LEAST COST WORLD TRADE PATTERNS FOR GRAINS AND MEATS

John R. Moore, Sammy Elaassar, and Billy V. Lessley

There are many barriers to a perfectly free flow of goods among countries. These barriers result in trade diversion and increased transportation costs for the goods involved. This paper reports findings of a study on the ocean transportation cost of trade diversion for grains and meats in 1965-66 where diversion is defined as the difference between the least cost world trade pattern for these commodities as determined by linear programming (transportation model) and the actual trade patterns. The change in United States export patterns and shipping costs that would have resulted from a 10 percent decrease in United States outgoing ocean freight rates for grain and meat in 1965-66 was also calculated. This was done to show the effects of what some feel to be a rate pattern that discriminates against United States exports.[1]

METHODOLOGY AND DATA SOURCES USED TO OBTAIN LEAST COST TRADING PATTERNS

The least cost trading pattern, as noted, for specified grains and meats is defined in this study as that combination of importers and exporters that would have minimized the world ocean transport costs for the volume of meats and grains actually shipped in international trade in 1965-66, the study year.[2] In the transportation model used, each exporting and importing country was required to import and export the same amount as they actually did in the study year. Only the pattern of trade was subject to change. The actual and least cost patterns of trade could be expected to differ because of trade and political policies of both exporting and importing countries (trade agreements, embargos, quotas, tariffs, subsidies, aid, etc.), imperfect knowledge about prices and shipping costs, and lack of homogeneity within the product class being analyzed. Thus the actual transportation cost for various agricultural products in excess of the least cost pattern can be considered one of the costs of not having completely free trade.

The data used in the study came from many sources. The primary source of trade statistics was the FAO *Trade Yearbook, 1967* [4]. Ocean freight rates were computed from data in 1965-66 issues of *Fairplay Shipping Journal* [3], *Chartering Annual* [1], and from files of the Federal Maritime Commission. Some data were obtained from shipbrokers, and direct inquiries to foreign embassies. Freight rates between points for which no published data were available were estimated using regression analysis relating cost and distance.

STUDY FINDINGS

The following is a discussion of the study findings for wheat, corn, sorghum and millets, poultry meat, and beef and veal.[3] The discussion in this section centers on three points:

John R. Moore is professor, Sammy Elaassar is research associate and Billy V. Lessley is associate professor of agricultural economics at the University of Maryland.

[1] See U. S. Congress Joint Economic Committee [6].

[2] Trade data for 1965-66 were used because they were the latest comprehensive data available from international sources at the time of the study. The specific year of the data used, however, is not particularly important in determining the general magnitude of the cost of trade barriers as trade barriers are relatively slow to change.

[3] The study also included several less important commodities not reported here.

1. Shipping costs among countries for the various commodities.
2. How the pattern of shipments would have changed had the least cost pattern been followed.
3. What the least cost pattern would have been had United States shipping rates been reduced 10 percent while rates of other countries remained the same.

WHEAT

In 1965-66, 48 million tons of wheat were shipped in world trade (Table 1). The three largest exporters were United States (40 percent), Canada (27 percent), and Argentina (16 percent). The three largest importers were USSR (17 percent), India (16 percent), and Mainland China (13 percent). The three largest importers of United States wheat were India (37 percent), Japan (10 percent), and Yugoslavia (8 percent).

Freignt Rates between wheat trading countries in 1965-66 varied considerably. Rates from the United States averaged $9.83 per metric ton but ranged from $4.85 to West Germany to $35.15 per metric ton to Pakistan. Rates from other exporting countries in general showed less variation (Table 2).

