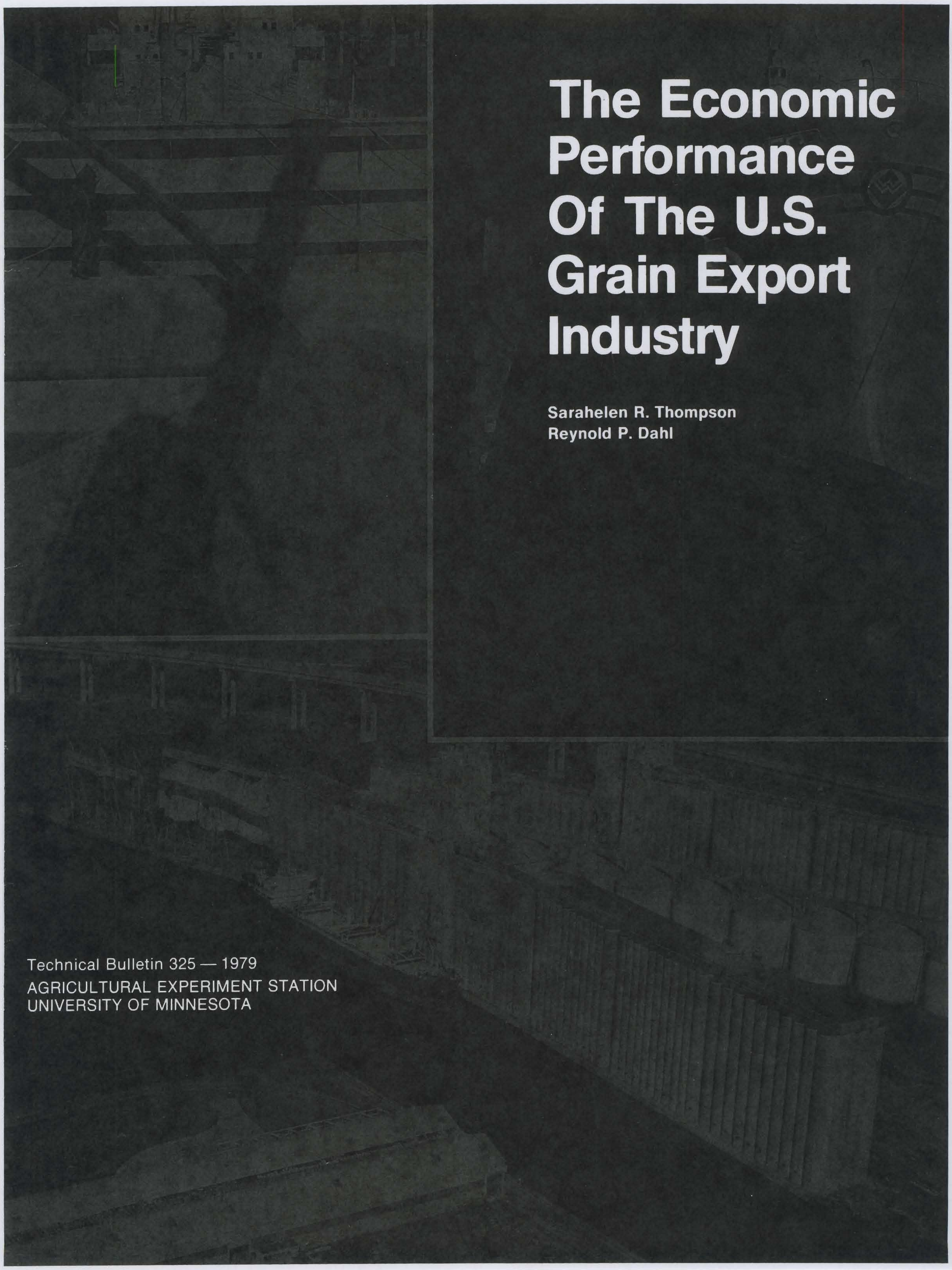

The Economic Performance Of The U.S. Grain Export Industry

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Summary and Conclusions

The U.S. grain export industry has been in the public spotlight in recent years. The industry consists of a small number of large firms, so its market structure resembles that of an oligopoly. This leads many to conclude that its economic performance is suboptimal as compared to perfectly competitive norms. The purpose of this research is to analyze the economic performance of the U.S. grain export industry using performance criteria of pricing and productive efficiency.

