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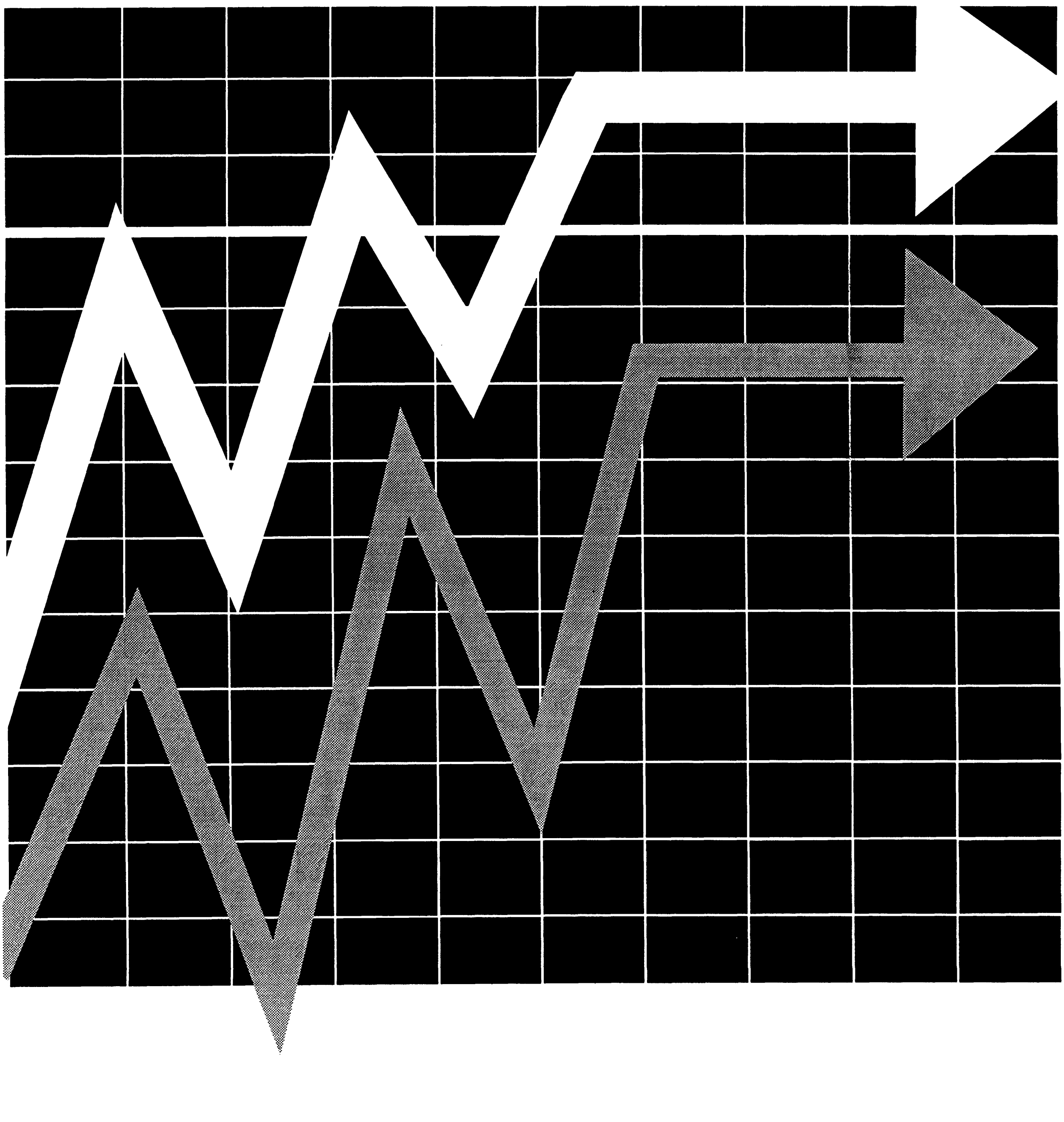
Product Differentiation in Wheat Trade Modeling

Stephen L. Haley



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Abstract

Economic research described in this report indicates that wheat should be differentiated by end use and by country of origin for trade policy modeling. This study uses wheat market information gathered as part of the international component of the grain quality study conducted by USDA's Economic Research Service to construct world wheat models and to analyze the U.S. Export Enhancement Program (EEP). Results indicate that the wheat differentiation issue is crucial when analyzing an important policy instrument such as the EEP. Compared with an analysis incorporating differentiation and program targeting, failure to use differentiation has led to apparent overstating of benefits of the EEP. On the other hand, omitting targeting has led to an understatement of the EEP's benefits. Multicommodity modeling efforts on which policymakers rely may need to focus more on product characteristics that differentiate similar products across national borders.

Keywords: Agricultural trade, Armington trade model, export enhancement program, wheat.

Acknowledgments

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Product Differentiation in Wheat Trade Modeling

Stephen L. Haley

Introduction

This paper examines whether product differentiation in agricultural trade modeling matters. The specific commodity examined is wheat, and the analysis is based on two sets of world wheat models constructed from information about wheat import markets collected as part of the grain quality study by USDA's Economic Research Service (ERS). One modeling framework incorporates product differentiation and the other does not. Both modeling frameworks are used to analyze the U.S. Export Enhancement Program (EEP). The key part of the analysis is whether conclusions from the modeling frameworks differ significantly regarding the evaluation of the benefits and costs of the EEP.

This report is organized into five sections. The first section describes product differentiation and agricultural trade modeling and shows that assumptions placed on the degree of differentiation for the commodity can strongly influence commodity policy evaluation. The second section discusses the modeling approach, specifically, a three-stage theory of wheat import demand, and how this theory is fitted into an applied, comparative static, partial equilibrium framework for analysis. The third section shows special problem areas associated with analyzing the EEP. These areas concern the EEP as a targeted-subsidy program, the EEP as an in-kind subsidy program, and how producers are assumed to respond to changed prices or expectations of changing prices. The fourth section discusses modeling scenarios and results. The fifth section presents a summary and the conclusions of the research.

Product Differentiation and Agricultural Trade Modeling

As detailed by Grubel and Lloyd nearly 20 years ago, intra-industry trade constitutes a large and ever-increasing part of international trade. They argued that because exports and imports of the same commodity are netted out in many empirical applications, a large portion of the world's trade is being left unexplained. Since then, much of the recent theoretical work in international trade has focused on quality differences and product differentiation as determinants of trade flows in imperfectly competitive world market settings (Lancaster, 1980; Helpman and Krugman, 1985).

Armington-Type Trade Models

In the applied modeling field, Armington-type trade models have been developed to account for features that differentiate commodities according to source (Armington, 1969). Assumptions underlying the framework provide a method of calculating own- and cross-price elasticities between variants of a single commodity that are produced in differing countries.

Formally, the importing decision is split into two stages. In stage one, the importer decides how much of the commodity to import. In stage two, the importer allocates imports across competing exporters. The marginal rate of substitution between any two varieties is assumed to be independent of the decision of how much of the total product to consume (decided in stage one) and of the consumption of all other goods. This assumption is typically referred to as separability. Further, it is assumed that the substitution rate is constant and that the rate of substitution between two types of the product in a single import market is the same as the rate between any other versions of the product.

These assumptions are implemented by specifying that import demand for the product be indexed in a constant elasticity of substitution (CES) functional form. This specification implies that market shares are independent of total product expenditure and that income elasticities for each type of the product are all equal to unity. This restriction, typically referred to as homotheticity, implies that market shares change only in response to relative price changes.[1]

[1] See Alston and others (1990) for a critical assessment of the Amington restrictions.

Applications to Agricultural Trade

Many originally thought that primary commodities were sufficiently homogeneous that not much effort needed to be placed on product differentiation among agricultural commodities. However, in the late 1970's, Johnson, Grennes, and Thursby pointed out that prices of primary agricultural commodities tended to vary in single import markets according to the country source of the supply (Johnson, Grennes, and Thursby, 1977; Grennes, Johnson, and Thursby, 1978; and Johnson, Grennes, and Thursby, 1979). At that time, many agricultural trade models were built in a spatial equilibrium framework. The authors argued that product differentiation, transaction costs, and/or aggregation problems made the spatial equilibrium framework overly restrictive and potentially misleading for drawing policy implications. These authors were the first to apply the Armington framework to an analysis of international grains markets.

Other agricultural trade economists used the Armington framework throughout the 1980's. For example, Honma (1983) was the first to estimate a linearized version of an Armington framework and to use the results for trade analysis. Based on Figueroa's econometric work (1986), several Armington-type grain trade models were constructed to analyze the effects of the 1980 Soviet grain embargo (Figueroa and Webb, 1986; Abbott and Paarlberg, 1986; and Webb and others, 1989). De Gorter and Meilke (1987) estimated a two-stage system of wheat food demand in the European Community (EC) that distinguished between domestic and import supplies and that used the estimates to analyze differential effects of changing either threshold prices or intervention prices in the EC.

Results from these studies support the hypothesis that differentiation matters when analyzing policy. This conclusion is evidenced most directly in Abbott and Paarlberg's Soviet Grain Embargo study. Table 1 compares the estimated effects on U.S. wheat exports from spatial equilibrium and Armington frameworks. Three possible effects of the embargo on the aggregate level of Soviet wheat imports (none, moderate, and large) are accounted for. The effects of the embargo on U.S. exports vary widely. In essence, a more differentiated U.S. product implies a greater negative impact on U.S. wheat exports. Other trade-flow adjustments were similarly affected. The spatial approach implied that all exporters except Argentina lost export revenue due to the embargo, whereas the Armington approach implied that only the United States lost export revenue. Considering the debate over the embargo and consequent political fallout in the United States, knowledge of how the world wheat market functions seems a desirable attribute for economists charged with advising policymakers.