Table 1. ACTUAL AND LEAST COST COMBINATION OF MAJOR WORLD WHEAT TRADERS, 1965-66*

	Major importers								
Exporters	India	Japan	Yugoslavia	U.S.S.R.	Mainland China	U.K.	Brazil	Other	Total
	(Thousand metric tons)								
U.S.A.									
Actual	7,125	1,941	1,470	0	0	809	857	6,882	19,086
L.C.P.	0	3,589	0	2,885	0	4,072	0	8,538	19,086
Canada									
Actual	266	1,284	0	5,142	2,053	1,891	0	2,407	13,045
L.C.P.	7,109	0	0	5,138	797	0	0	0	13,045
Argentina									
Actual	0	0	0	2,208	2,216	338	1,323	1,479	7,566
L.C.P.	451	0	1,470	0	0	0	2,180	3,464	7,566
Other									
Actual	169	363	0	673	2,055	1,034	0	4,069	8,362
L.C.P.	0	0	0	0	5,527	0	0	2,835	8,362
Total									
Actual	7,560	3,589	1,470	8,023	6,324	4,072	2,180	14,837	48,059
L.C.P.	7,560	3,589	1,470	8,023	6,324	4,072	2,180	14,837	48,059

*Source: Actual trade pattern from FAO [4]. Least cost pattern (LCP) computed using linear programming transportation model.

Table 2. OCEAN FREIGHT RATES FOR WHEAT, 1965-66*

	Importers						
Exporters	India	Japan	Yugo-slavia	U.S.S.R.	Mainland China	U.K.	Brazil
	(Dollars per metric ton)						
U.S.A.	16.70	9.00	10.52	11.82	12.05[a]	6.13	7.75
Canada	9.35	8.50	9.74	8.48	10.00	7.05	8.51
Australia	10.15	9.10	9.90	13.25[a]	9.50[a]	10.50	10.00[a]
Argentina	13.93	16.65	10.85	14.50	16.70	11.20	7.00

*Source: Ocean freight rates were computed from data in [3], [1], and from files of The Federal Maritime Commission, Washington, D.C. Some data were obtained from shipbrokers and direct inquiries to foreign embassies.

[a]Rates with superscript "a" where estimated using regression analysis relating cost and distance.

The least cost trade pattern differed considerably from the actual pattern (Table 1). Had the least cost pattern been followed the three largest importers from the United States would have been United Kingdom (21 percent), Japan (19 percent), and USSR (15 percent), while Canada's main wheat importers would have been India (55 percent), and USSR (39 percent). Such a trading pattern would have reduced total shipping costs $119 million or 23 percent.

A 10 percent reduction in United States wheat export shipping rates would not have changed the least cost pattern for world wheat trade. The least cost solution appears quite stable and insensitive to small outgoing United States freight rate charges.

FEEDGRAINS

In 1965-66 the United States exported 24.9 million metric tons of major feedgrains. The most important of these grains, the amount shipped of each, and their share of total United States feedgrain exports in 1965-66 are shown in Table 3.

The actual and least cost world trade pattern for the two most important classes of United States feedgrain exports, corn, and sorghum and millets, are discussed below.

Table 3. UNITED STATES FEEDGRAIN EXPORTS, 1965-66*

Major feedgrains	U. S. Exports	
	Weight	Share of total U. S. feedgrain exports
	(Mil. metric tons)	(Percent)
Corn (maize)	16.7	67
Sorghum and millets	6.0	24
Barley	1.6	7
Oats	0.5	2
Rye	0.1	-
Total	24.9	100

*Source: FAO [4].

