AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

USDA's Economic Research Service has provided this report for historical research purposes.

Current reports are available in
AgEcon Search
(http://ageconsearch.umn.edu)
and on https://www.ers.usda.gov.

United States Department of Agriculture
Economic Research Service
https://www.ers.usda.gov

A
93.44
AGES
89-55

ed States
artment of
culture

Economic
Research
Service

**Agriculture
and Trade
Analysis
Division**

Estimation and Evaluation of Economic Community Wheat Export Subsidies

Peter S. Liapis

WAITE MEMORIAL BOOK COLLECTION
DEPT. OF AG. AND APPLIED ECONOMICS
1994 BUFORD AVE. - 232 COB
UNIVERSITY OF MINNESOTA
ST. PAUL, MN 55108 U.S.A.

It's Easy To Order Another Copy!

Just dial 1-800-999-6779. Toll free.

Ask for *Estimation and Evaluation of Economic Community Wheat Export Subsidies* (AGES 89-55).

The cost is $5.50 per copy. For non-U.S. addresses, add 25 percent (includes Canada). Charge your purchase to your VISA or MasterCard, or we can bill you. Or send a check or purchase order (made payable to ERS-NASS) to:

ERS-NASS
P.O. Box 1608
Rockville, MD 20849-1608.

We'll fill your order by first-class mail.

A
93.44
AGES
89-55

Estimation and Evaluation of Economic Community Wheat Export Subsidies. By Peter S. Liapis, Agriculture and Trade Analysis Division, Economic Research Service, U.S. Department of Agriculture. Staff Report No. AGES 89-55.

Abstract

This report uses Granger's notion of causality to examine the relationship between the EC export subsidies and U.S. wheat export prices. The hypothesis that the EC's per unit export subsidy does not "cause" U.S., world, or EC export prices in the short run cannot be rejected, nor can the hypothesis be rejected that the U.S. or the world wheat price does not "cause" the per unit wheat subsidy. The results suggest a one-way causal relationship between EC exports and EC export price, but neither the export volume nor the per unit subsidy "cause" U.S. wheat export prices. The hypothesis that EC wheat exports are not caused by U.S. export prices is rejected, but causation is one directional without feedback; EC exports do not cause U.S. export prices. In determining the level of the monthly per unit subsidy granted, the EC responds to changes in the price of U.S. corn, but not to changes in the price of U.S. wheat, indicating that EC wheat competes with feed grains rather than U.S. wheat. The refund level also depends upon the ECU-U.S. dollar exchange rate. A 10-percent devaluation of the dollar relative to the ECU results in a 15-percent increase in the maximum wheat subsidy.

Keywords: European Community, export subsidies, Granger causality, trade, wheat.

Acknowledgments

The author thanks Jerry Sharples, Steve Magiera, and Robert Bishop for helpful comments, and Walter Gardiner and Ron Trostle for their careful review of the manuscript. Thanks are also extented to Wynette Phillips for her assistance with the tables and to Bonnie Moore and Jim Sayre for their editorial assistance.

WAITE MEMORIAL BOOK COLLECTION
DEPT. OF AG. AND APPLIED ECONOMICS
1994 BUFORD AVE. - 232 COB
UNIVERSITY OF MINNESOTA
ST. PAUL, MN 55108 U.S.A.

Washington, DC 20005-4788

November 1989

Contents

	Page
Introduction	1
The Role of the EC in World Wheat Trade	2
EC Grain Export Policy	5
Graphical Representation of the EC Wheat Market	7
Previous Analysis of the International Wheat Market	11
Causality Tests	13
Estimation of EC Per Unit Wheat Export Subsidy	21
Estimation Results	22
Specification Test	26
Conclusions	27
References	30

Estimation and Evaluation of Economic Community Wheat Export Subsidies

Peter S. Liapis

Introduction

The Common Agricultural Policy (CAP) of the European Community (EC) has been a source of contention in world agricultural markets. In the eighties, the United States and the EC have become more confrontational regarding world trade. A particular source of controversy has been the grains market, especially wheat, where the EC has become a significant exporter while the market share of the United States has declined. The United States and other exporting countries contend that the EC increased its market share at the expense of the other exporters because of unfair trading practices, including the use of export subsidies. Partly in response to EC export subsidies, the United States announced its Export Enhancement Program (EEP) whereby exports are subsidized to countries where the United States has lost market share due to unfair trading practices of competitors.

The United States and other exporters contend that the major reason the EC has increased its market share is through the use of export refunds. In 1974, the EC spent 76 million European Currency Units (ECU's) on cereal (mostly wheat) export refunds. Twelve years later, in 1986, the EC spent over 1.7 billion ECU to subsidize grain exports.

Such a staggering increase in export subsidies (and subsidized exports) has undoubtedly disrupted the world cereal markets. This report provides background information on the role of the EC in world grain trade, analyzes the effects of EC wheat export subsidies on U.S. wheat exports, and econometrically estimates the per unit wheat export subsidy relationship in the EC. Important questions addressed include the following. Is there a causal relationship between the per unit EC wheat export subsidy or export volume and U.S. export wheat prices? What is the EC's wheat export reaction function? What are the important variables that determine the per unit export subsidy? Answers to these questions may enlighten the controversy.

The Role of the EC in World Wheat Trade

The EC has been exporting wheat since the 1970's, but became a major wheat exporter in the eighties. It is now the third largest exporter after the United States and Canada. Figure 1 shows the evolution of EC wheat exports to, and imports from, nonmember countries. Note that exports increased dramatically while imports declined from 1975/76 to 1985/86.

Trade data for the EC, the United States, and world total are presented in table 1. World trade increased steadily until 1981/82, then rebounded in 1983-85 before tumbling in 1985/86. Until the eighties, U.S. exports tended to follow the world pattern. However, even though world trade rebounded between 1983 and 1985, U.S. exports continued to decrease. Provisional data indicate that worldwide wheat trade decreased 26 percent in 1985/86 marketing year while U.S. wheat exports decreased 59 percent. Wheat exports from the EC, on the other hand, increased throughout most of the 10-year period. Although EC exports also decreased in 1985/86, they decreased less than the U.S. or total world exports (23 percent decline for the EC relative to the previous year). Thus, the EC's share of world wheat trade increased from 8 percent (excluding intra EC trade) in 1975/76 to 14 percent in 1985/86, while the U.S. share declined from 50 percent to 29 percent.

Figure 1. EC wheat trade with nonmember countries

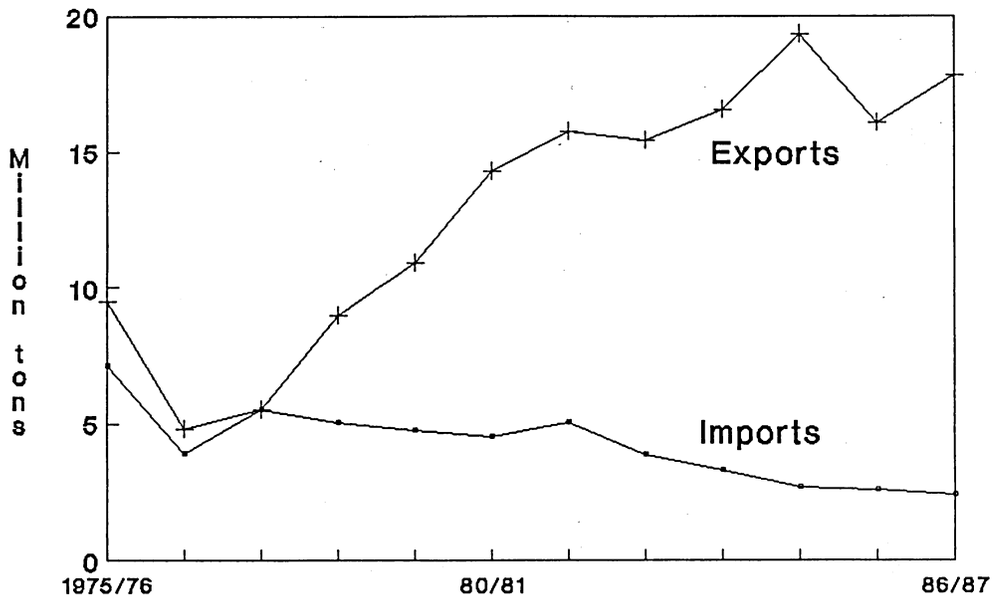


Table 1--EC, U.S., and world total wheat and wheat flour exports

July/June year	EC[1]			U.S.			World		
	Wheat	Flour[2]	Total	Wheat	Flour[2]	Total	Wheat	Flour[2]	Total
	1,000 tons								
1975/76	4,823	2,906	7,729	30,732	790	31,522	61,289	5,234	66,523
1976/77	1,512	2,400	3,912	24,749	1,646	26,395	55,982	5,813	61,795
1977/78	1,383	3,096	4,479	29,956	1,539	31,495	65,767	6,594	72,361
1978/79	4,065	3,284	7,349	30,987	1,463	32,450	65,048	6,681	71,729
1979/80	6,146	4,125	10,271	35,095	1,486	36,581	78,490	7,495	85,985
1980/81	8,353	4,331	12,684	40,372	1,705	42,077	85,601	8,451	94,052
1981/82	9,609	4,331	13,990	48,011	1,320	49,331	93,805	6,940	100,745
1982/83	11,105	3,069	14,174	37,485	1,825	39,310	89,849	6,296	96,145
1983/84	11,108	3,932	15,040	36,152	2,166	38,318	92,992	7,428	100,420
1984/85	13,388	3,909	17,297	35,644	1,087	36,731	96,650	5,959	102,609
1985/86	10,889	3,525	14,414	22,392	1,103	23,495	76,764	5,326	82,090

[1] EC exports do not include intra-EC trade.
[2] Including durum.