Wheat as a Differentiated Product

Although wheat probably seems to be a homogeneous commodity to the uninformed, closer analysis reveals characteristics that differentiate it for a number of end uses. The most important characteristics are hardness, protein content, and gluten strength.[2]

Wheat is primarily used as an input into flour production. Flour in turn is used for producing baked goods. The pattern of flour use, and thus the demand for types of wheat, differ from one world region to another and also, in many cases, within regions. Table 2 provides a description of major end uses of wheat.

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[2] See USDA (1993) for an amplified discussion of differing wheat characteristics.

Table 1—Abbott/Paarlberg analysis of Soviet grain embargo: Percentage reduction in U.S. wheat exports

Modeling approach	Demand not affected	Demand reduced by 3 MMT[1]	Demand reduced by 11 MMT[1]
		Percent	
Spatial equilibrium	0.5	1.6	4.5
Armington	2.9	3.8	6.7

1 MMT = Million metric tons.

Although demand for wheat characteristics differs internationally, it is unclear how important it is to account for the differences in economic modeling and policy analysis. Hjort (1988) estimated wheat import demand for a wide cross-section of importers. Hjort differentiated wheat by class and source country and separated importers according to wheat purchase patterns. Hjort's work emphasized the importance of nonprice factors in determining market outcomes and concluded that wheat exporters have only limited ability to influence import market shares in many major wheat import markets.

Following a line of research begun by Veeman (1987), Henning and Martin (1989), Wilson (1989), and Espinosa and Goodwin (1991), Larue (1991) rigorously confirmed their results and more firmly established the proposition that in econometric modeling, wheat should be differentiated by end use. Larue also found additional differentiation for wheat according to country of origin. A major implication is that econometric wheat models that assume product homogeneity generate estimates with no clear interpretation.

Wheat is a heterogeneous commodity, and the heterogeneity is not a trivial matter for modeling purposes. Accurately analyzing the importance of wheat's heterogeneity depends on the successful incorporation of the survey data into the modeling framework.

Modeling Approach

Previous world wheat models, with few exceptions (Hjort), analyze the competition among exporters facing a market of homogeneous quality. Even the Armington assumptions differentiate a product by its country of origin, with no explicit recognition that quality requirements are not necessarily related to supply sources. The model constructed for this analysis recognizes that competitiveness among exporters is largely determined by the end-use requirements of wheat product demand and by the policy structure of the importing country.

Three-Stage Theory of Wheat Import Demand

Wheat import demand is modeled as a three-stage decision process (fig. 1). In the first stage, the importer determines how much wheat needs to be imported to satisfy domestic end-use demand for wheat. This wheat is referred to as "standard-

Table 2—End uses for wheat

Product	Regional demand	Desirable flour/wheat characteristics
Leavened bread	Europe, the Americas	Hard wheat, with high-protein content and high gluten strength. Required protein levels can vary: white pan-bread requires protein levels of 12.5-14.5 percent, and hardness is less desirable than in high-raised loaves. High-protein flour is often blended with flour from lower protein wheat.
Unleavened bread	India and South Asia	Chapatis flour requires wheat of medium hardness, with protein levels of 9-10 percent.
Flatbreads	Middle East and North Africa	Desirable protein levels in the 9-12 percent range.
Steam breads	Southeast Asia	Desirable protein levels in the 10-11 percent range.
Confectionery products (crackers, cookies, pastries, cakes)	Many locations	Soft wheat with low protein levels in 7.5-9 percent range.
Oriental noodles	East and Southeast Asia	Desirable protein levels in 10-11.5 percent range, with wheat of medium hardness.
Pasta noodles	North Africa, Western countries	Semolina flour from durum wheat.
Feed	Many locations	Medium hard and soft wheats.

quality wheat" and possesses characteristics particular to each importing country's needs. For the next two stages, some level of substitution among wheat classes and suppliers is assumed to occur. This substitution allows aggregation across characteristics to obtain a quality standard that can satisfy demand for imports of different classes from different suppliers of wheat. The importing agent can thereby determine what classes of wheat will satisfy excess demands, given rates of substitution between "standard-quality wheat" and imported wheat.

In the second stage, the importer determines what class(es) of wheat will optimally satisfy wheat import demand, which is determined in the first stage. The goal of the importer is to minimize the costs of fulfilling the aggregate demand for wheat. This goal holds for both private and state traders. The solution to the cost minimization problem shows the mix of wheats that will satisfy demand for wheat-quality characteristics. In the third stage, the importer determines from which supplier to purchase the class of wheat identified in the second stage. Factors that influence supplier-specific quality characteristics are potentially many, but in particular they include spatial/timing characteristics, political and trade ties, and policy goals, including supply assurance and diversification objectives.

Making the Model Operational

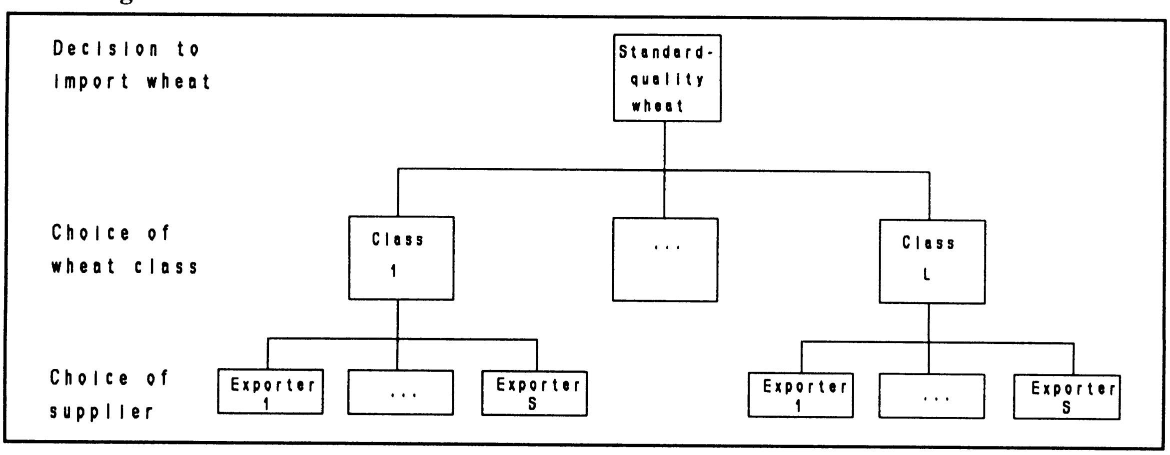
The world wheat model was built in the Static World Policy Simulation (SWOPSIM) modeling framework, modified to incorporate the three-stage wheat import demand structure. SWOPSIM is a static, partial equilibrium, nonspatial modeling framework (Roningen, Sullivan, and Dixit, 1991).[3] Supply and demand are functions of own- and cross-prices. Trade is the difference between domestic supply and demand. Domestic incentive prices depend on the level of consumer and producer support and on world prices denominated in local currency. Price transmission elasticities regulate the extent to which domestic prices change when world prices change. World markets clear when net trade of a commodity across all regions sums to zero.

Because the SWOPSIM structure assumes product homogeneity, the framework must be modified to make the modeling framework consistent with the theory of differentiated wheat demand. Seven types of wheat are included in the model. Six of the wheats are identified with the country-source of production: the United States, Canada, the EC, Australia, Argentina, and Saudi Arabia. The seventh type is a generic wheat category comprising wheat produced elsewhere.

Armington's methodology is employed to calculate own- and cross-price elasticities for the wheat types, according to the procedures described in table 3. Necessary elements for setting the demand elasticity parameters are an own-price elasticity of demand for standard-quality wheat (stage 1), elasticities of substitution corresponding to wheat classes (σ, stage 2) and to wheat suppliers of particular classes (σ_i, stage 3), and consumption and/or import shares.

[3] To avoid confusion, the reader is reminded that SWOPSIM is a modeling framework and not a formal model of agricultural trade used for trade liberalization anaylsis. Because SWOPSIM was originally developed at ERS for trade liberalization analysis, many readers confuse the trade liberalization model (that is, ST86) with the framework. However, some of the same parameters used in the trade liberalization model are also used in the model constructed for the analysis in this report.

Figure 1
Three-stage demand for wheat



The first-stage demand elasticities, along with supply and price transmission elasticities, are shown in table 4. These elasticities are based on those used in ERS's trade liberalization studies (Sullivan and others, 1992; and Sullivan, 1990).

The elasticities of substitution were inferred from a review of the Grain Quality surveys. The countries included in the study were chosen on the basis of their share of purchases on the world wheat market (58 percent of 1992 imports and 63 percent of U.S. sales) and to yield a representative view of worldwide demand for wheat. These countries are separated out in table 4.

Table 5 shows how wheat is classified in each of the countries, the between-class substitution elasticities, the principal suppliers within wheat classes, and the within-class substitution elasticities. For most countries in the model, the between-class elasticities are estimated to be low (usually about 0.50), while the between-supplier elasticities tend to be higher (usually about 3.00). For the countries and regions not surveyed, historical wheat import and consumption patterns are used to construct the wheat class categories (table 6). An appendix to this report (available from the author) details wheat import demand in each of the importing countries or regions, implications for U.S. wheat competitiveness, and selection of parameter values.

Modeling the Export Enhancement Program

Over the July-June marketing years 1986/87 through 1991/92, 143 million metric tons (mmt) of wheat received EEP assistance, and more than $3 billion was expended on the subsidies. Figure 3 shows the distribution of expenditures over the 6-year timeframe. Figure 3 reveals that the highest yearly expenditures occurred in 1987/88 and 1991/92. Expenditures dipped during the middle years of 1988/89 and 1989/90 due to tighter worldwide wheat supply conditions.