Table 4. ACTUAL AND LEAST COST COMBINATION OF MAJOR CORN TRADERS, 1965-66*

Exporters	Importers						
	Italy	Japan	Netherlands	U.K.	W. Germany	Other	Total
	(Thousand metric tons)						
U.S.A.							
Actual	2,573.2	2,337.2	2,640.0	2,369.3	1,260.6	5,505.0	16,685.3
L.C.P.	3,563.2	2,378.2	2,828.4	0	2,330.5	5,585.0	16,685.3
Argentina							
Actual	2,176.5	2.5	186.9	43.7	55.4	388.2	2,853.2
L.C.P.	1,214.6	0	0	427.2	0	1,211.4	2,853.2
Mexico							
Actual	0	106.4	0	41.4	0	1,095.2	1,243.0
L.C.P.	0	0	0	1,243.0	0	0	1,243.0
Other							
Actual	28.1	775.8	1.5	16.4	1,014.5	632.0	2,468.3
L.C.P.	0	843.7	0	800.6	0	824.0	2,468.3
Total							
Actual	4,777.8	3,221.9	2,828.4	2,470.8	2,330.5	7,620.4	23,249.8
L.C.P.	4,777.8	3,221.9	2,828.4	2,470.8	2,330.5	7,620.4	23,249.8

*Source: Same as Table 1.

Corn (Maize)

In 1965-66, 23.2 million metric tons of corn were shipped in world trade. The three largest exporters were the United States (72 percent), Argentina (12 percent) and Mexico (5 percent) (Table 4). The three largest importers in the same period were Italy (21 percent), Japan (14 percent) and Netherlands (12 percent). The three largest importers of United States corn were Netherlands (16 percent), Italy (15 percent) and the United Kingdom (14 percent).

United States heavy feedgrain freight rates varied from $5.45 per metric ton to France to $11.53 per metric ton to Austria. Rate variations were about the same for the other countries.

The least cost trade pattern for corn differed somewhat from the actual pattern but the difference was not nearly as great as for wheat. According to the linear programming solution, the least cost pattern would have had the United States shipping 21 percent of its corn exports to Italy, 17 percent to Netherlands, and 14 percent to Japan. Had the least cost transport pattern been followed total shipping costs for corn would have been reduced from $178 million to $169 million or ten percent.

A ten percent reduction in United States export freight rates for corn would have had no effect on the world-wide least cost pattern for corn distribution. The pattern would, however, have changed with a 15 percent reduction.

Table 5. OCEAN FREIGHT RATES FOR HEAVY GRAINS, 1965-66*

	Major Importers						
Exporters	Italy	Japan	Netherlands	U.K.	W. Germany	India	Belgium-Luxembourg
	(Dollars per metric ton)						
U.S.A.	7.75	9.15	6.70	10.20	5.55	15.30	6.10
Argentina	10.30	15.10	9.80	11.00	10.35	12.40	10.50
Mexico	10.05	10.95	7.85	6.20	7.25	20.30	6.90
Thailand	13.70	4.25	15.55	15.90	16.05	4.60	14.90
France	6.00	20.10	4.25	4.85	5.00	13.10	4.10

*Source: Same as Table 2.

Table 6. ACTUAL AND LEAST COST COMBINATION OF MAJOR SORGHUM AND MILLET TRADERS, 1965-66*

	Importers					
Exporters	Japan	India	Netherlands	Belgium-Luxembourg	Other	Total
	(Thousand metric tons)					
U.S.A.						
Actual	1,833.7	1,037.6	908.8	752.6	1,451.8	5,984.5
L.C.P.	1,977.8	579.0	980.1	814.7	1,632.9	5,984.5
Argentina						
Actual	144.1	0	70.6	58.6	169.8	443.1
L.C.P.	0	430.2	0	0	12.9	443.1
Other						
Actual	0	0	.7	3.5	46.8	51.0
L.C.P.	0	28.4	0	0	22.6	51.0
Total						
Actual	1,977.8	1,037.6	980.1	814.7	1,668.4	6,478.6
L.C.P.	1,977.8	1,037.6	980.1	814.7	1,668.4	6,478.6

*Source: Same as Table 1.