Trade flow data indicate that many regions/countries import wheat from both the United States and the EC. Table 2 shows various importing regions and the proportion of their imports supplied by the United States and the EC since 1979/80. During this period, the EC exported between 93 and 97 percent of its total exports to these regions, while the United States exported 79-84 percent of its total exports to these regions. From the data in table 1, one can calculate the U.S. and EC share of world wheat trade. Table 1 data indicate that the EC increased its market share while the U.S. market share decreased. A possible explanation for this development (aside from exchange rate considerations) is that the EC has unfairly encroached on U.S. markets through the use of export subsidies. The data in table 2, however, do not show a marked increase in EC market share at the expense of the United States except in the USSR and Eastern Europe markets. The large shifts in EC share relative to the U.S. share in Eastern Europe and USSR, may have more to do with political considerations (the U.S. grain embargo, Poland) rather than economic factors.

Another consideration is that wheat is traded in bulk and in processed form as wheat flour. Table 1 also presents data on flour trade in wheat equivalent. Between 1975/76 and 1985/86, the grain equivalent of wheat flour averaged 8 percent of total wheat exports. When the wheat equivalent of flour exports is

Table 2--Proportion on total wheat and wheat flour imports supplied by the United States and the EC

Area	1979/80		1980/81		1981/82		1982/83		1983/84		1984/85		1985/86	
	EC	U.S.	EC	U.S.	EC	U.S.	EC	U.S.	EC	U.S.	EC	U.S.	EC	U.S.
	Percent													
Africa	36	38	39	39	35	44	29	48	34	43	36	39	34	37
W. Europe	4	59	8	54	9	56	4	47	7	46	10	45	7	39
E. Europe	27	38	37	13	55	5	45	4	47	3	37	3	35	4
USSR	6	34	5	20	9	35	17	15	21	21	22	22	31	1
Near East	20	28	15	27	13	37	13	29	12	26	13	23	12	22
Far East	5	44	5	62	4	63	8	54	3	49	3	49	3	39

EC exports to Western Europe exclude intra-EC trade.

added to wheat trade statistics, the EC's share of the world market increases while the U.S. share decreases slightly.

Table 1 indicates a major difference in the composition of wheat trade of the EC compared with that of the United States. The proportion of wheat exported as flour is significantly larger for the EC than the United States. The EC is the major world exporter of flour, providing more than 50 percent of world's exports in most years, while the United States provides about 20 percent in most years. The wheat equivalent of flour exports averaged 4 percent of total wheat exports for the United States during 1975/76 to 1985/86. For the EC, 38 percent of total wheat exports were exported as flour. However, the importance of wheat exported as flour by the EC has decreased in the eighties. Wheat exports increased substantially while flour exports were relatively stagnant.

EC Grain Export Policy

The EC grain prices are fixed by the Council of Agricultural Ministers each year. The most important of these prices are the intervention price and the threshold price. The intervention price essentially serves as the floor price on EC grain prices. The threshold price is used to insulate the EC grain markets from the world markets. Grain imported from nonmember countries cannot enter the EC below this price.

EC grain trade is highly regulated. All imports and exports between the EC and nonmember countries require an import or export license. Traders apply for a license, indicating the volume they want to either import or export. The license imposes an obligation on the trader to import or export the stated quantity within the time period for which the license is valid. Once the license is granted, failure to comply with the requirements results in forfeiture of the security deposit which is paid with the license application.

Grain imports by the EC from nonmember countries are subject to a variable levy which is the difference between the lowest "world" price, including cost, insurance, and freight (cif), available at an EC port and the threshold price. A levy is calculated for each type of grain. This levy varies with changing world prices and is set daily by the EC Commission.[1] The import levy assures that imported grain does not sell below the threshold price.

---

[1] To calculate the wheat import levy, one adjusts imported wheat prices by various coefficients which account for quality differences and convert the various wheat grades into a homogeneous, "standard wheat" upon whose price the levy is determined.

The EC Commission has considerable discretion in operating the mechanism which determines grain exports to nonmember countries. Grain exports are facilitated by using export refunds (subsidies) which bridge the gap between the relatively high domestic prices and low "world" prices.[2]

Export refunds are determined by one of two methods. Under one method, export refunds are fixed weekly by the Cereals Management Committee and can vary depending upon where the importing country is located. The world is divided into seven zones for determining export refunds.

The second method of determining export refunds is the tender system under which most EC grain is exported. Traders submit bids and compete for the subsidy. Wheat exported under this process is from the open market (commercial stocks), from EC intervention stocks, or to meet the EC's commitment for food aid.

Under the open market system, exporters submit their bids to authorities in a member country, who then send them to the Cereals Management Committee. The bid contains information on the desired export volume and the per unit refund. Each week, the Cereals Management Committee, based on the bids before it, decides whether to fix a maximum refund. If the Committee decides to fix a maximum refund, a contract is granted to everyone who submitted bids equal to or less than that refund. After the contracts are awarded, exporters must apply for a license to export the volume awarded. The license is normally valid for the month when the bid was submitted, plus 4 months. These licenses are transferable and a market for them exists. Exporters do not have to export all of the grain stipulated on the license. However, if only part of the quantity tendered is exported, part of the security deposit is withheld. As is the case under the fixed export refund system, the Commission can manipulate exports by restricting open market tenders to destinations in particular countries or zones.

Tenders are also held to export wheat that was originally sold to intervention agencies. The rules for exporting out of intervention stocks are similar to the rules governing exports from the open market. However, the tenders to export wheat from intervention stocks must specify the price exporters are willing to pay. The subsidy is implied in the bid price. Bids with the highest price (lowest implied subsidy) are accepted.

The intervention agency of a member country issues an invitation for bids to export grain from intervention stocks. The Commission authorizes the volume that can be exported and the EC

---

[2] The terms refund and subsidy are used interchangeably in this report.

regions to which the tenders will apply. Based on the bids submitted, the Management Committee fixes a minimum sales price which can differ according to destination. Bids that are equal to or above the minimum price are accepted.

Food aid to developing countries is an additional outlet for EC grain exports. The grain for food aid can come from either open market or intervention stocks and bids are submitted once an invitation to tender has been issued. The volume exported through this method is not very large. The EC under the 1986 Food Aid Convention is committed to supply 1.67 million tons of grain annually. A portion of the grain provided as food aid is exported through the bilateral aid schemes of individual member states and the rest is provided through Community operations.

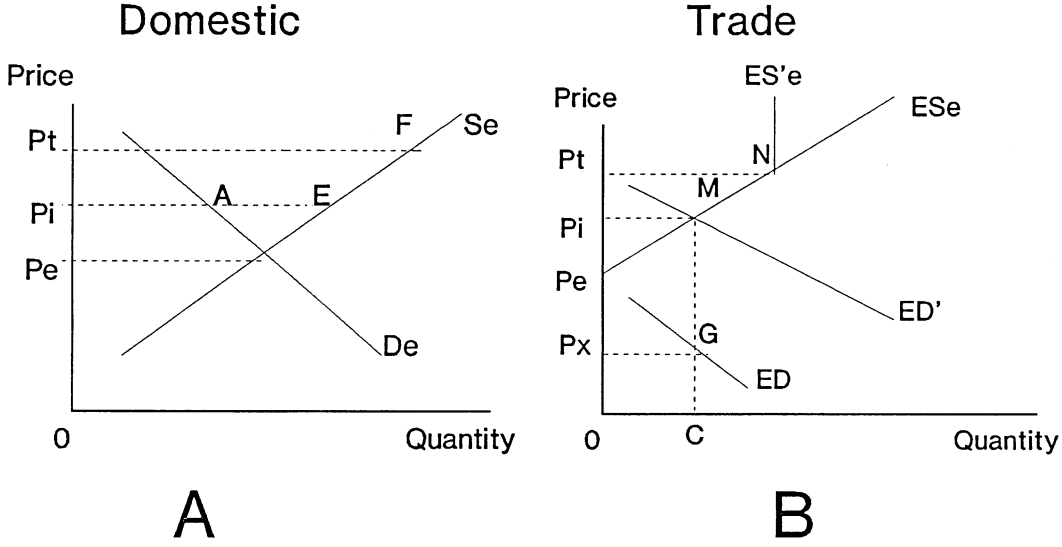
Graphical Representation of the EC Wheat Market

Figure 2 illustrates the operation of the EC wheat market. D_e and S_e in panel A represent domestic wheat demand and supply respectively. Assuming no government intervention and a closed economy, P_e would be the equilibrium price. With the imposition of the CAP for grains, P_i represents the intervention price for wheat, the price that the EC essentially guarantees to the domestic wheat producers. The intervention price, P_i, provides a floor on domestic prices because wheat which meets quality and other criteria can be sold to intervention at this price. P_t is the threshold price, or the minimum import price. In most years, the intervention price, P_i, has been above P_e and below the threshold price, P_t.