Figure 3 shows the volume of EEP-assisted wheat exports and the proportion of wheat exports constituted by EEP-assisted sales. EEP-assisted sales constituted about 70 percent of all wheat sales during the 1986/87-1991/92 period. Even during the years when EEP expenditures were low, this proportion did not fall.

Targeted-Subsidy Program

The EEP is a subsidy program targeted to specific importers. Table 7 presents the yearly average unit subsidy amounts that importers in the model received. The last line shows the subsidy averaged over the volume of all wheat exported for each of the marketing years.

The targeting issue introduces a problem into the analysis when wheat is assumed to be homogeneous. It is not possible to track specific exporter-importer trade flows; that is, the EEP must be modeled as a uniform subsidy program.[4] Therefore, when results from the differentiated and homogeneous models are compared, the homogeneous model contains a distortion introduced by its inability to account for the targeted nature of the EEP.

The procedure followed in this paper is to separately compare the results from the case that assumes targeted-subsidies and differentiated wheat with results from cases that assume (1) uniform-subsidies and homogeneous wheat and (2) uniform subsidies and differentiated wheat. Figure 4 shows the modeling implications. The left panel shows the uniform-subsidy case. The subsidy is modeled explicitly in terms of the exporter, thereby barring any specific importer targeting. The excess supply curve incorporating the export subsidy (ES') is vertically displaced below the true underlying excess supply curve (ES) by the value of subsidy averaged across the volume of all exports (dp_o - wp_o). Removal of the subsidy implies fewer exports, a higher world price (wp_1 up from wp_o), and a lower domestic price (dp_1 down from dp_o). The right panel shows the targeting case, where the effect of the subsidy is modeled explicitly in terms of the importer. The price the importer pays is lower than the exporter's border price by the amount of the unit subsidy targeted to it (less the transport rate). If there were only one importer, the price and trade effects would be equivalent, as implied in the diagram. For the case of multiple importers (as in this study), a subsidy targeted to a subset of importers can be explicitly modeled, whereas it cannot if the methodology underlying the left panel of figure 4 were being used.

[4] Abbott, Paarlberg, and Sharples (1987) have developed a theory regarding the optimal targeting of export subsidies and have shown that an optimally targeted export subsidy dominates an optimal uniform export subsidy.

Table 3—Three-stage demand for wheat

Stage 1: Decision to import wheat

Define:	η	=	Demand elasticity for standard-quality wheat

Stage 2: Choice of wheat class

Define:	σ	=	Elasticity of substitution between wheat classes
	η_{ii}	=	Own-price demand elasticity of class i wheat
	η_{ih}	=	Cross-price demand elasticity of class i wheat, with respect to class h wheat
	S_h	=	Expenditure share of class h wheat imports

Own-price demand elasticity of class i wheat:

$$\eta_{ii} = -(1-S_i)*\sigma + S_i*\eta$$

Cross-price demand elasticity of class i wheat:

$$\eta_{ih} = S_h*(\sigma + \eta)$$

Stage 3: Choice of supplier

Define:	σ_i	=	Elasticity of substitution between suppliers of class i wheat
	$\eta_{i,jj}$	=	Own-price demand elasticity of class i wheat from exporter j
	$\eta_{i,jm}$	=	Cross-price demand elasticity of class i wheat from exporter j, with respect to exporter m
	$S_{i,m}$	=	Expenditure share of class i wheat imports from supplier m

$$\eta_{i,jj} = -(1-S_{i,j})*\sigma_i + S_{i,j}*\eta_{ii}$$

$$\eta_{i,jm} = S_{i,m}*(\sigma_i + \eta_{ii})$$

$$\eta_{i,jm} = S_{h,m}*\eta_{ih} \text{ where } h \neq i$$

In-Kind Subsidy Program

Up until the latter part of 1991, EEP subsidies were given to exporters in the form of commodity certificates that could either be sold or exchanged for commodities owned by the Commodity Credit Corporation (CCC). This operation, called an in-kind subsidy program, presents analytical problems. Although export volume clearly will expand, the effects on the domestic price are less certain. The stimulation of export demand (the "subsidy" effect) puts upward pressure on the domestic commodity price, while deliveries into the market out of CCC stocks (the "stock release" effect) depress prices. Houck (1986) has shown that, for the case of a uniform export subsidy, the elasticity of export demand plays a determining role in which effect will dominate. If export demand is elastic (absolute value greater than unity), then the subsidy effect will dominate and the domestic wheat price should rise, all else constant.

An additional complication is introduced through the commodity certificate program. The certificates need not be redeemed for the commodity for whose export they were issued. Any commodity in CCC inventories can be redeemed. Therefore, if only a fraction of the certificates issued for wheat were redeemed for wheat, the program effect would begin to resemble more a cash subsidy, for which there is no domestic price ambiguity.

Table 4—Supply, demand, and price transmission elasticities

Item	Own-price supply elasticity	Own-price demand elasticity	Price transmission
Exporters:			
United States	0.60	(0.25)	1.00
Canada	0.50	(0.43)	0.85
EC	0.50	(0.37)	0.15
Australia	0.90	(0.35)	0.80
Argentina	0.60	(0.20)	0.80
Saudi Arabia	0.30	(0.31)	0.30
Surveyed importers:			
Venezuela	-	(0.28)	1.00
Brazil	0.38	(0.20)	0.30
Italy	0.50	(0.20)	0.15
Former Soviet Union	0.23	(0.24)	0.14
Morocco	0.30	(0.20)	0.60
Tunisia	0.30	(0.20)	0.60
Ghana	-	(0.30)	0.40
Togo	-	(0.30)	0.40
Egypt	0.30	(0.31)	0.35
Yemen	0.30	(0.30)	0.60
Pakistan	0.40	(0.30)	0.25
Sri Lanka	-	(0.30)	0.25
Japan	0.52	(0.10)	0.40
Korea	-	(0.36)	0.50
Taiwan	-	(0.33)	0.30
China	0.15	(0.30)	0.15
The Philippines	-	(0.30)	0.50
Indonesia	-	(0.30)	0.25
Other importers:			
Mexico, Central America	0.55	(0.26)	0.50
Other South America	0.38	(0.30)	0.70
Other Western Europe	0.80	(0.25)	0.15
Eastern Europe	0.25	(0.28)	0.40
Other North Africa	0.30	(0.20)	0.60
Other Sub-Saharan Africa	0.50	(0.30)	0.40
Other Near East	0.30	(0.30)	0.60
Other Far East	0.40	(0.30)	0.60
Rest of World	-	(0.30)	0.70

- = Not applicable.

Table 5—Elasticities of substitution: Surveyed importers

Importer	Wheat class	Between-class substitution elasticity	Suppliers[1]	Within-class substitution elasticity
Venezuela	Hard	0.5	US-CN	3.0
	Soft		US-AR-EC-SA	3.0
Brazil	Preferred	0.5	DM-AR	1.0
	Hard		CN-US	3.0
Italy	EC	0.5	DM-Other EC	-
	Hard		US-CN-SA	3.0
	Durum		CN-US	0.5
Former Soviet Union	Generic	-	DM-US-CN-EC-AR-AU	3.0
Morocco	Durum	1.0	DM	-
	Common		DM-Foreign	3.0
			Foreign:US-EC-CN	4.0
Tunisia	Durum	0.5	DM-EC-US-CN	4.0
	Common		US-EC-DM	4.0
Ghana	Hard	0.5	CN-US	4.0
	Soft		EC	-
Togo	Hard	1.0	US-CN	2.0
	Soft		EC	-
Egypt	Domestic	3.0	DM	-
	Foreign		AU-Other	-
	Australian	0.5	AU	-
	Other		US-EC-SA-CN	3.0
Yemen	Generic	_	AU-EC-US-DM-CN	4.0
Pakistan	Domestic	0.5	DM	-
	Foreign		US-AU-EC-CN-SA	3.0
Sri Lanka	Hard	0.5	US-SA-CN	3.0
	Soft		US-EC-AU-AR	3.0
Japan	High Quality	0.5	US-CN-AU	1.0
	Low Quality		DM-AU	1.0
Korea	Food	0.5	US-AU-CN	1.0
	Feed		CN-EC-SA-AR	1.0
Taiwan	Hard	0.5	US-CN	1.0
	Soft		US	-
China	High Protein	0.5	CN-US-AU-AR-SA	3.0
	Low Protein		DM-US-EC	3.0
The Philippines	Hard	0.5	US-CN	3.0
	Soft		US-EC-AU-SA	3.0
Indonesia	Hard	0.5	CN-AR-SA-US	3.0
	Soft		AU-EC-US	3.0

- = Not applicable.

[1] Supplier codes: US- United States; CN- Canada; EC- European Community; AU- Australia; AR- Argentina; SA- Saudi Arabia; DM- Domestic.

Table 6—Elasticities of substitution: Other importers

Importer	Wheat class	Between-class substitution elasticity	Suppliers[1]	Within-class substitution elasticity
United States	Durum	0.5	US-CN	4.0
	Non-Durum			
	Hard	1.0	US-CN	4.0
	Soft		US	-
European Community	Soft	0.5	EC	-
	Hard		US-CN-SA	3.0
Mexico, Central America	Hard	0.5	US-CN	3.0
	Soft		EC-US-AR-DM	3.0
Other South America	High Protein	0.5	US-CN	3.0
	Low Protein		DM-AR-US-EC	3.0
Other Western Europe	Soft	0.5	DM-EC	-
	Hard		US-CN-SA	3.0
Eastern Europe	Soft	0.5	DM-EC	-
	Hard		US-CN-SA	3.0
Other North Africa	Durum	0.5	DM-CN-US-EC	4.0
	Common		EC-US-DM-CN	4.0
Other Sub-Saharan Africa	Domestic	3.0	DM	-
	Hard		US-CN-SA	4.0
	Soft		EC	-
Other Near East	Domestic	3.0	DM-SA	-
	Foreign			
	Australian	1.0	AU	-
	Other		EC-US-CN-AR	4.0
Other Far East	Hard	0.5	AU-US-CN-SA	3.0
	Soft		EC-US	3.0
Rest of World	Generic	-	US-EC-AU-SA-DM	3.0

- = Not applicable.
[1] Supplier Codes: US- United States; CN- Canada; EC- European Community; AU- Australia; AR- Argentina; SA- Saudi Arabia; DM- Domestic.

