	-347.77	-347.26	-347.02
Country C			
-Producer surplus	-14.79	-14.47	-14.32
-Net welfare change	-14.79	-14.47	-14.32
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	201.29	1,867.86	4,680.78
-Bonus revenue	167.20	1,545.66	3,866.45
-Net welfare change	-34.09	-322.20	-814.33
Country B			
-Producer surplus	54.24	53.10	52.58
-Government cost	568.93	567.26	566.51
-Net welfare change	-514.69	-514.17	-513.93
Country C			
-Producer surplus	-29.92	-29.28	-28.99
-Net welfare change	-29.92	-29.28	-28.99

TABLE A4.3b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE ELASTICITY OF EXCESS SUPPLY OF COUNTRY A VARIES
Reciprocal Formulation, Millions Of Dollars

Welfare changes of importing countries	Elasticity of excess supply of country A		
TARGETED EXPORTS SUBSIDIES	0.2	1.2	2.2
Country D	2,386.85	2,480.97	2,526.52
Country E	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D	2,386.85	2,480.97	2,526.55
Country E	922.64	924.32	925.09

TABLE A4.4a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF THE-WORLD VARIES, Linear Formulation, Millions Of Dollars

Welfare changes of exporting countries	Elasticity of net import demand for the rest-of-the-world		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	680.76	686.72	690.46
-Bonus revenue	622.17	628.14	631.88
-Net welfare change	-58.59	-58.59	-58.59
Country B			
-Producer surplus	32.45	32.74	32.92
-Government cost	373.32	373.86	374.19
-Net welfare change	-340.87	-341.12	-341.28
Country C			
-Producer surplus	-17.56	-17.71	-17.81
-Net welfare change	-17.56	-17.71	-17.81
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,361.52	1,373.45	1,380.93
-Bonus revenue	1,127.17	1,139.10	1,146.58
-Net welfare change	-234.35	-234.35	-234.35
Country B			
-Producer surplus	64.91	65.48	65.83
-Government cost	567.35	568.16	568.66
-Net welfare change	-502.45	-502.68	-502.83
Country C			
-Producer surplus	-35.12	-35.43	-35.62
-Net welfare change	-35.12	-35.43	-35.62

TABLE A4.4b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF-THE-WORLD VARIES, Linear Formulation, Millions Of Dollars

Welfare changes of importing countries	Elasticity of net import demand for the rest-of-the-world		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country D			
-Consumer surplus	1,979.84	2,109.81	2,232.90
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,979.84	2,109.81	2,232.90
Country E			
-Consumer surplus	918.24	920.44	922.61

TABLE A4.5a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF-THE-WORLD VARIES, Semi-log Formulation, Millions Of Dollars

Welfare changes of exporting countries	Elasticity of net import demand for the rest-of-the-world		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	730.72	734.89	733.00
-Bonus revenue	667.21	671.19	669.39
-Net welfare change	-63.50	-63.70	-63.61
Country B			
-Producer surplus	28.68	28.76	28.72
-Government cost	372.88	373.03	372.96
-Net welfare change	-344.20	-344.27	-344.24
Country C			
-Producer surplus	-15.85	-15.89	-15.87
-Net welfare change	-15.85	-15.89	-15.87
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,541.03	1,549.83	1,545.86
-Bonus revenue	1,273.19	1,281.15	1,277.55
-Net welfare change	-267.85	-268.68	-268.31
Country B			
-Producer surplus	57.76	57.92	57.85
-Government cost	566.52	566.76	566.65
-Net welfare change	-508.77	-508.84	-508.81
Country C			
-Producer surplus	-31.57	-31.66	-31.62
-Net welfare change	-31.57	-31.66	-31.62

TABLE A4.5b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF-THE-WORLD VARIES, Semi-log Formulation, Millions Of Dollars

Welfare changes of importing countries	Elasticity of net import demand for the rest-of-the-world		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country D			
-Consumer surplus	1,998.24	2,174.20	2,376.05
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,998.24	2,174.20	2,376.05
Country E			
-Consumer surplus	918.81	921.64	925.30

TABLE A4.6a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF-THE-WORLD VARIES, Reciprocal Formulation, Millions Of Dollars

Welfare changes of exporting countries	Elasticity of net import demand for the rest-of-the-world		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	806.33	819.23	821.52
-Bonus revenue	736.43	748.52	750.67
-Net welfare change	-69.90	-70.71	-70.85
Country B			
-Producer surplus	26.06	26.19	26.22
-Government cost	373.17	373.43	373.47
-Net welfare change	-347.11	-347.23	-347.26
Country C			
-Producer surplus	-14.38	-14.45	-14.47
-Net welfare change	-14.38	-14.45	-14.47
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,831.53	1,862.37	1,867.86
-Bonus revenue	1,513.97	1,540.87	1,545.66
-Net welfare change	-317.56	-321.50	-322.20
Country B			
-Producer surplus	52.78	53.05	53.10
-Government cost	566.81	567.19	567.26
-Net welfare change	-514.02	-514.15	-514.17
Country C			
-Producer surplus	-29.11	-29.26	-29.28
-Net welfare change	-29.11	-29.26	-29.28