Panel B in figure 2, represents the EC's excess supply curve (the difference between domestic supply and demand) and the rest of the world excess demand for EC wheat. Excess demand is downward sloping because the EC is a large country case. In the absence of the CAP, excess supply is ES_e. With intervention and threshold prices, the excess supply is $CMNES'_e$. At the intervention price, the difference between supply and demand (AE in panel A) represents the volume available to export (OC in panel B). When the world price is between the intervention and threshold price, the excess supply is the curve ES between points M and N. Excess supply becomes inelastic above the threshold price (point N) because, if excess demand increases and intersects excess supply above N, the EC imposes export taxes.

The intersection of excess demand and excess supply curves determines the EC export price and, under normal conditions, the per unit export subsidy, which is the difference between the intervention and the export price. The excess demand faced by EC exporters normally results in an export price which is below the intervention price. For example, if the excess demand is ED in panel B, the export price is P_x, and the per unit export

Figure 2. EC wheat market

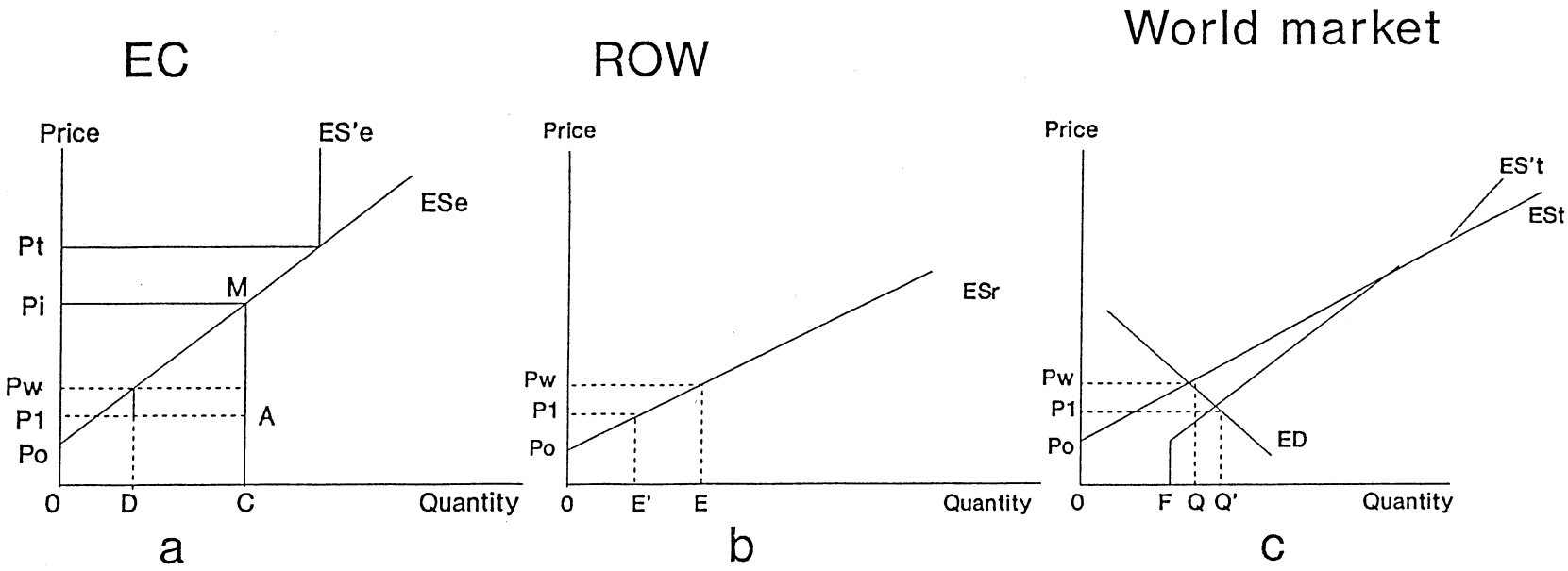


subsidy is $OP_i - OP_x$. If the excess demand is ED', however, the export price equals the intervention price and the per unit export refund is zero. In the unusual event that the excess demand is above N, the EC imposes export taxes to prevent additional exports.

As indicated in figure 2, for a given domestic demand and supply, the intervention price determines the volume available for export and the export revenue. Thus, for a given intervention price, changes in demand or supply in the rest of the world (as long as they result in excess demand lying everywhere below ED') do not affect the total revenue received by EC exporters. Rather, they affect the proportion that is paid by foreigners and the EC treasury. Total revenue received by exporting, say, quantity C, would be $C * P_i$, where $C * P_x$ comes from importers, and $(P_i - P_x) * C$ comes from the EC treasury. If the excess demand is ED', the export subsidy is zero, the cost to EC treasury is zero, and importers pay the total bill.

The effects of the intervention and export subsidy policy on other exporting countries and the world wheat market are illustrated in figure 3. Panel a represents the EC wheat export market from figure 2 (panel B). Panel b represents the excess supply schedule for all other wheat-exporting countries (ROW),

Figure 3. EC and world wheat market



and panel c represents the world wheat market where the excess supply schedule ES_t is the sum of the EC's and ROW excess supply schedules ($ES_e + ES_r$).[3]

Assuming free trade, equilibrium in the world market results in price of P_w and quantity traded of OQ which equals OD + OE. As illustrated, the EC is a wheat exporter even without the intervention/export subsidy mechanism.

When the EC sets the intervention price at P_i, its export supply increases to OC. This additional supply of EC wheat on the world market causes the world excess supply schedule to shift to the right by OF which equals OC. With this EC policy, if world price decreases below P_o, the EC would be the only exporter. Notice that the new world excess supply schedule, ES'_t, has a steeper slope than the old schedule when prices are below P_i and when prices are above P_t. The two schedules are the same for prices between P_i and P_t.

The EC policy increases world trade from OQ to OQ' while lowering world price to P_1. EC policy, therefore, helps importing countries at the expense of other exporting countries and EC consumers. The cost to the EC treasury is represented by the area of the rectangle P_iMRP_1 in panel a. The cost of the EC policy on other exporters is indicated in panel b. The lowered world price induces supply to decrease in other exporting countries from OE to OE', and lost revenue from exports is the shaded area P_1P_wEE'.

The extent of the loss incurred by ROW exporters from the EC policy depends on the relative elasticity of their excess supply and world demand. For a given excess supply schedule, the more inelastic the excess demand, the larger the change in the world price and the smaller the change in total quantity traded. The ROW exporting countries, therefore, have to cut back their exports relatively more when world demand is inelastic to accommodate the added supply pushed on the world market by the EC policy. In the extreme case of perfectly elastic excess demand, world price does not change, ROW exporters do not adjust their trade volume, and total trade increases by the amount offered by the EC. In this case, importers benefit and ROW exporters are no worse off than before the EC exports. The only losers are the EC consumers.

Similarly, for a given excess demand, the more inelastic the excess supply function of ROW exporting countries, the larger the change in world price that results from additional EC exports, and the smaller the adjustment in the traded volume of the ROW exporters. In the case of perfectly inelastic supply by the ROW

---

[3] Assuming constant exchange rates.

exporters, coupled with the perfectly inelastic EC supply, total world trade increases by the added EC supply while world price decreases to accommodate the added volume. In this case, although export volume from ROW does not change, ROW exporters are worse off because their export revenue decreases.

As illustrated in figure 3, the EC policy of guaranteed minimum intervention price along with export refunds benefits importing countries by enabling them to import more wheat at lower prices than would be the case without the EC policy. Rest of the world exporters are damaged by the EC policy because of lower world price and decreased export volume. Only in the case of perfectly elastic demand does the EC policy not hurt other exporters because, in that case, world price and ROW exports do not change.

Figure 3 can be used to infer direction of changes in the wheat market. For example, an increase in the excess supply by ROW exporters, holding EC trade and world demand constant, implies an increase in world trade, a lower world price, a larger per unit export subsidy by the EC, and a larger subsidy bill to the EC treasury. Similarly, an increase in EC exports (whether due to an increase in intervention price or a shift out of the supply curve), holding everything else constant, leads to the same results: lower world price, increased world trade, and an increase in the per unit and total export subsidy by the EC. An increase in world excess demand, holding everything else constant, will increase world price and lower the per unit and total EC export subsidy.