It is not possible to trace the EEP certificates because certificates were also issued for in-kind payments of other Government programs. However, personal contact with officials of the Agricultural Stabilization and Conservation Service (ASCS) in Kansas City indicates that, of all certificates issued over the life of the commodity certificate program, 25 percent were redeemed for wheat. This proportion is incorporated in this analysis for both the differentiated and homogeneous wheat cases. When scenarios are run, the total amount of reduced EEP expenditures is calculated. This amount is divided by the domestic wheat price to yield the volume of EEP shipments. Twenty-five percent of this amount is assumed to have been originally released from CCC stocks to help finance the program subsidies. With the modeling of the program removal, this amount is withdrawn back into CCC stocks, thereby putting upward pressure on wheat prices when the program is removed.[5]

[5] The proportion can be adjusted to judge the sensitivity of results to particular proportions. These are not reported in the analysis because the goal of the analysis is a comparison of outcomes based on wheat heterogeneity assumptions rather than a formal analysis of the EEP. Nonetheless, the higher the proportion, the less the domestic price is affected by EEP removal. In the case where the proportion is set at 1.0, the domestic price still falls when the EEP is removed. This result would indicate elastic export demand.

Figure 2
Export Enhancement Program for wheat:
Export volume and proportion of total trade,
1986/87-1991/92

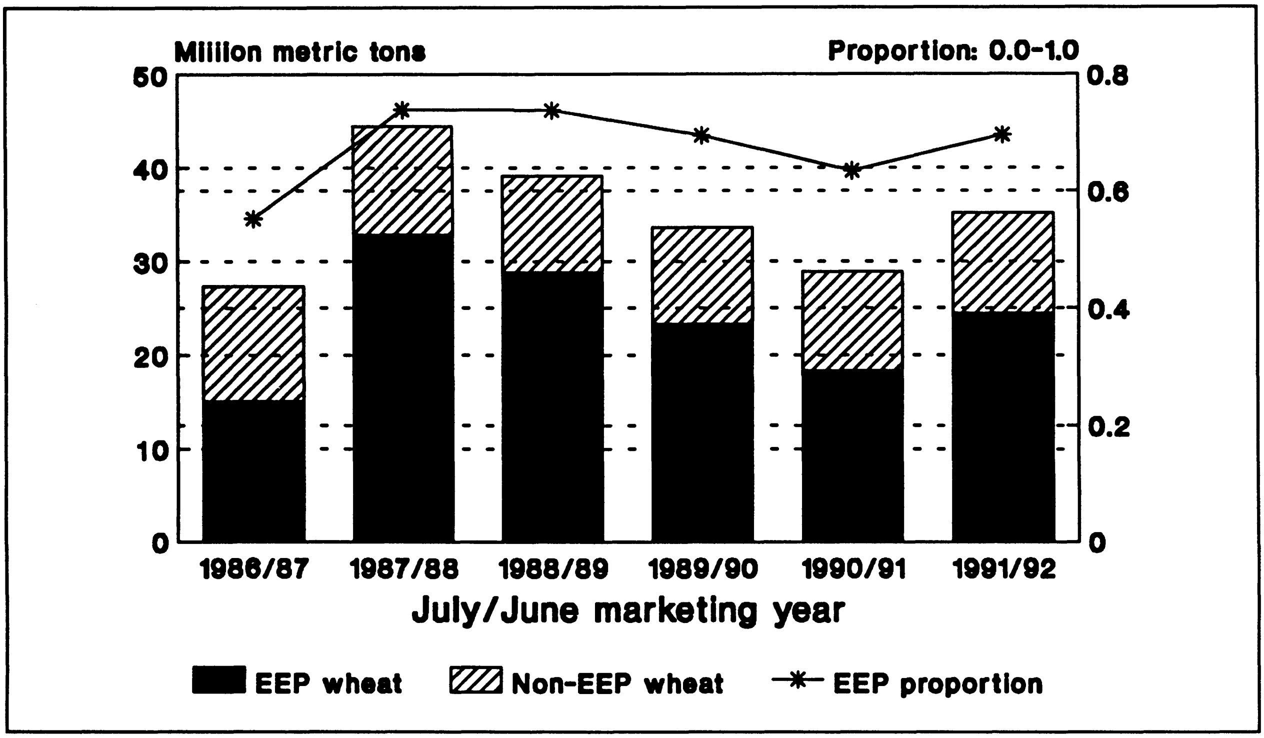


Figure 3
Export Enhancement Program for wheat:
Yearly subsidization, 1986/87-1991/92

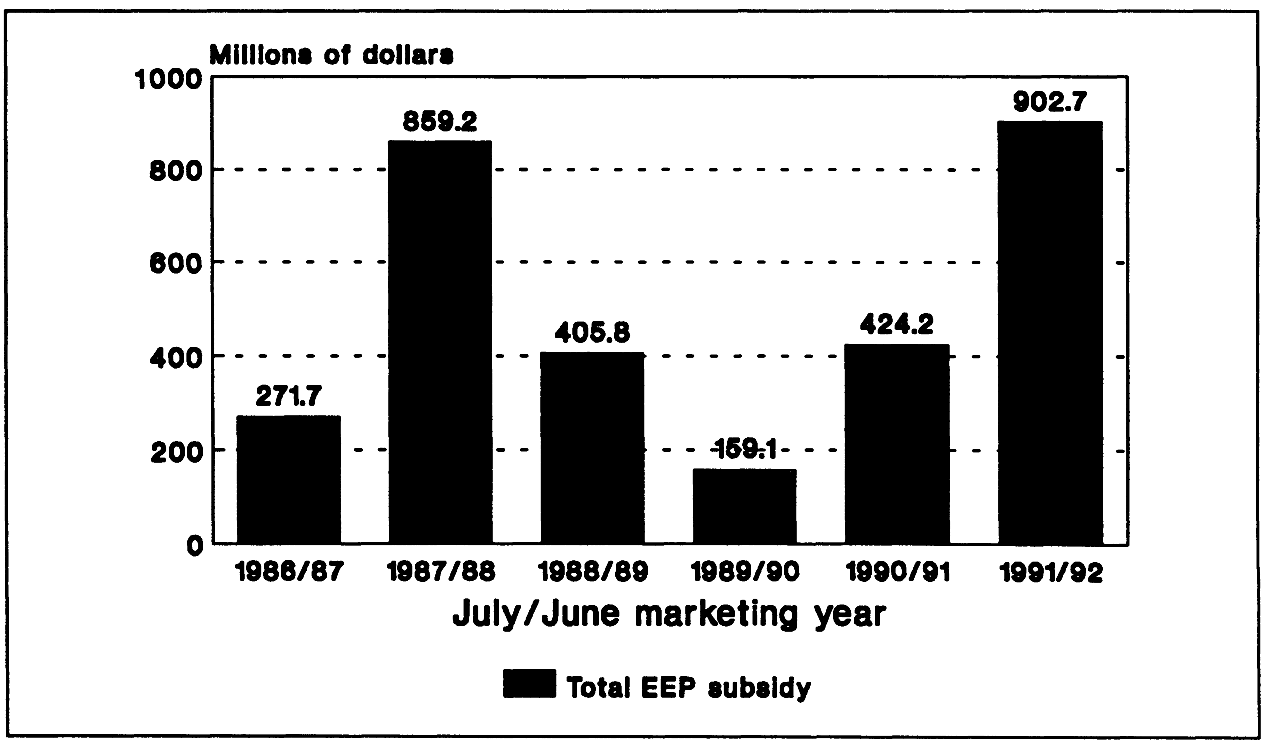
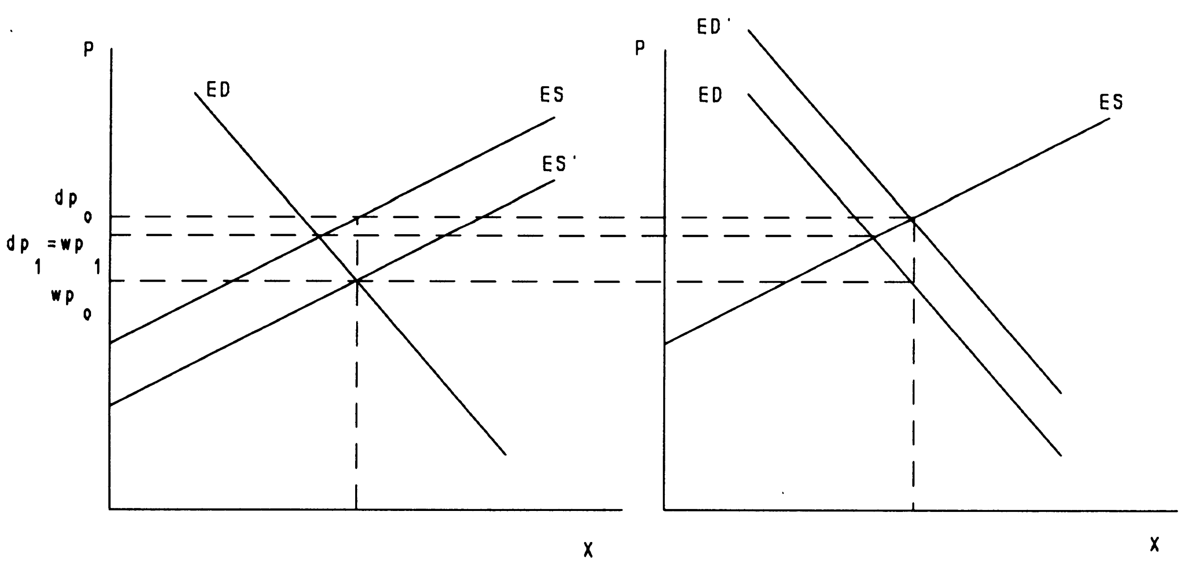