TABLE A4.6b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE ELASTICITY OF NET IMPORT DEMAND OF THE REST-OF-THE-WORLD VARIES, Reciprocal Formulation, Millions Of Dollars

Welfare changes of importing countries	Elasticity of net import demand for the rest-of-the-world		
TARGETED EXPORT SUBSIDIES	0.8	1.4	2.0
Country D			
-Consumer surplus	2,006.01	2,210.74	2,480.97
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	2,006.01	2,210.74	2,480.97
Country E			
-Consumer surplus	918.73	921.43	924.32

TABLE A4.7a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE GENERIC SUBSIDY VALUE VARIES, Linear Formulation
Millions Of Dollars

Welfare changes of exporting countries	Subsidy value ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	581.21	690.46	799.71
-Bonus revenue	539.70	631.88	721.12
-Net welfare change	-41.51	-58.59	-78.59
Country B			
-Producer surplus	27.71	32.92	38.12
-Government cost	314.28	374.19	434.37
-Net welfare change	-286.57	-341.28	-396.25
Country C			
-Producer surplus	-14.99	-17.81	-20.63
-Net welfare change	-14.99	-17.81	-20.63
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,162.43	1,380.93	1,599.43
-Bonus revenue	996.37	1,146.58	1,285.05
-Net welfare change	-166.06	-234.35	-314.38
Country B			
-Producer surplus	55.42	65.83	76.25
-Government cost	476.58	586.66	661.55
-Net welfare change	-421.16	-502.83	-585.30
Country C			
-Producer surplus	-29.98	-35.62	-41.25
-Net welfare change	-29.28	-35.62	-41.25

TABLE A4.7b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE GENERIC SUBSIDY VALUE VARIES, Linear Formulation
Millions Of Dollars

Welfare changes of importing countries	Subsidy value ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country D			
-Consumer surplus	1,834.19	2,232.90	2,648.68
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,834.19	2,232.90	2,648.68
Country E			
-Consumer surplus	775.20	922.61	1,070.55

TABLE A4.8a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE GENERIC SUBSIDY VALUE VARIES, Semi-log Formulation
Millions Of Dollars

Welfare changes of exporting countries	Subsidy values ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	611.92	733.00	856.09
-Bonus revenue	567.22	669.39	770.04
-Net welfare change	-44.70	-63.61	-86.05
Country B			
-Producer surplus	24.15	28.72	33.31
-Government cost	313.27	372.96	432.92
-Net welfare change	-289.12	-344.24	-399.61
Country C			
-Producer surplus	-13.37	-15.87	-18.37
-Net welfare change	-13.37	-15.87	-18.37
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,297.48	1,545.86	1,821.09
-Bonus revenue	1,092.54	1,277.55	1,455.00
-Net welfare change	-186.93	-268.31	-366.09
Country B			
-Producer surplus	48.59	57.85	67.15
-Government cost	474.92	566.65	659.18
-Net welfare change	-426.33	-508.81	-592.03
Country C			
-Producer surplus	-26.65	-31.62	-36.58
-Net welfare change	-26.65	-31.62	-36.58

TABLE A4.8b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE GENERIC SUBSIDY VALUE VARIES, Semi-Log Formulation
Millions Of Dollars

Welfare changes of importing countries	Subsidy values ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country D			
-Consumer surplus	1,938.56	2,376.05	2,840.19
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,938.56	2,376.05	2,840.19
Country E			
-Consumer surplus	776.96	925.30	1,073.05

TABLE A4.9a
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE GENERIC SUBSIDY VALUE VARIES, Reciprocal Formulation
Millions Of Dollars

Welfare changes of exporting countries	Subsidy value ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	678.61	821.52	969.98
-Bonus revenue	629.35	750.67	873.09
-Net welfare change	-49.27	-70.85	-96.90
Country B			
-Producer surplus	22.02	26.22	30.42
-Government cost	313.71	373.47	433.48
-Net welfare change	-291.69	-347.26	-403.06
Country C			
-Producer surplus	-12.23	-14.47	-16.69
-Net welfare change	-12.23	-14.47	-16.69
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,507.06	1,867.86	2,261.31
-Bonus revenue	1,288.23	1,545.66	1,809.53
-Net welfare change	-218.83	-322.20	-451.79
Country B			
-Producer surplus	44.52	53.10	61.74
-Government cost	475.46	567.26	659.86
-Net welfare change	-430.95	-514.17	-598.11
Country C			
-Producer surplus	-24.70	-29.28	-33.84
-Net welfare change	-24.70	-29.28	-33.84

TABLE A4.9b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE GENERIC SUBSIDY VALUE VARIES, Reciprocal Formulation
Millions Of Dollars

Welfare changes of importing countries	Subsidy value ($/tonne)		
TARGETED EXPORT SUBSIDIES	26.60	31.60	36.60
Country D			
-Consumer surplus	1,994.51	2,480.97	3,021.29
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,994.51	2,480.97	3,021.29
Country E			
-Consumer surplus	776.59	924.32	1,072.62