Previous Analysis of the International Wheat Market

The world wheat market is more complicated than the simple model represented by figure 3. Considerable research has been undertaken to analyze this market and many models, using different approaches, have been developed to describe it. The wheat market has been modeled assuming that it is a homogeneous product and it has been modeled assuming it is a differentiated product (23, 34, 42).[4] Furthermore, many different approaches have been used to quantify the relationships in the wheat market. For example, relationships in the wheat market have been estimated econometrically (either as a single commodity or in a system of equations incorporating other commodities) (9,13, 22, 23, 25, 38) or have been derived synthetically, or using Delphi techniques (22, 42). Game theory has also been used to analyze the wheat market. The game theory paradigm, rather than using the competitive market framework, assumes the market is oligopolistic; a few dominant firms (importing or exporting

[4] Underscored numbers in parentheses refer to literature listed in the References at the end of this report.

nations) control the market (8). Since the wheat market is notorious for government intervention, the impacts of such interference on world trade have also been examined (1, 2). The references cited here are only partially indicative of the volume of analysis conducted. For example, a 1981 survey on agricultural trade models by Thompson (34), lists 276 citations, many dealing with the wheat market, while a 1985 bibliography by Grennes (18) lists over 250 citations of articles on the economics of world grain trade, most dealing with wheat.

The EC's role in the world wheat market has also been analyzed extensively, with a variety of models and methods. Most of the recent studies have focused on the issue of trade liberalization. What is the impact of the CAP on world wheat trade (volume and price), and what will happen if the EC liberalized trade? All analysts reached the same conclusion: the CAP has reduced the world wheat price while increasing its variability.

For the most part, this conclusion is reached with models that assume wheat is a homogeneous commodity and employ the law of one price to obtain equilibrium conditions in world wheat market (3, 25, 27, 28, 29, 30, 31, 40, 41). With the exception of the paper by de Gorter and Meilke (12), the models ignored the simultaneous importing and exporting behavior of the EC.

With respect to the current controversy between the United States and the EC, some analysts have examined the impact on the world wheat market (and the EC) of the United States retaliating and providing export subsidies, either across the board (27) or targeted (21). However, these models also assume that wheat is homogeneous and employ the law of one price. Furthermore, none of the models uses econometrically estimated relationships between EC export subsidies and U.S. or world wheat price.

There are many different wheat prices in the world wheat market. For example, there is a different price for Argentine, Australian, and EC wheat, different prices for two varieties of Canadian wheat from four ports of export, and different prices for five varieties of U.S. wheat from three ports of export. This, coupled with trade flow data that show imports from more than one exporter, suggests that purchasers and sellers do distinguish among wheat varieties or source of supply, and although these different varieties may be close substitutes, there are perceived differences. There is some evidence that wheat is indeed a differentiated product (34, 42).[5]

---

[5] One could argue that the simultaneous import and export behavior of the EC is prima facie evidence that wheat is not a homogeneous product.

The law of one price, although a useful abstraction in longrun analysis will generally not hold in the short run, especially in a world where wheat is considered a differentiated product for political (risk considerations spreading supply sources), economic (price, quality), and other (seasonality, northern versus southern hemisphere) reasons.

The impact, if any, of EC export subsidies on U.S. wheat export prices, is an empirical one. One approach to quantifying the impact of EC export subsidies on world and U.S. wheat price and trade is to build a structural model and econometrically estimate export supply and import demand functions that include the EC's export subsidy as an explanatory variable. Previous researchers however, have described the pitfalls and problems with data, multicollinearity, specification, degrees of freedom, and others to adequately econometrically estimate these relationships (15, 34, 42). Furthermore, in cases where direct estimation was conducted, different researchers obtained very different results (15, 38, 39, 42), suggesting the sensitivity of the results to the method employed.

An additional factor that limits the feasibility of econometrically estimating a structural model that includes EC export refunds is data sparsities regarding those refunds; the EC did not become a substantial wheat exporter to nonmember countries until the late seventies. Furthermore, as figures 2 and 3 indicate, there are nonlinearities in the EC and world wheat markets, further reducing the applicability of conventional linear regression techniques to estimate a structural model. Since the evidence suggests that a single "best" modeling approach may not exist and there are data sparsities limiting the degrees of freedom, econometric estimation of a structural model is difficult. Therefore, I employed Granger's notion of causality to determine the relationship between EC export subsidies and U.S. wheat export prices. This technique uses bivariate time-series to directly address the intertemporal relationship between EC export refunds and U.S. prices, thereby reducing data needs.

Causality Tests

In this section, the empirical question--do shortrun variations in EC exports and export subsidies affect U.S. and world wheat prices--is addressed. The direction of causality is also examined.

The causal relationship between EC wheat export subsidies and U.S. wheat export price is examined by using the technique developed by Granger as described in Chow (10) and in Greenberg and Webster (18). It is not the purpose of this paper to enter into a theoretical or philosophical discussion regarding what is

meant by causality, although the reader is encouraged to examine the literature on the topic, including (11, 16, 43). I use Granger's definition of causality which exploits time-series relationships to identify causality. The notion is conditional on the information set which is generally bivariate. According to Granger's definition, variable X causes variable Y if we are better able to predict Y using past values of X and Y than by past values of Y alone. Instantaneous causality occurs when current as well as past values of X are employed to predict Y, and feedback or bidirectional causality occurs when X causes Y and Y causes X (10, 18). In the following, the terms causality, Granger cause, and effect, are used interchangeably. All are defined as above.

Causality tests for temporal ordering of economic variables have proliferated since the early seventies. Causality tests have been used to analyze the relationship between money and income (GNP) (14, 32), to test the hypothesis that the United States is a residual supplier of coarse grains (7), to determine relationships in fed cattle market (33), and to analyze agricultural productivity (4), to name a few. The usefulness of the technique is that it allows the data to specify the dynamic relationships between the two variables since theory is often ambiguous on explicit lead-lag relationships. Economic theory is used to suggest variables to be related.

Of the different methods that have been developed to empirically test causality, the two that are used here are based on regression techniques. The direct Granger method to test whether X causes Y is to regress Y on lagged Y and lagged X:

$$Y_t = \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{j=1}^{m} b_j X_{t-j} + e_t \qquad (1)$$

Under the null hypothesis that X does not cause Y, all the b_j should jointly equal 0. To test for instantaneous causation, current as well as lagged X are included in the regression; that is, the index j starts at 0. To test whether Y causes X, the regression above is estimated again with X as the dependent variable:

$$X_t = \sum_{i=1}^{n} c_i X_{t-i} + \sum_{j=1}^{m} d_j Y_{t-j} + u_t \qquad (2)$$

Under the null hypothesis that Y does not cause X, all d_j should jointly equal zero. Unidirectional causality from X to Y requires that some of the b_j must be nonzero while all the d_j

must equal zero. Similarly for Y to cause X, some of the d_j must be nonzero while all the b_j must be zero. Feedback occurs when some of the b_j and some of the d_j are nonzero.

A second approach to testing whether X causes Y is that developed by Sims (32). His method is to regress X on past, present, and future values of Y:

$$X_t = \sum_{i=-k}^{p} c_i \; Y_{t-i} + w_t \qquad (3)$$

The null hypothesis of no causality from X to Y is tested by determining whether the coefficients on the future values of Y are zero as a group. An analogous regression of Y on past and future X is estimated to test if Y causes X.

The null hypothesis of no causation in both approaches is tested using an F test on the constrained (some parameters are assumed to be zero a priori) and unconstrained regressions. The statistical validity of these methods depends on the assumption that the time series are stationary (that is, invariant with respect to time) and that the error series are white noise (5, 6, 10, 14, 18). Consequently, empirical implementations have transformed or filtered the time series so as to make them stationary while preserving causality. Frequently used transformations or filters include the natural log or the first difference of each series.

An alternative filtering technique, introduced by Sims (32), is $\{(1 - .75*L)^2\} * X_t$, where L is the lag operator, and X is expressed in natural logs. Sims assumed that this filter would result in regression residuals that are nearly white noise, thereby reducing or eliminating serial correlation. However, Bishop (5) and Belongia and Dickey (6) discovered that this filter does not transform all economic series into white noise processes, indicating that one should check the residuals to determine if they are well behaved.

Feige and Pearce (14) determined that causality results were sensitive to the type of prefiltering employed on the data, on the lag length, and on the specific causality test. In this analysis, therefore, the data were subjected to two causality tests using different filters and lag lengths to check on the robustness of the results. In order to determine causal relationships between EC export subsidies and "world" or U.S. wheat price, the Granger and Sims causality tests were employed while the data series were filtered using Sims transformation or first differences. Various lag lengths were also examined to determine the robustness of the results.