Table 7–Export Enhancement Program bonuses for U.S. wheat: July-June marketing year

Country/Region	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	AV
				Dollars per metric ton			
Venezuela	--	--	--	--	--	1.29	0.13
Brazil	--	23.21	--	--	7.55	28.74	13.72
Mexico, Central America	--	12.18	10.84	2.53	1.95	4.84	6.43
Other South America	--	7.17	1.88	1.86	8.47	3.66	4.06
Other Western Europe	--	12.83	2.61	0.28	45.17	36.47	14.64
Former Soviet Union	43.14	27.65	20.59	15.98	38.90	46.68	30.45
Eastern Europe	34.39	38.30	3.31	6.48	2.02	40.68	34.88
Morocco	40.93	30.44	18.47	15.14	41.98	42.11	31.64
Tunisia	24.32	33.43	--	5.65	45.71	41.02	28.91
Other North Africa	32.34	32.26	19.14	13.33	37.24	51.30	30.72
Ghana	40.21	34.82	22.06	16.88	44.07	55.95	27.56
Togo	40.21	34.82	22.06	16.88	44.07	55.95	37.18
Other Sub-Saharan Africa	7.15	9.41	8.41	16.57	5.75	55.95	13.39
Egypt	30.19	21.83	13.39	4.30	33.96	55.55	25.20
Yemen	--	8.98	21.42	9.94	20.24	30.89	18.94
Sri Lanka	33.69	31.62	11.86	7.33	35.38	44.97	25.67
Other Near East	15.16	12.27	9.64	3.64	15.20	7.62	9.99
China	34.25	35.42	20.38	5.15	27.32	43.47	25.52
Philippines	--	21.11	7.90	2.79	22.08	35.34	17.15
Other Far East	--	25.72	10.36	--	--	10.46	10.60
All importers	10.10	20.04	10.48	4.79	14.99	26.38	14.83

AV = Average.
-- = None.

Figure 4
Alternative ways to model the EEP



Cases:
(1) Homogeneous wheat,
(2) Differentiated wheat and
uniform subsidy.

Case:
(3) Differentiated wheat and
targeted subsidy.

Producer Responses

When evaluating the effects of the EEP, we assumed that the effects are incorporated in the base data used to initialize the model. Modeling the removal of the program identifies the effects of the EEP. EEP removal affects prices, consumption, stock levels, production, and therefore, trade.

How producers are assumed to adjust to changed prices is a problem stemming from the use of a static model for analyzing the effects for a specific year. Most planting decisions would have been made on the basis of expected prices rather than actual realized prices. Also, the supply elasticities from the SWOPSIM database are typically assumed to represent medium term (3-year) supply adjustments to changed prices. While one can formulate appropriate price expectation assumptions under which the medium-term elasticities are entirely appropriate for the analysis, that option is not fully exercised here. Rather, ranges of results are reported. At one extreme, we assumed that there is no production response due to changed prices (supply elasticities set at zero). All adjustments come from changed consumption levels and changes in CCC stock levels. At the other extreme, producers are assumed to adjust fully within the current year to changed prices (supply elasticities set at levels in table 4). The true responses are assumed to be within the ranges presented. The distribution of "true" responses within the ranges could vary depending on whether an EEP was assumed to exist in the previous years. At some point, the modeling process becomes somewhat arbitrary. Nonetheless, whatever assumptions are necessary apply equally to both the cases of heterogeneous and homogeneous wheat.

Modeling Results

We modeled the removal of all EEP subsidy wedges. The subsidies shown in table 7 are assumed withdrawn from importers of U.S. wheat for 1986/87 through 1991/92. The effects of the withdrawals are analyzed through six separate comparative static world wheat models, each having been constructed to capture relevant features of world wheat trade for each year for which analysis is intended.

Table 8 shows base export volume and price data for the cases of homogeneous and heterogeneous wheat. Export volume in the homogeneous case is net wheat trade; that is, wheat produced domestically less wheat imported. Export volume for the differentiated case shows how much of the domestically produced wheat is exported. The world price in the homogeneous case is U.S. HRW, No. 2, valued at U.S. gulf ports. Prices of other exporters in the differentiated case are those reported by the International Wheat Council (IWC). These data provide the base against which to report modeling results, in terms of percentage changes from the base.

A priori, one expects a greater U.S. volume response due to export subsidy withdrawals for homogeneous wheat. Lack of distinguishing characteristics implies easy replacement of competitors' wheat for the higher priced U.S. alternative. This easy replacement implies that price movements toward a new world market equilibrium due to EEP removal would be small for differentiated wheat.

The situation is illustrated in figure 5. In terms of this discussion, the excess demand that the United States faces for homogeneous wheat (ED_H) is more elastic (because of numerous substitution possibilities) than the excess demand for differentiated wheat (ED_D). When the United States removes the subsidy wedge implicit in the vertical distancing of ES (no EEP subsidy included) and ES' (EEP subsidy included), exports fall more in the case of homogeneous wheat to X_H from X_o than in the case of differentiated wheat (to X_D). The price rises by less as well: from WP_o to WP_H instead of to WP_D. Rough calculations of these excess demand elasticities yield values of -1.44 for differentiated wheat and -4.84 for homogeneous wheat, more than three times as much. Therefore, one should expect the analysis to imply substantial differences.

Differentiated versus Homogeneous Wheat

Table 9 shows the range of results on wheat export volume. The U.S. range for the homogeneous case is larger than, and actually encompasses, the corresponding range for the differentiated case. This result is somewhat surprising in that one would expect the lower volume bound of the homogeneous case to be higher than the corresponding lower bound for the differentiated case. The upper bounds, which result from assuming that producers respond to changed prices, line up with expectations. Averaged over the entire 6-year period, export volume is reduced 15.8 percent for the homogeneous case and 10.9 percent for the differentiated case.

Table 8—Base export data

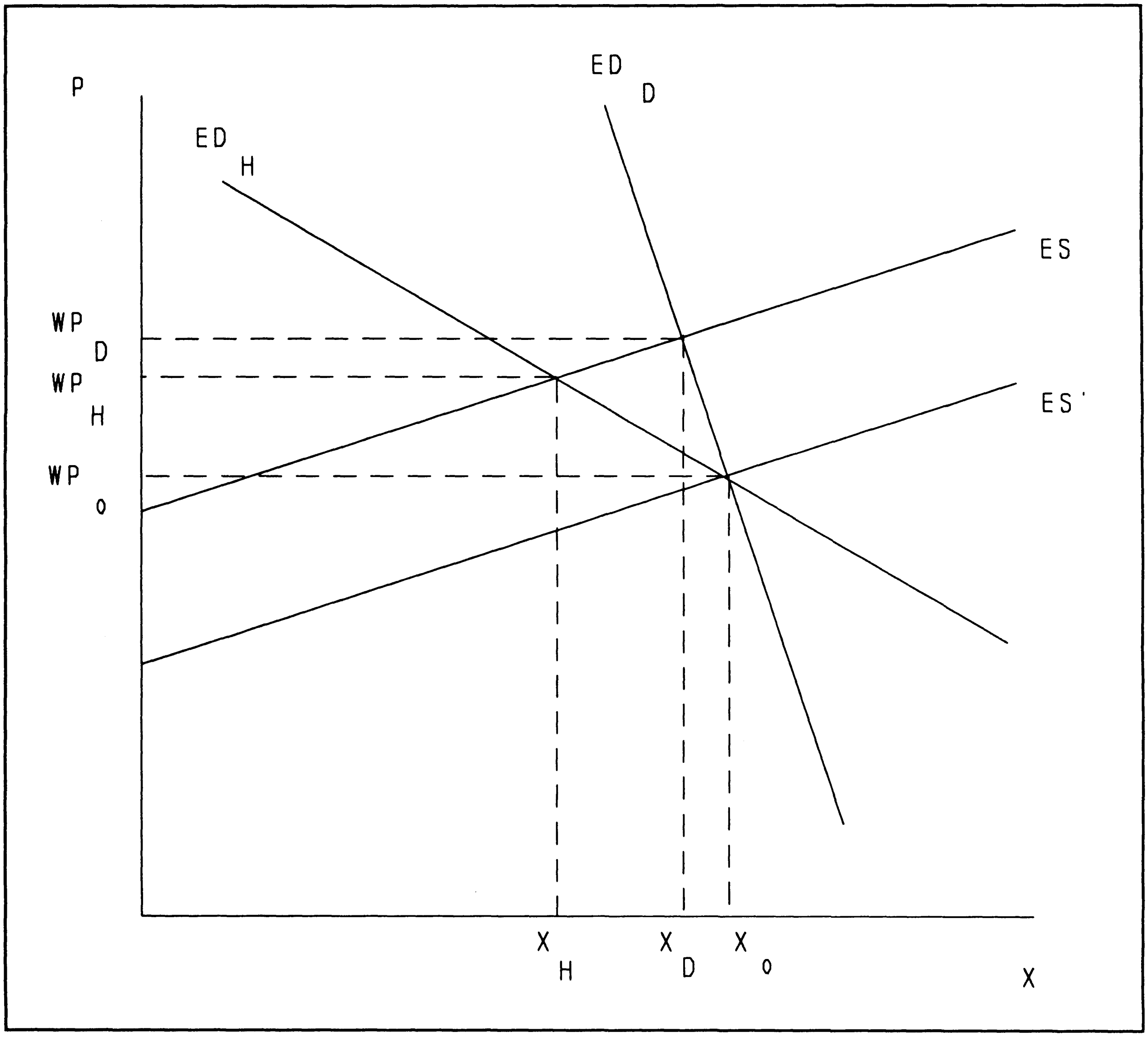
Item	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
Homogeneous case:						
			Export volume: 1,000 metric tons			
United States	26,903	44,086	38,733	33,213	28,305	34,220
Canada	20,914	23,716	13,751	17,045	20,714	24,280
European Union	12,753	12,397	17,085	17,049	16,632	17,871
Australia	14,997	12,232	11,081	10,866	11,924	8,282
Argentina	4,359	3,824	3,416	5,779	4,680	5,539
Saudi Arabia	1,504	2,435	1,956	1,583	1,514	2,204
SUM	81,430	98,690	86,022	85,535	83,769	92,396
			Export prices: Dollars per metric ton			
U.S. HRW, No.2	110	124	167	162	118	150 (Gulf)
Differentiated case:						
			Export volume: 1,000 metric tons			
United States	27,330	44,436	39,086	33,549	28,893	35,161
Canada	20,914	23,716	13,751	17,045	20,721	24,316
European Union	15,485	14,678	19,382	18,914	18,286	19,283
Australia	14,997	12,232	10,848	10,866	11,925	8,283
Argentina	4,359	3,824	3,416	5,779	4,706	5,539
Saudi Arabia	1,504	2,435	1,956	1,583	1,671	2,425
SUM	84,589	101,321	88,439	87,736	86,202	95,007
			Export prices: Dollars per metric ton			
United States	110	124	167	162	118	150
Canada	136	152	211	181	147	175
European Union	83	84	147	142	90	126
Australia	110	125	172	168	127	160
Argentina	84	101	151	139	87	118
Saudi Arabia	73	83	114	111	84	106