The pricing efficiency criteria are prices and the differences between prices at spatially separated markets expected under perfect competition. Economic theory specifies that the price of a commodity at different locations in competitive markets should, at most, differ by the minimum cost of transfer between markets. Arbitrage, a function of competitive markets, keeps prices at different locations in line with these specifications. Therefore, by testing whether grain prices at different locations in the export marketing channel differ only by the transfer costs between locations, an evaluation of the industry's pricing performance is possible.

The industry's productive efficiency depends on its load and scale factors. These indicate the extent to which the industry is organized to minimize short and long-run average costs. The load factor is a measure of the extent to which firms and/or plants make reasonably full use of their existing facilities and reflects whether they are operating at their minimum short-run average costs. The scale factor reflects the extent to which firms and/or plants are organized to operate at minimum long-run average costs. If average costs decline as the size of firm increases, positive returns to scale exist in the industry.

The methodology used to test for efficient pricing compares the actual price differentials in spatially separated markets with the optimal price differentials under perfect competition. The only transfer cost used to test for efficient and competitive pricing is the cost of transportation between

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markets. While there are other costs involved in moving grain from one market location to another, the cost of transporting grain between markets is the largest single transfer cost. The differences between prices for corn at five different locations in the export marketing channel were analyzed to test whether they approximate transportation costs between markets.

Destination prices for corn were adjusted for transportation costs. The original prices for corn at each stage of the marketing channel were then subtracted from the adjusted destination prices. The differences between adjusted destination and origin prices were examined to determine whether the remaining differences approximate transfer costs other than transportation between markets. The distribution characteristics of these differences were also tested to determine whether deviations from the average adjusted differences represent exogenous, or random, shocks to markets. However, they may also represent systematic factors affecting the differences between prices not accounted for by transportation costs between markets.

The tests for efficient pricing showed that movements in prices at one location are usually reflected in corresponding movements at every other market location. Prices for corn at various stages in the export marketing channel differ largely by transportation cost between markets. The remaining differences between prices do not appear to be randomly distributed around a constant transfer cost in most cases.

It is not possible to say conclusively that these apparent non-random differences in corn prices are not a reflection of market imperfections, including imperfect competition among grain export firms. However, the correlations in both the adjusted and unadjusted prices among various points in the marketing channel were very high. Consequently, the unexplained variation, even if nonrandom, was very small. Furthermore, there are good reasons to support the conclusion that this apparent nonrandom behavior is largely attributable to other market factors such as institutional rigidities in rail rates, seasonality in elevation costs, and external shocks to the marketing system.

The results lead to the conclusions that the U.S. grain export industry's pricing performance is efficient. The differences between prices in spatially separated markets and competitive arbitrage efficiently allocate grain flows through the export marketing channel. The pricing efficiency in the grain export industry meets efficiency criteria characteristic of perfectly competitive markets. Hence, there is little statistical evidence of oligopolistic exploitation by the small number of large firms that make up this industry.

The analysis of the grain export industry's productive performance indicates that it is also productively efficient. A comparison of turnover rates for export elevators at different port locations showed that the most active and important ports have the highest turnover rates, indicating that the busiest ports are also the most efficient.

Grain export firms are also organized to take advantage of sizeable economies of scale in grain exporting. Scale economies are found in the operation of terminal and export elevators. In 1976 the five largest grain exporters operated 54 percent of the port elevator capacity and 21 percent of the inland terminal elevator capacity. This moderately high concentration of facilities is probably of little economic significance because of substitutability between channels of distribution and competition between storage points along and between channels. Sizable scale economies also exist in grain transportation, market information systems, and financial risk management in the grain export industry. Returns to scale are the prime reasons for the small number of large firms in this industry.

Introduction

The U.S. grain export industry has come under increased public scrutiny as grain exports have expanded in the 1970's. After the large grain sales to the Soviet Union in 1972-73, questions were raised concerning the ability of private U.S. grain exporting firms to deal with the state-trading organizations in many importing counties. Bills have been introduced in the U.S. Congress calling for a greater direct role of the U.S. government in grain exports. Comparisons are also frequently made of the U.S. grain export system to government-owned and/or regulated marketing systems in many other grain exporting countries.

A small number of largely private multinational firms handle a substantial share of all U.S. grain exports. One study reports that five firms handle 85 percent of all U.S. grain exports.[1] Consequently, the industry possesses one of the market structure characteristics of an oligopoly. This leads many to conclude that the economic performance of the U.S. grain export industry is suboptimal as compared to perfectly competitive norms. The evidence upon which such conclusions are based, however, is limited and largely subjective. Hence, there is a need for empirical research on economic performance of this important industry.