The discussion on the operation of the CAP and the simple illustrative model suggest several hypotheses that are tested using causality tests. The simple model suggested that, in the short run, EC wheat exports are predominantly a function of domestic market conditions. Do the data support this hypothesis; that is, does the world price "cause" EC wheat exports? The simple model also indicated that the volume of wheat exported by the EC "caused" world prices. Do the data support this contention? Finally, the model indicated that the per unit export subsidy is a residual of domestic conditions; that is, the per unit refund is not manipulated by the Cereals Management Committee to influence EC exports. If that is the case, the data should indicate that the per unit refund does not "cause" the world price nor the volume of wheat exported by the EC.

The hypotheses above referred to a world price. Since there are many different wheat export prices, the causality tests were conducted using various export prices. Monthly wheat prices (January 1981 to December 1985) for the United States, the EC, and the "world" were obtained from World Wheat Statistics, while monthly export refunds and volume of wheat exports were calculated from Agra Europe. For the United States, the prices examined were: No. 2 Dark Northern Spring 14% protein (US14%), No. 2 Hard Winter 13% protein (US13%), and No. 2 Hard Winter Ordinary protein (USord), all fob gulf. The EC export price used was EC standard wheat, fob Rouen. The world indicative price calculated by the International Wheat Council was also tested as a proxy for the world price. This is a simple average of several international prices excluding the EC price.

Reported in table 3 are the calculated F-statistics testing the null hypothesis that the variable on the left of the arrow does not cause the variable on the right. Table 4 reports the Box-Pierce Q-statistics, used to determine whether the residuals are white noise for each of the causality tests reported in table 3. The results in table 4 indicate that the inferences based on the F-statistics are valid.

Granger causality tests were conducted using the first difference filter, while 3-, 4-, and 5-month lag structures were examined. The results from the 4- and 5-month lags are reported in table 3. Sims causality tests were conducted using either first difference of the natural logs, or the Sims filter described above (applied to either the right hand side of the equation or to both sides), while the lag structure employed was 4-period lags and 4-period leads, and 6-period lags and 4-period leads. The results reported in table 3 are based on the filter with the lowest Q-statistic.

Table 3--Granger and Sims causality tests

Causality test	Granger		Sims	
	4 lags	5 lags	4 lags-4 leads	6 lags-4 leads
	F-statistics			
(1) EC refund ----------> Price U.S. No. 2 Dark Winter 13 percent	0.76	0.89	0.89	0.92
(2) EC refund ----------> Price U.S. No. 2 Hard Winter Ordinary	0.54	0.76	0.62	0.50
(3) EC refund ----------> U.S. No. 2 Dark Northern Spring 14 percent	0.97	1.20	1.06	1.93
(4) EC refund ----------> World indicative price	1.14	1.21	1.63	1.38
(5) EC refund ----------> EC export price	.11	.12	.10	.33
(6) Price U.S. No. 2 Dark Winter 13 percent ----------> EC refund	.65	.61	.66	.79
(7) Price U.S. No. 2 Hard Winter Ordinary ----------> EC refund	1.06	.76	1.04	1.28
(8) Price U.S. No. 2 Dark Northern Spring 14 percent ---------> EC refund	.93	.96	.87	.88
(9) World indicative price ----------> EC Refund	.80	.67	1.16	1.26
(10) EC export price ----------> EC Refund	2.76**	2.16*	1.04	.57
(11) Price U.S. No. 2 Dark Winter 13 percent ----------> EC export volume	1.71	3.88**	1.24	1.21
(12) Price U.S. No. 2 Hard Winter Ordinary ----------> EC export volume	2.01	3.34**	2.02	.89
(13) Price U.S. No. 2 Dark Northern Spring 14 percent ---------> EC export volume	.73	.78	.77	.67
(14) EC export price ----------> EC export volume	1.25	1.14	1.59	.95
(15) World indicative price ----------> EC export volume	1.71	1.85	1.98	1.28
(16) EC export volume ----------> Price U.S. No. 2 Dark Winter 13 percent	1.88	1.73	1.96	1.85
(17) EC export volume ----------> Price U.S. No. 2 Hard Winter Ordinary	1.59	1.47	1.60	1.40
(18) EC export volume ----------> Price U.S. No. 2 Dark Northern Spring 14 percent	1.00	1.67	.50	1.16
(19) EC export volume ----------> EC export price	4.58**	3.36**	3.32**	4.14**
(20) EC export volume ----------> World indicative price	2.37*	2.18*	3.41**	3.10**
(21) EC export refund ----------> EC export volume	1.58	1.18	.36	.44
(22) EC export volume ----------> EC export refund	.56	.52	.54	.29

* Significant at the 10-percent level
** Significant at the 5-percent level

Table 4--Box-Pierce Q-statistics for Granger and Sims causality tests

Causality test (see table 3)	Granger test		Sims test	
	4 lags	5 lags	4 lags-4 leads	6 lags-4 leads
			Q-statistic	
(1)	28.93	16.77	18.13	15.79
(2)	29.60	24.36	29.15	27.41
(3)	18.48	13.97	34.21	31.16
(4)	23.72	21.51	28.78	25.80
(5)	13.56	11.91	26.84	14.40
(6)	5.44	5.57	49.30*	39.52*
(7)	7.26	7.37	47.38*	42.26*
(8)	6.06	6.45	31.39	8.90
(9)	6.60	7.08	21.13	14.01
(10)	9.64	10.44	24.84	23.82
(11)	14.06	11.79	23.93	18.35
(12)	14.59	9.14	16.00	12.38
(13)	11.71	11.07	14.27	13.83
(14)	9.76	9.80	24.13	29.04
(15)	13.37	8.20	21.37	24.00
(16)	19.40	12.17	26.33	20.71
(17)	21.27	18.97	23.60	24.03
(18)	22.12	14.43	19.91	19.32
(19)	8.29	7.38	10.34	11.63
(20)	10.60	10.73	28.94	16.60
(21)	14.47	14.58	30.64	30.63
(22)	6.26	7.09	24.57	27.19

The reported Q statistic contains 24 degrees of freedom.
* Significant at the 5-percent level.

The two tests and the different lag structures generally yielded similar results. Where the two tests disagreed, the results from the direct Granger test should be preferred because, in finite samples, Granger's test usually performs better than other methods (16).

The calculated F-statistics in table 3 (numbers 1 to 5) indicate that the hypothesis that per unit export refunds do not Granger cause U.S., world, or EC wheat export prices cannot be rejected.

Reversing the direction of causation, the F-statistics (numbers 6 to 10), indicate that the hypothesis that the U.S. or world indicative price do not Granger cause wheat subsidies also should not be rejected. These results imply that information on U.S. or world wheat prices will not be very helpful in predicting the per unit subsidy, and vice versa.

The direct Granger test, however, indicates that the hypothesis that EC export price does not "cause" per unit EC refunds (10) should be rejected. This result implies a one-way causation from the EC export price to the EC export refund. The data support the hypothesis that per unit export refunds are a residual since the export price "causes" the refunds but the reverse does not hold. It was demonstrated in figure 3 that the subsidies were used by the EC to bridge the gap between "world" price and domestic price. The results here suggest that the "world" price that the EC Commission responds to is the EC export price and not other international prices. Finally, the results suggest that, in the short run, the export subsidies provided by the EC do not significantly affect U.S. export prices, and vice versa.

The causal relationship between the different export prices and wheat exported through the EC open market bidding system was also examined. The results, (11)-(15), indicate that the hypothesis of no causal relationship between the price of US14% wheat, (13), EC export price, (14), or the world indicative price, (15), and the volume of wheat exports should not be rejected. However, Granger's test with five lags suggests that the hypothesis that the price of US13% (11) or USord (12) wheat does not cause the quantity of wheat exported through the open market system should be rejected. Thus, the results regarding the hypothesis that EC exports are strictly a function of domestic conditions are mixed. EC wheat exported through the open market system appears to be influenced by certain U.S. wheat prices.

The direction of causality was reversed to test whether the volume of wheat exported by the EC through the open market system Granger causes U.S., EC, or the world wheat price (16)-(20). The results indicate that the volume of EC exports does not "cause" U.S. wheat export prices (16)-(18). Coupled with the result from (11) and (12) above, this suggests a one-way causation from U.S. export prices to EC wheat exports. That is, the volume of EC exports does not cause U.S. wheat export prices, but the price of US13% and USord wheat do cause EC exports. This suggests that the EC exports are not perfectly inelastic with respect to changes in U.S. wheat prices. Since the price of US14% wheat is not influenced by EC wheat exports, and since EC wheat exports are not influenced by the price of US14% wheat, it appears that the EC does not compete with the relatively protein-rich U.S. wheat (US14%).

According to Bredahl and Green (7), a country is a residual supplier if, among other criterion, exports of competing exporters do not respond to world prices. Using Granger causality tests, they determined that the United States was the residual supplier in the world corn market. Since the results in this analysis indicate that EC exports are caused by U.S. wheat prices, the United States is not the sole residual supplier in the wheat market.