Source: All except Saudi export price - IWC; Saudi export price - imputed by author.

Exports of the other exporters are minimally affected when producers are assumed to be not price-responsive (supply elasticities equal zero), regardless of the heterogeneity assumption. When producers are assumed to respond to price (supply elasticities at table 4 values), the expected pattern of export response is more evident. For Canada, the homogeneous case implies a 3.4-percent volume expansion when the EEP is eliminated versus a 2.4-percent expansion in the differentiated case. Corresponding percentages for the other exporters are as follows: EC, 2.0 versus 0.8 percent; Australia, 2.4 versus 1.4 percent; Argentina, 3.1 versus 2.1 percent; and Saudi Arabia, 0.3 versus 0.2 percent.

Table 10 shows the effects of EEP subsidy removals on wheat prices. The results are somewhat difficult to compare across all exporters because, in the homogeneous case, one wheat price is assumed to apply to all the exporters. Nonetheless, the predicted effect of a more modest price effect for the homogeneous case holds where it was expected, that is, for the United States. Averaged over the 6-year timeframe, the U.S. export unit value for the homogeneous case increases between 2.5 and 3.9 percent. The increase for the differentiated case is between 5.2 and 7.9 percent. Viewed from a perspective of the

Figure 5
Effects of removing an export subsidy:
Homogeneous product (elastic demand) versus
differentiated product (less elastic demand)



U.S. wheat exporting firm, EEP removal appears as a price decrease because the firm is no longer receiving the EEP subsidy. In this case, the loss associated with the homogeneous case is larger--between 6.0 and 7.3 percent--than with the differentiated case, which is between 3.4 and 5.8 percent.

Export revenue changes are shown in table 11. Export revenue is much more affected in the case of wheat homogeneity, especially when producers are assumed to respond to price changes. For the United States over the 6-year timeframe, EEP removal implies a 12.5-percent export revenue decrease, net of actual EEP subsidies, for the homogeneous wheat case. If wheat is treated as a differentiated product, the reduction is much less: 3.9 percent. Calculated in terms of how much export revenue is decreased by a unit EEP dollar, the homogeneous case makes EEP appear to have been fairly effective--export revenue is decreased $1.06 for each EEP dollar. This amount compares with $0.33 per EEP dollar for the differentiated case.

Table 9—EEP removal and the effects on wheat export volume

Item	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
			Percent changes from base[1]			
Cases:						
Reduction from base --						
United States:						
Homogeneous	5.2-16.7	6.3-17.9	2.6-7.1	1.2-3.7	7.5-22.2	7.9-24.7
Differentiated	6.6-9.0	9.8-15.1	3.5-5.6	1.9-3.3	9.5-14.0	11.8-17.9
Increase above base: assuming production response[2,3] --						
Other Exporters:						
Homogeneous --						
Canada	4.2	5.2	1.0	0.8	2.8	4.8
European Union	1.9	4.2	0.9	0.5	1.9	3.0
Australia	3.0	5.1	(2.1)	0.9	2.7	4.6
Argentina	3.1	6.8	2.1	0.8	2.0	4.4
Saudi Arabia	0.2	0.2	0.2	0.1	0.5	0.8
Differentiated --						
Canada	1.6	3.0	1.0	0.3	1.8	5.4
European Union	0.5	1.1	0.6	0.3	0.9	1.4
Australia	0.5	2.6	1.9	0.2	1.1	2.2
Argentina	1.7	4.6	2.3	0.3	1.2	3.4
Saudi Arabia	0.4	0.1	0.2	0.1	0.2	0.5

[1] Assuming: (i) No production response to changed prices, and (ii) Production response.
[2] Export volume response assuming no EEP effect on production is less than 1 percent.
[3] Parentheses indicate reduction from base.

Table 10—EEP removal and the effects on wheat export prices

Item	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
			Percent changes from base[1]			
Cases:						
Homogeneous	2.1-2.7	4.4-5.2	1.0-1.5	0.6-0.9	1.7-2.9	4.1-5.1
Differentiated --						
United States	5.6-7.9	6.4-10.6	2.2-3.6	0.4-1.5	6.2-10.2	10.1-13.4
Canada	1.4-1.7	3.8-4.7	1.3-1.4	0.0-0.3	1.4-1.7	4.9-6.7
European Union	2.8-2.9	6.9-7.1	2.4-2.6	0.6-0.9	5.5-5.8	5.1-6.6
Australia	0.5-1.1	2.9-5.2	1.4-2.7	0.0-0.1	0.9-1.8	2.0-4.9
Argentina	1.4-2.2	3.2-5.1	1.5-2.3	0.2-0.5	1.8-2.6	3.1-6.9
Saudi Arabia	4.8-4.9	4.4-4.7	1.6-1.7	0.1-0.5	1.1-1.2	7.6-8.7

[1] Assuming: (i) No production response to changed prices, and (ii) Production response.

The degree of assumed differentiation greatly affects the calculation of export revenue changes for the competitors. For Canada, export revenue would have been 6.7 percent higher had there been no EEP program for the 6-year period, assuming wheat homogeneity. The comparable percentage assuming differentiation is 4.9.

Comparable percentages for the EC are 4.8 versus 4.3 percent; for Australia, 5.1 versus 2.6 percent; and for Argentina, 6.0 versus 3.9 percent. Only for Saudi Arabia are percentages roughly equal: 3.5 to 3.9 percent.

Table 12 presents the volume and revenue changes, in yearly averages, that wheat differentiation assumptions implied. Because the averages were calculated from six observation points (each associated with a particular marketing year), one can test for the equality of means across the differentiation cases. The tests generally show that the volume and revenue differences are statistically significant, especially for the United States, Australia, and Argentina. The tests imply that for Canada and the EC, volume differences are more significant than the revenue differences. It only appears doubtful in the Saudi case that differentiation makes a difference in measuring the effects of the EEP.

Similar statistical tests were attempted for comparing volume and revenue levels (rather than the changes) between the EEP removal scenario and the base model that includes the EEP. For the most part, these tests did not produce statistically significant results, implying that factors other than the EEP were more important for year-to-year changes in the levels of wheat exports and export revenue. The only test that indicated a significant EEP effect involved market share. Table 13 shows the results.

Examination of table 13 reveals five noteworthy points. First, the U.S. trade share change is the only one that is statistically significant. This is not too surprising, given that the EEP is a U.S. program designed to expand U.S. market share. Second,

Table 11–EEP removal and the effects on wheat export revenue

Item	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92
			Percent changes from base[1]			
Cases:						
Reduction from base --						
United States:						
Homogeneous	3.1-14.5	2.2-13.6	1.6-5.7	0.6-2.9	6.0-25.1	4.1-20.9
Differentiated	1.4-1.8	4.0-6.1	1.3-2.1	1.5-1.8	3.9-5.2	2.9-6.9
Increase above base[2] --						
Other exporters:						
Homogeneous:						
Canada	2.5-7.0	4.5-10.8	1.0-2.5	0.7-1.7	2.0-5.8	4.5-10.1
European Union	2.7-4.7	5.7-9.6	1.2-2.4	0.8-1.4	2.1-4.9	5.0-8.2
Australia	2.2-5.8	4.4-10.6	(0.6-1.1)	0.7-1.7	1.8-5.7	4.4-10.0
Argentina	2.5-5.8	5.3-12.4	1.2-3.7	0.7-1.7	2.1-4.9	4.5-9.8
Saudi Arabia	2.3-2.9	4.4-5.4	1.0-1.7	0.7-1.0	2.0-3.4	4.4-5.9
Differentiated:						
Canada	1.9-3.0	4.8-7.0	1.5-2.3	0.0-0.6	2.2-3.2	7.6-10.6
European Union	3.0-3.3	7.4-8.1	2.8-3.0	0.7-1.2	6.1-6.4	6.5-7.2
Australia	0.9-1.1	5.2-5.7	2.9-3.3	0.0-0.3	2.0-2.0	4.2-5.4
Argentina	2.5-3.1	6.3-8.0	2.9-3.8	0.2-0.8	3.0-3.2	6.6-7.8
Saudi Arabia	5.2-5.4	4.5-4.8	1.8-1.8	0.1-0.6	1.3-1.4	8.1-9.1

[1] Assuming: (i) No production response to changed prices, and (ii) Production response.
[2] Parentheses indicate reduction from base.

in the case of homogeneous wheat, the average U.S. trade share decreases more than 5 percentage points when the EEP is removed, versus about 3 percentage points in the case of differentiated wheat. Third, the significance levels are uniformly lower for the homogeneous case, implying a stronger justification for believing in the effectiveness of the EEP when wheat is modeled as a homogeneous product. Fourth, the ordering of exporters whose trade position has been the most adversely affected by the EEP is the same in both cases: Canada, the EC, Australia, Argentina, and Saudi Arabia. Fifth, the relative harm done to Australia and the EC is indicated higher in the homogeneous case than in the differentiated case. In terms of percentage changes, Australia's trade share position is increased by 7.6 percent for the homogeneous case, versus 4.7 percent for the differentiated case. The EC trade share position increases 6.7 percent versus 4.1 percent, respectively.