Sorghum and Millets

In 1965-66, 6.5 million metric tons of sorghum and millets were shipped in world trade. The three largest exporters were United States (92 percent), Argentina (7 percent) and Sudan (1 percent) (Table 6). The three largest sorghum and millet importers were Japan (30 percent), India (16 percent) and Netherlands (15 percent). The three largest importers of United States sorghum and millets in 1965-66 were Japan (31 percent), India (17 percent) and Netherlands (15 percent). The least cost transport pattern would have involved the United States shipping 33 percent of her sorghum and millet exports to Japan 16 percent to Netherlands, and 14 percent to Belgium-Luxembourg. Had the least cost transport pattern been followed, total world-wide shipping costs for sorghum and millets would have been reduced from $65 million to $56 million or 14 percent.

A ten percent reduction in United States export freight rates for sorghum and millets would have had no effect on the least cost pattern solution for sorghum and millet in world trade.

MEATS

Considerable meat flows in international trade. The most important items in 1965-66 were poultry, beef, and pork. The United States' share of these items was 17 percent, 1 percent, and 7 percent, respectively. The meat items produced by various countries are less homogeneous than the various grains produced and shipped in international trade, therefore, shipping rates have a less important bearing on the pattern of meat trade. Importers may buy from more distant markets to obtain a specific type of meat even though other types of meat are available from nearby sources. Still meat transport costs can be reduced and the least cost pattern provides guides for such a reduction. Poultry and beef shipments are discussed below.

Poultry

In 1965-66, 277,200 metric tons of poultry meat were shipped in world trade. The three largest exporters were Netherlands (40 percent), United States (17 percent), and Denmark (12 percent) (Table 7). The three largest poultry meat importers were West Germany (69 percent), Switzerland (9 percent), and Austria (4 percent). The three largest importers of United States poultry meat in 1965-66 were West Germany (60 percent), Hong-Kong (12 percent) and Japan (12 percent). Freight rates for poultry exports from the United States to major importers ranged from $54.00 per metric ton to West Germany to $132.00 per metric ton to Greece (Table 8). European exporters enjoyed much lower freight rates

Table 7. ACTUAL AND LEAST COST COMBINATION OF MAJOR POULTRY TRADERS, 1965-66*

Exporters	Importers					
	W. Germany	Switzerland	Austria	Hong-Kong	Other	Total
	(Million pounds)					
U.S.A						
Actual	62.8	3.0	3.5	12.4	22.0	103.7
L.C.P.	50.6	6.3	0	11.3	35.5	103.7
Netherlands						
Actual	228.9	8.5	3.1	.2	6.5	247.2
L.C.P.	247.2	0	0	0	0	247.2
Denmark						
Actual	19.6	12.1	9.7	.5	31.0	72.9
L.C.P.	72.9	0	0	0	0	72.9
Other						
Actual	119.8	30.2	11.2	13.8	22.2	197.2
L.C.P.	60.4	47.5	27.5	15.6	46.2	197.2
Total						
Actual	431.1	53.8	27.5	26.9	81.7	621.0
L.C.P.	431.1	53.8	27.5	26.9	81.7	621.0

*Source: Same as Table 1.

Table 8. OCEAN FREIGHT RATES FOR POULTRY, 1965-66*

Exporters	Importers										
	West Germany	Switzer-land	Austria	Hong Kong	Greece	U. K.	Japan	Spain	U. A. R.	Argen-tina	Australia
	(Dollars per metric ton or 40 cu. ft.)										
U. S. A.	54.00	62.60	70.20	121.00	132.00[a]	97.00	90.00	51.60	126.00[a]	65.00	100.00
Netherlands	20.00	30.00	35.00	120.00	63.00	45.00	100.00	50.00	72.00	55.00	60.00
Denmark	25.00	43.00	49.00	141.00	70.00	50.00	115.00	70.00	81.00	62.00	68.00

*Source: Same as Table 2.

[a]The freight rates from the United States to the Eastern Mediterranean seem excessive but are the ones reported. Ocean freight rates vary not only with distance but also with port-handling costs and opportunities for picking up cargo.