The hypothesis that the export volume does not cause EC export price (19) should be rejected. As one would expect, the volume exported does "cause" the export price received by EC traders; however, the causation is one directional, without feedback. The volume exported by the EC is not "caused" by the export price (14) in the short run.

The results also indicate that the volume of wheat exported through the open market does "cause" the world indicative price (20) (the broad measure of world wheat price). Although EC wheat exports do not directly affect U.S. wheat prices, the EC cannot be considered a small-country case since EC exports do influence the world wheat prices.

These results support the theoretical depiction of the EC's impact on the world wheat market that was shown in figure 3 and are consistent with results of other analysis referenced earlier. EC exports do affect international wheat prices, but the impact seems to be on the price that the EC exporters are able to obtain and on the broader measure of world price. The results indicate that the direction of causality is one directional from volume of wheat exports to EC or world price.

Finally, the hypothesis that the volume of EC exports does not cause the per unit EC export subsidy (22) should not be rejected nor should the hypothesis that the export refund does not cause exports (21). These results support the hypothesis of no causation between EC wheat exports and the per unit subsidy, and again indicate the residual nature of the refund since it does not "cause" the volume exported, nor does the volume exported "cause" the per unit subsidy.

To summarize, the direction of causality detected is from U.S. export price to EC wheat exports, from EC wheat exports to EC export price, and from EC export price to per unit refund; causality is one directional. The data failed to indicate feedback relationships, suggesting shortrun rigidities in the world wheat market.

Although the two causality tests employed for this analysis yielded some ambiguous conclusions, other researchers also determined that results could differ depending upon the test used (14). The analysis indicates that the EC export refunds are not

an overt part of EC trade policy. The refunds are not manipulated to increase or decrease EC exports (volume or price), nor do they appear to directly affect world or U.S. prices. Rather, they are a residual, used by the EC to accommodate disposal of domestic surplus.

These results are conditional on the data, the methodology, and possibly on the time period of the analysis. U.S. wheat prices during the sample period may have been more influenced by domestic policies of high loan rates than by forces in the export market, and the time period of the analysis only partly includes the effects of the Export Enhancement Program initiated by the United States in mid-1985. In addition, the tests will not pick up relationships if monthly data are not appropriate. But, data with periodicity less than 1 month were not available. Given these caveats, the results suggest that the open market operation of the CAP is not a trade policy per se, but rather it responds to domestic need for surplus disposal due to the high domestic price policy of the EC.

Estimation of EC Per Unit Wheat Export Subsidy

The causality tests in the previous section were based on the temporal relationship between EC wheat export subsidies and various international wheat prices. An interesting question which cannot be addressed with causality tests is: by how much does the monthly maximum export refund change, given an exogenous change in the EC export price? In this section, I focus on the econometric estimation of the magnitude of the per unit export subsidy. What are the key variables that determine the value of the monthly refund and by how much does the refund change in response to changes in those variables?

The Cereals Management Committee provides little information regarding its decisionmaking process in determining the maximum per unit export subsidy. Consequently, one has to speculate on which variables, other than intervention and export prices, are important in this process. The variables finally chosen depended upon economic theory and econometric results.

The EC Commission is not directly involved in exporting EC wheat. The reader will recall that the open market bidding system operates with exporters submitting bids to the Cereal Management Committee. These bids specify the export volume and the per unit subsidy desired. The Committee decides the maximum subsidy that will be granted, while EC traders determine the amount of wheat that will be exported through this process. Based on this information and the results of the previous section which indicate that export volume did not determine the per unit subsidy, volume is excluded as an explanatory variable.

The maximum export refund for wheat is assumed to be a function of domestic (EC) intervention price, world price, the ECU-U.S. dollar exchange rate, budget expenditures, the price of competing goods, and EC wheat trade share. It is expected that per unit export subsidies are positively related to domestic wheat price and negatively related to the world wheat price (fig. 2). One would also expect a negative relationship between export subsidies and the ECU-dollar exchange rate. Wheat contracts are generally denominated in dollars. An appreciation of the dollar relative to the ECU, holding everything else constant, implies that wheat price in ECU is higher, necessitating lower per unit subsidies.

Although the Commission does not export wheat, the subsidy requested by traders will be a function of the demand and supply conditions in the world wheat market (fig. 3). When the wheat price of other exporting countries increases, holding everything else constant, the demand for their wheat should decrease, while demand for EC wheat should increase. This leads to an increase in the EC wheat export price and a decrease in the per unit refund (fig. 2). Similarly, when the prices of competing goods increase, the demand for EC wheat will increase, also resulting in lower subsidies.

The cost of operating the CAP has increased tremendously. In 1974, the cost was 2.6 billion ECU, while in 1985 the cost had increased to almost 20 billion ECU. During the same time period, expenditures on cereal export refunds (mostly wheat) increased from 76 million ECU to over 1.7 billion ECU. Consequently, there have been pressures to reduce the budget, especially in the cereals market. Since wheat is the major cereal grown and exported by the EC, expenditures on wheat export refunds is one area in which the EC may try to lower costs. If the Commission is concerned about budget exposure of export refunds, one would expect the maximum refund to be negatively related with total export subsidy expenditures in previous periods.

The EC has indicated a willingness to cooperate with other exporters in managing world wheat trade by restricting wheat exports to a given share of the world market. If the EC tries to accomplish this, then one would expect per unit refunds to decrease when EC wheat exports increase above the target share of world market.

Estimation Results

Ordinary least squares were used to estimate the maximum per unit wheat export subsidy as a function of the variables discussed above. Data on wheat export refunds and wheat prices were described previously. Monthly shipments of wheat world trade were obtained from International Wheat Council. The exchange

rate is from Eurostat, External Trade Monthly Statistics. Corn was chosen to represent goods (other than wheat from other exporting countries) that compete with EC wheat to test the hypothesis that exported EC wheat is really a feed-grade wheat which competes with feed grains rather than wheat. The price used is the monthly price of corn No. 2 yellow, gulf ports from USDA's Feed Situation and Outlook Report.

As mentioned earlier, several different wheat prices are quoted in the world wheat market; a single "world" price does not exist. Each of the three U.S. wheat export prices used in the causality tests, the price of U.S. No. 2 Soft Red Winter, the world indicative price, and the EC export price were examined to determine which is used to fix the maximum subsidy. The results for each of the U.S. prices confirmed the results from the causality tests. None of the estimated price coefficients were statistically different from zero, indicating no relationship between changes in U.S. export wheat price and the maximum EC wheat export subsidy. These variables were consequently dropped from the final specification.

When the world indicative price was used as an explanatory variable, the estimated parameter was statistically significant and had the right sign. As expected, an increase in the world indicative price, holding everything else constant, resulted in lower per unit export subsidies. However, when the EC export price was substituted for the world indicative price, the resulting estimated equation was significantly better as measured by adjusted R^2 and standard error of equation. Once again, the results here confirm the results from the causality tests.

To capture the cereal budget constraint, I constructed an expenditure variable by multiplying the maximum per unit subsidy for wheat and barley by the export volume, deflated by a representative EC consumer price index (CPI). Since an export license was valid for up to 4 months during the observation period, a 4-month moving sum was calculated to represent the budget constraint. The CPI was defined as the average of the CPI of the 10 individual member countries, weighted by their share of GNP.

The market-share variable was defined as the absolute value of the 4-month moving-average of the ratio of EC wheat exports (awarded through the open market operation) to total wheat shipments in the world, subtracted from 14 percent (the assumed EC target).[6] The market share is an annual target but the periodicity of the data is monthly. Rather than assume that the EC adjusts export refunds to meet its target each month, I

---

[6] I also assumed a target of 16 percent and obtained results similar to those reported in the text.

assumed that the refunds respond to the 4-month moving average of past shares. A 4-month average was chosen because during the sample period, export licenses were valid for up to 4 months. Taking the absolute value of the difference implies that the per unit subsidies are adjusted equally regardless of whether the target is undershot or overshot.

During the sample period, open market operations were either suspended or export refunds were not granted for a total of 5 months. A dummy variable was constructed to capture this occurrence.

The estimated equation for the sample period, January 1981 to December 1985, is reported below (numbers in parentheses are t-statistics; numbers in brackets are elasticities calculated at the mean).

$$\begin{aligned} RLREF = {} & 111 - .049\ USECU - 28.27\ D1 + .87\ RLINTPR \\ & (5.00)\ (-6.54) \quad (-8.07) \quad (6.31) \\ & \quad [-1.50] \quad\quad\quad [3.45] \\ & - .85\ RLECPR - .00005\ MRLTEXP4(-1) - 137.4\ TRATIOQ4(-1) \\ & (-7.07) \quad\quad (-2.04) \quad\quad\quad (2.89) \\ & [-2.81] \quad\quad [-0.18] \\ & - 7.12\ USCNPR \\ & (-2.50) \\ & [-0.59] \end{aligned} \qquad (4)$$

adj R^2 = .89; SE = 7.08; DW = 1.90; F(7, 48) = 62.53

where:

RLREF = maximum monthly wheat export subsidies granted, deflated by CPI(ECU per ton).