Table 14 shows trade volume results (aggregate wheat imports) from the importers' perspective for the 6-year period. The significance level of differences for all importers is 0.03, further stressing the importance of product differentiation in trade policy evaluation.

Targeted versus Uniform Subsidies

Targeting export subsidies is an important modeling concern contained within the differentiation issue. In the homogeneous wheat case, it is not possible to model targeting, because there is no way to distinguish a subsidy meant to expand U.S. imports from a general import subsidy covering all imports of wheat. For this analysis, a third scenario is run using the differentiated wheat model, but the EEP subsidy is modeled as a uniform subsidy.

Table 15 presents average yearly changes for the scenarios in a way similar to table 12 for wheat exporters. Except for Australia, targeting implies greater export volume and revenue effects than the uniform modeling approach. However, except for the EC and the United States in the case of export revenue, the significance levels are not low.

Over the 6-year timeframe, U.S. exports were calculated to be 9 percent lower if there had been no EEP. Explicit modeling of targeting implied 10.9 percent. The effects on U.S. export price were calculated to be between 7.4 and 9.4 percent higher than the base. This range compares with 5.2 and 7.9 percent for the targeted case. For export revenue, the uniform subsidy modeling implied only a 0.4-percent reduction compared with 3.9 percent under targeting. In terms of an EEP dollar, the return of export revenue enhancement would have been less than $0.04.

Table 12–EEP removal and effects on export volumes and revenues: Homogeneous versus differentiated wheat

	Average yearly change in export volume			Average yearly change in export revenue		
Exporter	Homogeneous	Differentiated	Significance level[1]	Homogeneous	Differentiated	Significance level
	1,000 metric tons			Million dollars		
United States	(5,422)	(3,792)	0.028	(601)	(168)	0.000
Canada	688	489	0.106	182	162	0.589
European Union	310	139	0.000	106	87	0.196
Australia	274	156	0.051	80	43	0.009
Argentina	142	99	0.047	39	21	0.004
Saudi Arabia	6	5	0.223	9	7	0.260

[1] Significance level of two-sided t-test shows that the difference in export volumes with and without the EEP is different from zero.

Table 13—EEP removal and effects on world wheat trade shares

Exporter	Homogeneous			Differentiated		
	Period average (with EEP)	Model result (without EEP)	Significance level[1]	Period average (with EEP)	Model result (without EEP)	Significance level
United States	0.398	0.343	0.008	0.384	0.353	0.031
Canada	0.228	0.247	0.107	0.222	0.235	0.223
European Union	0.178	0.190	0.131	0.195	0.203	0.250
Australia	0.131	0.141	0.230	0.127	0.133	0.404
Argentina	0.052	0.056	0.153	0.051	0.054	0.305
Saudi Arabia	0.021	0.022	0.182	0.021	0.022	0.373

[1] Significance level of two-sided t-test shows that the difference in trade shares with and without EEP is different from zero.

Table 14—EEP removal and the effects on import volumes: Homogeneous versus differentiated wheat

Item	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	Average	Significance level[1]
	Decreases in wheat imports: 1,000 metric tons							
All importers:								
Differentiated	1,837.87	5,219.88	1,567.72	935.15	3,213.02	4,006.28	2,796.65	-
Homogeneous	2,794.70	5,316.02	2,157.20	878.34	6,415.41	6,153.74	3,952.57	0.03

- = Not applicable.
[1] Significance level of two-sided t-test shows that the differences in average import volumes from 1986/87 through 1991/92 for the cases of differentiated and homogeneous wheat are different from zero.

Evaluation of Export Volume and Price Differences

Differentiation is important for modeling world wheat trade and for evaluating policy measures influencing wheat trade. Specifically, if the EEP is to be evaluated in terms of enhanced net export revenue, this analysis has shown large differences in results. Modeling wheat as a homogeneous commodity overstates the calculation of the net gains to the EEP, but modeling a targeted subsidy program as a uniform subsidy (which must be done when assuming homogeneity) causes an incomplete offsetting distortion.

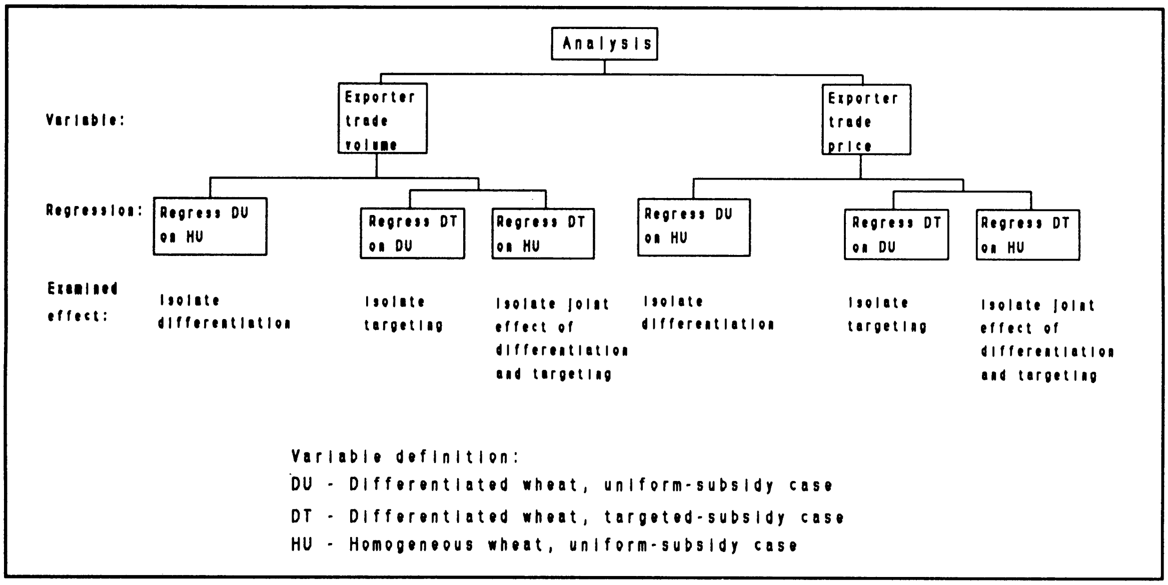
This section presents results from a method for allocating differentiation and targeting effects on export volumes and prices. Figure 6 illustrates the approach. Export volumes and prices resulting from modeling scenarios are used as observations in reduced-form econometric equations. There are two sets of three interdependent equations estimated (for a total of six equations): one set for exporter trade volumes, and the other set for exporter trade prices. In the first equation, either trade volume or export price from the differentiated wheat, uniform subsidy case (called DU) is regressed on the corresponding trade volumes or export prices from the equivalent scenario for the homogeneous wheat, uniform subsidy case (called HU). The difference between these variables DU and HU results from the differentiation of wheat. If the differences were not significant, the regression coefficient on the HU variable would be close to a value of unity.

Table 15—EEP removal and effects on export volumes and revenues: Uniform versus targeted subsidy

Exporter	Average yearly change in export volume			Average yearly change in export revenue		
	Uniform subsidy	Targeted subsidy	Significance level[1]	Uniform subsidy	Targeted subsidy	Significance level
	1,000 metric tons			*Million dollars*		
United States	(2,750)	(3,792)	0.056	(36)	(168)	0.000
Canada	375	489	0.236	122	162	0.226
European Union	80	139	0.003	51	87	0.002
Australia	152	156	0.863	41	43	0.781
Argentina	73	99	0.080	15	21	0.067
Saudi Arabia	4	5	0.276	5	7	0.207

[1] Significance level of two-sided t-test shows that the difference in export volumes with and without EEP is different from zero.

Figure 6
Regression method



In the second equation, trade volumes or export prices from the differentiated wheat, targeted subsidy case (called DT) are regressed on DU. The difference between DT and DU results from the targeting of subsidies. If the differences were not significant, the regression coefficient on the DU variable would be close to a value of unity. In the third equation, DT is regressed on HU. The difference between these variables results from the joint effect of differentiation and subsidy targeting. The quotient resulting from the division of the coefficient on HU by the second equation coefficient on DU yields an estimate of the differentiation effect. This value should be close to that of the coefficient on HU from the first equation.

Table 16 shows estimation results for the exporter trade volumes. The coefficient from the first equation equals 0.5779, with a small standard error of 0.0218. The hypothesis that this coefficient cannot be statistically distinguished from one is rejected with a significance level of 0.00 (tstat=(1-.5779)/.0218). This means that a lack of incorporating wheat differentiation overstates the effects of the EEP on exporters' trade volumes by an average of about 42 percent (that is, (1-0.5779)).