Table 9. OCEAN FREIGHT RATES FOR BEEF AND VEAL, 1965-66*

Exporters	Importers											
	U. S. A.	U. K.	Italy	Russia	West Germany	Spain	Switzer-land	Japan	France	Greece	Canada	Nether-lands
	(Dollars per metric ton or 40 cu. ft.)											
Argentina	59.60	73.82	88.85	49.00	74.64	66.66	82.55	109.60	69.96	93.65	68.80	69.69
Australia	71.55	94.30	69.58	84.95	79.88	77.60	74.45	85.10	73.10	63.80	78.40	79.88
New Zealand	72.50	92.10	67.58	83.60	78.80	76.30	73.10	90.40	72.00	62.50	80.10	78.60
France	110.15	61.40	57.60	68.75	55.30	47.80	49.40	145.30	-	79.90	95.60	50.60

Source: Same as Table 2

to European markets but had slightly higher rates to East Asia. The least cost transportation pattern for poultry meat would have involved the United States shipping 49 percent of her poultry meat to West Germany, 17 percent to Japan, and 11 percent to Hong-Kong. Had the least cost transport pattern been followed, total world-wide shipping costs for poultry meat would have been reduced from $9.7 million to $8.9 million or 8.2 percent.

A ten percent reduction in United States export freight rates for poultry meat would have had no appreciable effect on the least cost solution for world poultry meat distribution.

Beef and Veal

In 1965-66, 1,952,000 metric tons of beef and veal were shipped in world trade. The three largest exporters were Argentina (30 percent), Australia (23 percent), and New Zealand (8 percent). The three largest beef importers were United States (28 percent), U.K. (22 percent), and Italy (15 percent). The three most important sources of United States beef and veal imports were Australia (46 percent), Argentina (23 percent), and New Zealand (12 percent). Had the least cost pattern of beef shipments been followed the cost of beef and veal transport in world trade in 1965-66 would have been reduced from $144 million to $123 million or 15 percent.

Table 10. ACTUAL AND LEAST COST COMBINATION OF MAJOR BEEF AND VEAL TRADERS, 1965-66.*

	Importers					
Exporters	U. S. A.	U. K.	Italy	U. S. S. R.	Others	Total
	(Million pounds)					
Argentina						
Actual	281	290	206	97	422	1,296
L.C.P.	518	778	0	0	0	1,296
Australia						
Actual	554	127	110	17	176	984
L.C.P.	256	0	313	165	250	984
New Zealand						
Actual	145	85	60	0	58	348
L.C.P.	0	0	348	0	0	348
France						
Actual	0	74	75	0	79	228
L.C.P.	0	0	0	0	228	228
Other						
Actual	224	395	210	387	231	1,447
L.C.P.	430	193	0	286	552	1,447
Total						
Actual	1,204	971	661	501	966	4,303
L.C.P.	1,204	971	661	501	966	4,303

*Source: Same as Table 1.

SUMMARY

1. World-wide ocean transport costs for major grains and meats in 1965-66 ranged from $520 million for wheat to $10 million for poultry.
2. Potential savings from using the least cost trade pattern compared with the actual pattern for major grains and meats ranged from $119 million for wheat to $0.8 million for poultry. As a percent of total shipping costs, potential savings from using the least cost pattern ranged from 22.8 percent for wheat to 8.2 percent for poultry.

Commodity	Percent Savings
Wheat	22.8
Corn	10.0
Sorghum	14.1
Poultry	8.2
Beef and veal	15.1

3. A 10 percent reduction in outgoing United States freight rates had no appreciable effect on the least cost pattern of world grain and meat exports.
4. The cost of distortions in world grain and meat trade is about one percent of the total value of world trade shipments of these products.
5. There will always be some deviation in world trade patterns from the least cost linear programming model due to imperfect knowledge, bi- and multi-lateral trade arrangements, international political tensions, foreign aid programs, export subsidies and product heterogeneity.
6. Studies of this type should be continued to monitor trade diversion and point up its costs.

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