USECU = exchange rate (ECU's per $1,000).

D1 = zero, one dummy variable (equals 1 when open market operations were suspended or export refunds were not granted).

RLINTPR = monthly wheat intervention price including monthly increments, deflated by CPI (ECU's per ton).

RLECPR = wheat export price, fob Rouen, deflated by the CPI (ECU's per ton).

MRLTEXP4(-1) = 4-month moving sum of monthly budget expenditures on wheat and barley exported through the open market operation deflated, by CPI, lagged 1 month (1,000 ECU's).

TRATIOQ4(-1) = the absolute value of the difference between the 4-month moving average of the ratio of EC wheat exports through the open market to total wheat shipments in the world, subtracted from 0.14 and lagged 1 month.

USCNPR = price of U.S. corn No. 2 yellow fob gulf ports ($ per bushel).

The estimated equation explains almost 90 percent of the variation of the maximum per unit export subsidies given by the EC during the sample period. The very high value of the F-statistic, and the high value of the individual t-statistics indicate that the estimated equation as a whole and the individual parameters are all significantly different from zero at the 5-percent level.

As expected, appreciation of the dollar (increase in USECU) results in a decrease in maximum subsidies, holding all else constant. From the elasticity calculated at the sample mean, a 10-percent appreciation of the dollar relative to the ECU will result in a 15-percent decrease in the real per unit subsidy.

Similarly, an exogenous increase in the real EC export price (RLECPR) results in a reduced per unit export subsidy, while an increase in the real intervention price of wheat (RLINTPR) results in a larger per unit export subsidy. The estimated coefficients indicate that an exogenous 10-ECU increase in the real intervention price (RLINTPR) increases the real export refund by 8.7 ECU, while the same increase in the real EC export price (RLECPR) reduces the refund by 8.5 ECU per ton.

The results also indicate that the EC responds to budgetary constraints in setting per unit export subsidies. An increase in the previous 4 months real expenditures on cereal subsidies results in a decrease in the current per unit refund. The elasticity calculated at the sample mean indicates that a 10-percent increase in expenditures leads to less than a 2-percent decrease in the per unit subsidy.

The negative estimated coefficient for TRATIOQ4 indicates that the monthly export refund is reduced when exports deviate from the target. Holding everything else constant, if the average share of EC exports in the previous 4 months equals the target, the change in the refunds is zero. The monthly refund is reduced

by 1.37 ECU's for each percentage point difference between the actual ratio and the target.

The analysis also indicates that there is a negative relationship between the price of U.S. corn and EC export subsidies. An exogenous $1 increase in the fob price of U.S. corn (USCNPR) decreases real export refunds by 7.12 ECU. An increase in the price of corn results in an outward shift in the demand for EC wheat which leads to a decrease in export refunds, assuming all else constant. At the sample mean, a 10-percent increase in the export price of USCNPR leads to an almost 6-percent decrease in per unit refunds.

The results from the causality tests which suggested that U.S. wheat export prices did not influence the per unit subsidy, along with the results in this section lead to the same conclusion: in world markets, EC wheat competes more with U.S. corn than with U.S. wheat. It appears that the wheat exported through the open market system is feed quality wheat which competes with feed grains such as corn. Since the EC exports a relatively large proportion of wheat flour (table 1), it appears that the higher quality EC wheat is exported as a higher valued product, flour (which has its own export refund program).

Several other variables were examined to determine their influence on the export refund relationship. Some variables were created to determine whether the EC changed export refunds in response to changes in the U. S. share of world wheat shipments. The possibility of a seasonal pattern to export refunds was also investigated. In both cases, the results were poor and the estimated equations are not reported.[7]

Specification Test

Since there may be alternative ways to model the relationship presented, I tested whether the current model specification is acceptable. The method used is the regression error specification test (RESET) developed by Thursby and Schmidt (37). This is a nested test designed to detect specification error which may occur because of (1) omitted variables, (2) incorrect functional form, and (3) correlation between exogenous variables and the disturbance term (35, 36, 37, 38).

---

[7] The lack of EC response to changes in the U.S. market share may be due to the fact that during the sample period, EC market share increased while the U.S. market share decreased. This lack of response may not hold in the future, especially given the U.S. initiative to target export assistance.

The null hypothesis is that the correctly specified model is:

$$y = Xb + e \quad (5)$$

whereas the alternative hypothesis is that the correct model is:

$$y = Xb + Zc + e \quad (6)$$

where, X is a T x 1 regressor matrix, and Z is a matrix of test variables. The RESET procedure amounts to using an F test to determine whether the parameter vector, c, equals zero. If the null hypothesis is accepted, that is $c = 0$, one can conclude that the model is correctly specified. If $c \neq 0$, then the model is not specified correctly.

In order to perform the test, the matrix Z has to be defined. Thursby and Schmidt (37) determined that the best set of test variables for the matrix Z are various powers of the explanatory variables in the X matrix.

The test to determine whether the estimated export refund equation is correctly specified consisted of comparing the results from equation 4 with the results from estimating an augmented equation including the Z matrix. For our purposes, Z was defined to be the squared values of the exogenous variables. The hypothesis that the estimated coefficients, c, are zero, is compared with the hypothesis that the parameters in the c vector can take on any value, using an F test. The calculated F-statistic is 0.22 which implies that we cannot reject the null hypothesis that the parameters in the vector, c, are zero. Therefore, we cannot conclude that the estimated export refund equation is misspecified.

Conclusions

Both methods used to determine Granger causality agreed that there is no causal relationship between EC unit refunds and international prices. In cases where a causal relationship was found, it was one directional without feedback, indicating shortrun rigidities in the world wheat market. Both methods also agreed on the unidirectional causality between the volume of wheat exported through the EC open market system and the EC export price or the world indicative price. The EC cannot be treated as a small-country case; wheat exported through the open market system does influence, in the Granger sense, the price EC exporters receive for their exports, and the exports do "cause" the world indicative price.

The results from this research suggest that the EC does not overtly employ the per unit wheat subsidy to manipulate its wheat exports. Otherwise, the data would have detected causation

between the per unit refund and EC wheat exports. In the month-to-month operation of the world wheat market, the maximum per unit subsidy granted by the EC for wheat exported through the open market system is a residual. It does not "cause" U.S. wheat export prices, nor is it influenced by them, at least in the short run. Furthermore, the volume of wheat exported through the open-market bidding system, does not influence U.S. wheat prices. Rather, the direction of causation is reversed: U.S. export prices influence EC wheat exports. Since EC wheat exports are caused by U.S. wheat prices, the United States is not the sole residual supplier in the world wheat market.

This lack of a relationship between per unit wheat export subsidy and U.S. export prices may reflect the residual nature of the refunds and the short-term nature of the analysis. Also, domestic U.S. policies may have prevented adjustments in U.S. export prices during the time period of the analysis. Thus, given U.S. export prices, the EC adjusted the volume of wheat exported through the open market and EC export prices adjusted to accommodate those exports. In addition, U.S. and EC wheat trade is somewhat different. The United States exports most of its wheat in raw form, whereas a substantial proportion of EC wheat is traded as flour. Furthermore, the results indicate that the wheat exported through the open market system may be feed-quality wheat competing with U.S. corn in world markets, implying that the higher quality EC wheat is exported as flour.

The estimated monthly per unit export refund relationship showed that export refunds were very sensitive to changes in the intervention price, the EC export price, and the ECU-U.S. dollar exchange rate. A 1-percent depreciation in the dollar relative to the ECU results in a more than 1-percent increase in the export subsidy. If the U.S. strategy is to exert financial pressure on the EC in order to obtain policy changes, the analysis indicates that, in the short run, the variables to manipulate are the ECU-dollar exchange rate and the U.S. corn and wheat export prices. The exchange rate and corn price influence the value of the per unit subsidy, while the U.S. wheat export prices influence the volume of EC wheat exports. The analysis however, also indicates that this policy may not cause behavioral change by the EC since the refund level was not very sensitive to changes in the budget constraint variable.

It appears that analysis of the wheat market is more complex than indicated by models that employ the law of one price. In the short run, rigidities in the demand structure for wheat (long-term contracts, political considerations, and product differentiation) and rigidities in supply (heavy government intervention in the domestic market of major exporters) imply that within a year world wheat prices adjust slowly. However, the high intervention price established by the EC increases supply and exports. This could affect U.S. wheat export prices

in the longer run as exporters and importers adjust and commodities become more substitutable. In the long run, one would expect greater interaction in the world wheat market and the law of one price to dominate.