TABLE A4.10a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES, Linear Formulation, Millions Of Dollars

Welfare changes of exporting countries	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	690.46	757.34	824.22
-Bonus revenue	631.88	686.86	740.74
-Net welfare change	-58.59	-70.49	-83.49
Country B			
-Producer surplus	32.92	36.10	39.29
-Government cost	374.19	374.71	375.22
-Net welfare change	-341.28	-338.60	-335.92
Country C			
-Producer surplus	-17.81	-17.81	-17.81
-Net welfare change	-17.81	-17.81	-17.81
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	0.00	0.00	0.00
-Government cost	1,380.93	1,514.69	1,648.45
-Bonus revenue	1,146.58	1,232.74	1,314.50
-Net welfare change	-234.35	-281.95	-333.94
Country B			
-Producer surplus	65.83	72.21	78.59
-Government cost	568.66	570.20	571.73
-Net welfare change	-502.83	-497.99	-493.15
Country C			
-Producer surplus	-35.62	-35.62	-35.62
-Net welfare change	-35.62	-35.62	-35.62

TABLE A4.10b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES, Linear Formulation, Millions Of Dollars

Welfare changes of importing countries	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country D			
-Consumer surplus	2,232.90	2,232.90	2,232.90
Country E			
-Consumer surplus	0.00	0.00	0.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	2,232.90	2,232.90	2,232.90
Country E			
-Consumer surplus	922.68	922.68	922.68

TABLE A4.11a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE PERCENTAGE GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES, Semi-log Formulation, Millions Of Dollars

Welfare changes of exporting countries	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country A			
-Producer surplus	1,333.58	1,355.46	1,377.38
-Government cost	733.00	808.11	883.98
-Bonus revenue	669.39	731.19	792.40
-Net welfare change	1,269.97	1,278.53	1,285.81
Country B			
-Producer surplus	288.48	283.26	278.03
-Government cost	379.73	380.02	380.31
-Net welfare change	-91.24	-96.76	-102.28
Country C			
-Producer surplus	238.32	230.13	221.95
-Net welfare change	238.32	230.13	221.95
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	1,604.77	1,649.75	1,694.90
-Government cost	1,545.86	1,713.28	1,884.08
-Bonus revenue	1,277.55	1,387.11	1,493.73
-Net welfare change	1,336.47	1,323.58	1,304.54
Country B			
-Producer surplus	245.06	234.31	223.51
-Government cost	573.96	574.83	575.70
-Net welfare change	-328.90	-340.52	-352.19
Country C			
-Producer surplus	147.65	131.46	115.31
-Net welfare change	147.65	131.46	115.31

TABLE A4.11b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES, Semi-Log Formulation, Millions Of Dollars

Welfare changes of importing countries	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country D			
-Consumer surplus	1,171.14	1,206.48	1,242.00
Country E			
-Consumer surplus	-418.68	-405.39	-393.00
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,496.35	1,570.94	1,646.31
Country E			
-Consumer surplus	618.76	646.12	673.47

TABLE A4.12a
NET WELFARE CHANGES OF EXPORTING COUNTRIES AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES, Reciprocal Formulation, Millions Of Dollars

Welfare changes of exporting countries	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country A			
-Producer surplus	1,110.47	1,125.06	1,139.82
-Government cost	821.52	911.73	1,004.08
-Bonus Revenue	750.67	825.48	900.71
-Net welfare change	1,039.62	1,038.81	1,036.45
Country B			
-Producer surplus	239.21	233.55	227.87
-Government cost	378.91	379.19	379.47
-Net welfare change	-139.69	-145.64	-151.60
Country C			
-Producer surplus	193.91	185.58	177.26
-Net welfare change	193.91	185.58	177.26
GENERAL EXPORT SUBSIDIES			
Country A			
-Producer surplus	1,289.29	1,323.11	1,357.84
-Government cost	1,867.86	2,104.56	2,354.52
-Bonus revenue	1,545.66	1,706.37	1,869.70
-Net welfare change	967.10	924.92	873.02
Country B			
-Producer surplus	184.84	173.27	161.66
-Government cost	572.36	573.21	574.07
-Net welfare change	-387.52	-399.94	-412.41
Country C			
-Producer surplus	96.87	80.43	64.02
-Net welfare change	96.87	80.43	64.02

TABLE A4.12b
NET WELFARE CHANGES OF IMPORTING COUNTRIES AS THE PERCENTAGE OF GENERIC CERTIFICATES REDEEMED FOR WHEAT VARIES, Reciprocal Formulation, Millions Of Dollars

Welfare changes of importing countries	Percentage of generic certificates redeemed for wheat		
TARGETED EXPORT SUBSIDIES	10	20	30
Country D			
-Consumer surplus	1,390.74	1,429.66	1,468.90
Country E			
-Consumer surplus	-343.59	-330.01	-316.43
GENERAL EXPORT SUBSIDIES			
Country D			
-Consumer surplus	1,785.48	1,870.32	1,956.66
Country E			
-Consumer surplus	708.64	736.55	764.49