The results from the other two equations show similar statistical support for the importance of modeling targeting and differentiation. Results from the second equation imply that not modeling targeted subsidies understates the effects of the EEP on exporters' trade volumes by an average of about 20 percent. Results from the third equation imply that a lack of joint modeling of differentiation and targeting overstates the effects of the EEP on exporters' trade volumes by an average of about 30 percent. Results from the second and third equations taken together imply that a lack of differentiation causes a 42-percent overstatement of the EEP's effect on exporters' trade volumes (that is, (1-(0.6956/1.2002))). This result is nearly identical to that from the first equation.

Table 17 shows the estimation results for the exporters' trade prices. The statistical results do not tend to be as strong as they were in the case of exporters' trade volumes. Only in the second equation can it not be rejected that the estimated coefficient does not differ from one. This result implies that a lack of explicit modeling of targeting overstates the price effects by about 18 percent. Results from equation 1 and from equations 2 and 3 differ in their implications about a lack of modeling differentiation. Equation 1 implies that not modeling differentiation overstates the price effect by about 18 percent, while equations 2 and 3 imply an understatement of about 14 percent.

Conclusion

Casual observation and formal testing both show that wheat is not the homogeneous good it is often assumed to be in economic (and especially international trade) models. Wheat is the primary input into a plethora of baked goods. These products require flours possessing distinctive characteristics that can only be supplied by specific wheats or by blending various types of wheat. Although these distinctions exist and are important in certain contexts, they have not been well accounted for in the evaluation of producer and trade policies affecting wheat.

Economic research described in this report indicates that wheat should be differentiated by end use and by country of origin for trade policy modeling. An explicit implication is that economic wheat models assuming product homogeneity generate estimates that have no clear interpretation.

Another implication is that conclusions regarding policy efficacy are themselves a function of the degree of heterogeneity assumed. The studies completed in the mid-1980's on the effects of the Soviet grain embargo showed how models specified with Armington assumptions could change the conclusions of economic analysis vis-a-vis those assuming product homogeneity.

This study has relied on wheat market information gathered as part of the international component of the ERS Grain Quality study. A series of comparative static world wheat models were constructed for the July-June marketing years 1986/87 through 1991/92. These models were different from many wheat models constructed previously, in that the focus was on the importing countries rather than the exporters. Importer surveys from the Grain Quality study were used to specify wheat import demand in individual countries. Essentially, qualitative market information was joined with existing econometric results to specify demand structures.

This study focuses on an analysis of the EEP. Most previous studies of the EEP have focused on special features associated with the program, such as targeting of the subsidies to specific importers and EEP as an in-kind subsidy program. This study also deals with those issues, but is focused primarily on the differentiation issue. A second set of models was

Table 16–Export volume equations

Variable definitions:

DU -- Trade volume in 1,000 metric tons from case of differentiated wheat and uniform subsidizing.
HU -- Trade volume from case of homogeneous wheat and uniform subsidizing.
DT -- Trade volume from case of differentiated wheat and targeted subsidizing.

-------------------------- OLS RESULTS[1]: ------------------------------

Equation 1
Dependent variable: DU

Valid cases:	36	Missing cases:	0
Total SS:	74,325,311.0000	Degrees of freedom:	34
R-squared:	0.9540	Rbar-squared:	0.9526
Residual SS:	3,420,848.5538	Std. error of est:	317.1958
F(1,34):	704.7233	Probability of F:	0.0000
		Log-likelihood:	(257.3956)

Variable	Coefficient	Standard Error	t-Stat	P-Value
C	(0.0414)	54.8237	(0.0008)	0.9994
HU	0.5779	0.0218	26.5466	0.0000

-------------------------- OLS RESULTS: ------------------------------

Equation 2
Dependent variable: DT

Valid cases:	36	Missing cases:	0
Total SS:	107,246,289.6389	Degrees of freedom:	34
R-squared:	0.9983	Rbar-squared:	0.9982
Residual SS:	185,769.8766	Std. error of est:	73.9177
F(1,34):	19,594.4452	Probability of F:	0.0000
		Log-likelihood:	(204.9592)

Variable	Coefficient	Standard Error	t-Stat	P-Value
C	(21.6362)	12.7553	(1.6963)	0.0990
HU	1.2002	0.0086	139.9802	0.0000

-------------------------- OLS RESULTS: ------------------------------

Equation 3
Dependent variable: DT

Valid cases:	36	Missing cases:	0
Total SS:	107,246,289.6389	Degrees of freedom:	34
R-squared:	0.9578	Rbar-squared:	0.9566
Residual SS:	4,524,106.2763	Std. error of est:	364.7766
F(1,34):	771.9877	Probability of F:	0.0000
		Log-likelihood:	(262.4272)

Variable	Coefficient	Standard Error	t-Stat	P-Value
C	(20.3535)	63.0475	(0.3228)	0.7488
HU	0.6956	0.0250	27.7847	0.0000

[1] Econometric nomenclature is standard. For specific reference, see GAUSSX software econometrics manual.

Table 17–Export price equations

Variable definitions:

DU -- Export prices in dollars per metric ton from case of differentiated wheat and uniform subsidizing.
HU -- Export prices from case of homogeneous wheat and uniform subsidizing.
DT -- Export prices from case of differentiated wheat and targeted subsidizing.

-------------------------- OLS RESULTS[1]: ------------------------------

Equation 1
Dependent variable: DU

Valid cases:	36	Missing cases:	0
Total SS:	590.2443	Degrees of freedom:	34
R-squared:	0.2037	Rbar-squared:	0.1802
Residual SS:	470.0348	Std. error of est:	3.7181
F(1,34):	8.6954	Probability of F:	0.0057
		Log-likelihood:	(97.3290)

Variable	Coefficient	Standard Error	t-Stat	P-Value
C	0.6147	1.2856	0.4782	0.6356
HU	0.8157	0.2766	2.9488	0.0057

-------------------------- OLS RESULTS: ------------------------------

Equation 2
Dependent variable: DT

Valid cases:	36	Missing cases:	0
Total SS:	445.7776	Degrees of freedom:	34
R-squared:	0.8993	Rbar-squared:	0.8963
Residual SS:	44.8898	Std. error of est:	1.1490
F(1,34):	303.6365	Probability of F:	0.0000
		Log-likelihood:	(55.0542)

Variable	Coefficient	Standard Error	t-Stat	P-Value
C	0.7067	0.2671	2.6460	0.0122
DU	0.8241	0.0473	17.4252	0.0000

-------------------------- OLS RESULTS: ------------------------------

Equation 3
Dependent variable: DT

Valid cases:	36	Missing cases:	0
Total SS:	445.7776	Degrees of freedom:	34
R-squared:	0.3583	Rbar-squared:	0.3394
Residual SS:	286.0499	Std. error of est:	2.9006
F(1,34):	18.9853	Probability of F:	0.0001
		Log-likelihood:	(88.3894)

Variable	Coefficient	Standard Error	t-Stat	P-Value
C	0.1219	1.0029	0.1216	0.9039
HU	0.9403	0.2158	4.3572	0.0001

[1] Econometric nomenclature is standard. For specific reference, see GAUSSX software econometrics manual.

constructed by essentially stripping away the product differentiation specification: all wheats become one generic variety, not specific to any source country, end use, or other distinguishing characteristic. A modeling scenario is completed for both model sets in which the EEP subsidies are assumed removed. The effects on prices, production, consumption, and traded quantities are calculated and compared across modeling approaches.

This study concludes that attention to the wheat differentiation issue is crucial when analyzing an important policy instrument such as the EEP. If wheat is assumed to be homogeneous, the EEP is calculated to have expanded export revenue above the cost of the program by 12.5 percent during the period 1986/87 through 1991/92. This percentage compares with only 3.9 percent if differentiation is specified as described in this paper. The corresponding comparison of the export revenue expansion per EEP dollar is $1.06 versus $0.33, a substantial difference.

A related issue that affects the analysis is the targeting of subsidies. When wheat is assumed to be homogeneous, it is not possible to track specific exporter-importer trade flows. In essence, the homogeneous wheat model carries with it a second distortion of imposing a uniform level of subsidies for all countries that import wheat from the United States. The question pursued in the study is whether this distortion matters.

If wheat is assumed to be heterogeneous and the EEP is modeled as a uniform subsidy, export revenue expansion resulting from the EEP is calculated to be only 0.4 percent, or $0.04 per EEP dollar. This result suggests that the omission of targeting causes an understatement of the EEP's beneficial effects. Further analysis reported in this study supports this hypothesis. Regression results suggest that a lack of targeting understates the effects of the EEP on wheat exporters' trade volumes by about 20 percent. The implication is that the homogeneous wheat specification, because it carries with it the uniform targeting component, involves more of a distortionary effect than implied in the modeling results reported above. Regression results that isolate the differentiation effects on exporters' trade volumes show that a lack of differentiation overstates the effects of the EEP by about 42 percent. This amount is 12 percentage points higher than the calculated effect implied by the same methodology applied to the joint case of differentiation and targeting.

This study confirms the results of other researchers who argue for improved specifications of the world wheat market. The modeling of other agricultural commodities may evidence similar conclusions. An implication is that multicommodity modeling efforts on which policymakers rely may need to focus more on product characteristics that differentiate similar products across national borders. This study suggests that the biases introduced through ignoring the issue may be truly significant.

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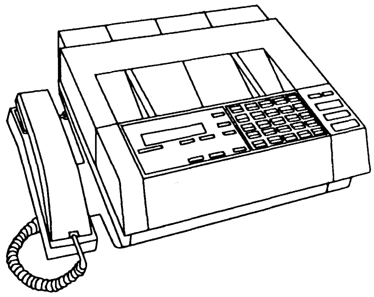

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