The results indicate that EC export price is influenced by EC exports and not by U.S. prices. EC export refunds responded to, rather than caused, changes in wheat price, implying that refunds are facilitating domestic needs to deal with surpluses. It is not a trade policy in the sense that the EC does not appear to manipulate the export refunds to adjust export volume.
A structural model of the EC export refund relationship and world wheat market interactions (if it could be estimated) would be preferable to the bivariate time-series techniques employed for this study. The approach is still helpful in describing lead-lag relationships and the residual nature of the refunds. Obviously, many more factors than those examined here contribute to price determination in the world wheat market. Future research on the role of exchange rates in the causal relationships may be warranted. Additional study is also needed to determine the impact on the EC export policy given the export subsidy programs initiated by the United States and to determine whether there are nonlinearities which complicate the causal relationships. Better data are also needed on wheat and wheat flour imports from various sources in order to determine the comparability of EC and U.S. wheat trade.

References

(1) Abbott, Philip C. "Modeling International Grain Trade with Government Controlled Markets." Amer. J. Agr. Econ. 61(1979): 22-31.

(2) Abbott, Philip C. "The Role of Government Interference in International Commodity Trade Models." Amer. J. Agr. Econ. 61(1979): 135-140.

(3) Anderson, Kym, and Rodney Tyers. "European Community Grain and Meat Policies: Effects on International Prices, Trade and Welfare." Euro. R. Agr. Econ. 11(1984): 367-394.

(4) Antle, John M. "Dynamics, Causality, and Agricultural Productivity." Paper prepared for the Agricultural Productivity Workshop, Resources for the Future, July 16-18, 1984.

(5) Bishop, Robert V. "The Construction and Use of Causality Tests." Agr. Econ. Res. 31(1979): 1-6.

(6) Belongia, Mike, and David A. Dickey. "Prefiltering and Causality Tests." Agr. Econ. Res. 34(1982): 10-14.

(7) Bredahl, Maury E., and Leonardo Green. "Residual Supplier Model of Coarse Grain Trade." Amer. J. Agr. Econ. 65(1983): 785-790.

(8) Carter, Colin, and Andrew Schmitz. "Import Tariffs and Price Formation in the World Wheat Market." Amer. J. Agr. Econ. 61(1979): 517-522.

(9) Chambers, Robert G., and Richard E. Just. "Effects of Exchange Rate Changes on U.S. Agriculture: A Dynamic Analysis." Amer. J. Agr. Econ. 63(1981): 32-46.

(10) Chow, Gregory C. Econometrics. New York, McGraw-Hill Book Co. 1983.

(11) Conway, Roger K., and others. "The Impossibility of Causality Testing." Agr. Econ. Res. 36(1984): 1-19.

(12) de Gorter, Harry, and Karl D. Meilke. "The EEC's Wheat Price Policies and International Trade in Differentiated Products." Amer. J. Agr. Econ. 69(1987): 223-229.

(13) Devadoss, S., Michael Helmar, and William H. Meyers. FAPRI Trade Model for the Wheat Sector: Specification, Estimation, and Validation. Center for Agr. and Rural

Devel. Iowa State Univ. Staff Rep. #86-SR3 (revised) Oct. 1986.

(14) Feige, Edgar L., and Douglas K. Pearce. "The Casual Causal Relationship between Money and Income: Some Caveats for Time Series Analysis." Rev. Econ. & Stat. 61(1979): 521-533.

(15) Gardiner, Walter H., and Praveen M. Dixit. Price Elasticity of Export Demand: Concepts and Estimation. FAER-228. U. S. Dept. Agr., Econ. Res. Serv., Feb. 1987.

(16) Geweke, John, Richard Meese, and Warren Dent. "Comparing Alternative Tests of Causality in Temporal Systems: Analytic Results and Experimental Evidence." J. Econometrics 21(1983): 161-194.

(17) Granger, C.W.J. "Testing for Causality: A Personal View." J. Econ. Dyn. and Control 2(1980): 329-352.

(18) Greenberg, Edward, and Charles E. Webster, Jr. Advanced Econometrics: A Bridge to the Literature. New York: John Wiley & Sons, 1983.

(19) Grennes, Thomas. A Bibliography on the Economics of World Grain Trade. Econ. Res. Rep. No. 47. Dept. Econ. Bus., North Carolina State Univ., Jan. 1985.

(20) Grennes, Thomas, Paul R. Johnson, and Marie Thursby. The Economics of World Grain Trade. New York: Praeger Publishers, 1978.

(21) Haley, Stephen L. Targeting of U.S. Agricultural Export Subsidies: A Theoretical Analysis. Staff Report AGES880203. U.S. Dept. Agr., Econ. Res. Serv., June 1988.

(22) Holland, Forrest D., and Jerry A. Sharples, "World Wheat Trade: Implications for U.S. Exports." Staff Paper No. 84-20. Dept. Agr. Econ., Purdue Univ. Nov., 1984.

(23) Johnson, Paul R., Thomas Grennes, and Marie Thursby. "Trade Models with Differentiated Products." Amer. J. Agr. Econ. 61(1979): 120-127.

(24) Johnson, Paul R., Thomas Grennes, and Marie Thursby. "Devaluation, Foreign Trade Controls, and Domestic Wheat Prices." Amer. J. Agr. Econ. 59(1977): 619-27.

(25) Koester, Ulrich. Policy Options for the Grain Economy of the European Community: Implications for Developing Countries. Res. Rep. No. 35. Inter. Food Pol. Res. Inst., Washington, DC. Nov. 1982.

(26) Konandreas, Panos, Peter Bushnell, and Richard Green. "Estimation of Export Demand Functions for U.S. Wheat." W. J. Agr. Econ. 3(1978): 39-49.

(27) Paarlberg, Philip L., and Jerry A. Sharples. Japanese and European Community Agricultural Trade Policies: Some U.S. Strategies. FAER-204. U.S. Dept. Agr., Econ. Res. Serv., Aug. 1984.

(28) Sampson, Gary P., and Richard H. Snape. "Effects of the EEC's Variable Import Levies." J. Pol. Econ. 88(1980): 1026-1040.

(29) Sampson, Gary P., and Alexander J. Yeats. "An Evaluation of the Common Agricultural Policy as a Barrier Facing Agricultural Exports to the European Economic Community." Amer. J. Agr. Econ. 59(1977): 99-106.

(30) Sarris, Alexander H., and John Freebairn. "Endogenous Price Policies and International Wheat Prices." Amer. J. Agr. Econ. 65(1983): 214-224.

(31) Schmitz, Peter Michael. "The Common Agricultural Policy and Instability on World Food Markets." Price and Market Policies in European Agriculture. Ed. K.J. Thomson and R. M. Warren. Dept. Agr. Econ. Univ. New Castle Upon Tyne, 1981.

(32) Sims, Christopher A. "Money, Income, and Causality." Amer. Econ. Rev. 62(1972): 540-552.

(33) Spreen, Thomas H., and J. Scott Shonkwiler. "Causal Relationships in the Fed Cattle Market." S. Jour. Agr. Econ. 13(1981): 149-153.

(34) Thompson, Robert L. A Survey of Recent U.S. Developments in International Agricultural Trade Models. BLA-21. U.S. Dept. Agr., Econ. Res. Serv., Sept. 1981.

(35) Thursby, Jerry G. "A Test Strategy for Discriminating Between Autocorrelation and Misspecification in Regression Analysis." Rev. Econ. Stat. 63(1981): 117-123.

(36) Thursby, Jerry G. "Alternative Specification Error Tests: A Comparative Study." J. Amer. Stat. Assn. 74(1979): 222-225.

(37) Thursby, Jerry G., and Peter Schmidt. "Some Properties of Tests for Specification Error in a Linear Regression Model." J. Amer. Stat. Assn. 72(1977): 635-641.

(38) Thursby, Jerry G., and Marie C. Thursby. "Elasticities in International Trade: Theoretical and Methodological Issues." Paper presented at Trade Res. Consortium, Dearborn MI, 1987.

(39) Thursby, Jerry, and Marie Thursby. "How Reliable are Simple, Single Equation Specifications of Import Demand." Rev. Econ. and Stat. 66(1984): 120-128.

(40) Tyers, Rodney. "International Impacts of Protection: Model Structure and Results for EC Agricultural Policy." J. Policy Mod. 7(1985): 219-251.

(41) Tyers, Rodney, and Kym Anderson. "Liberalizing OECD Agricultural Policies in the Uruguay Round: Effects on Trade and Welfare." Working Papers in Trade and Development No. 87/10. Australian National University, July 1987. Paper presented at a seminar at the International Food Policy Research Institute, Washington, DC, Aug. 6, 1987.

(42) U.S. Department of Agriculture, Economic Research Service. Embargoes, Surplus Disposal, and U.S. Agriculture. AER-564. Dec. 1986.

(43) Zelner, Arnold. "Causality and Econometrics." Carnegie-Rochester Conference Series on Public Policy. Vol. 10 (ed. Karl Brunner and Allen H. Meltzer). Supplementary Series to the Journal of Monetary Economics.

UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
1301 NEW YORK AVENUE, NW.
WASHINGTON, DC 20005-4788