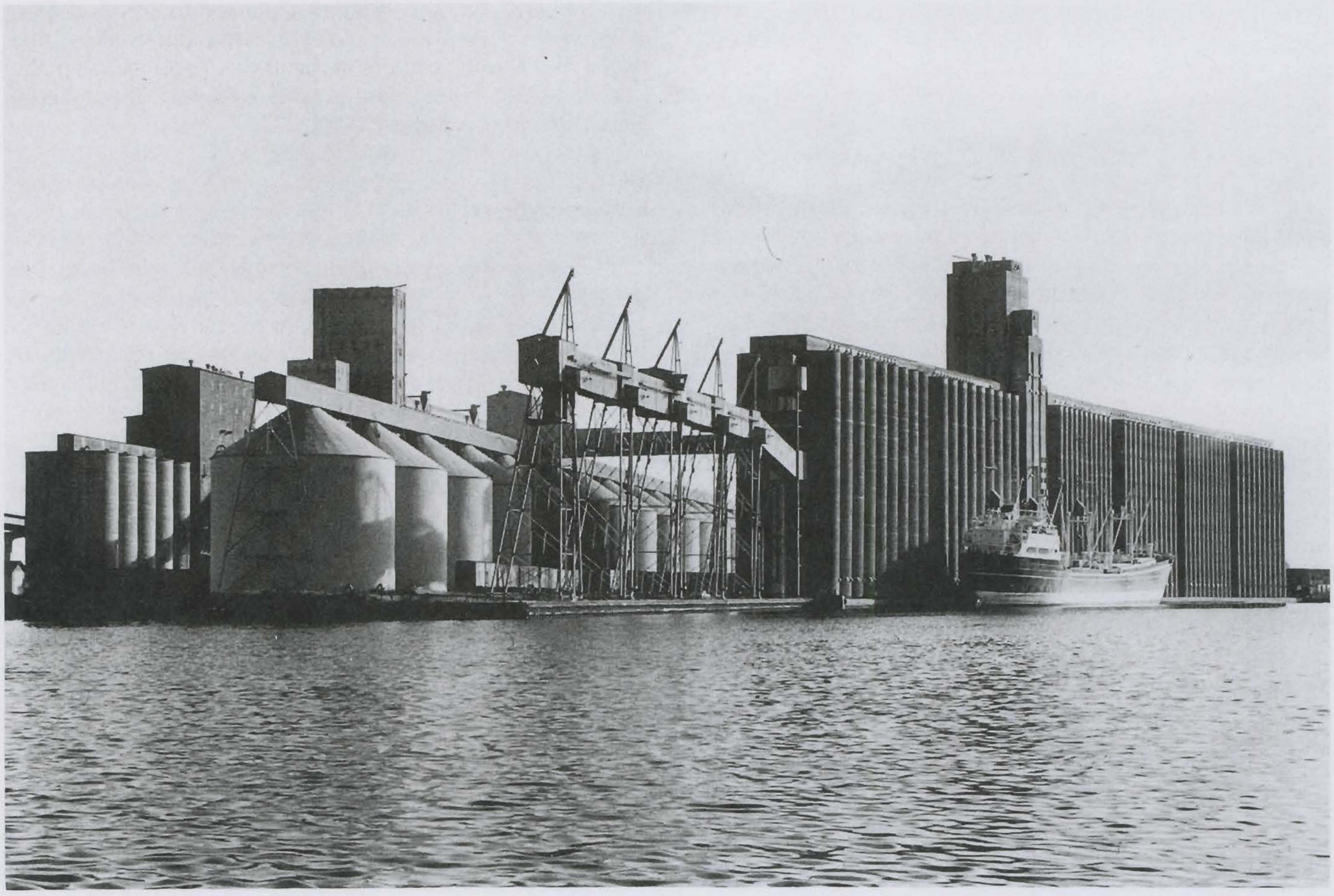
The purpose of this research is to analyze the economic performance of the U.S. grain export industry using performance criteria of pricing and productive efficiency. The objectives are to analyze the pricing and productive efficiency of the U.S. grain export industry and to relate these dimensions of economic performance to the market organization of this industry.

Methodology and Sources of Data

Economists often use the market structure, conduct, and performance approach to analyze problems of efficiency and performance in concentrated industries. The market structure model drawn from industrial organization theory assumes a causal relationship between the structure, conduct, and performance of an industry. Given certain structural characteristics of an industry, such as number and size of firms, and perhaps some information as to the conduct, or behavior, of firms within the industry, the performance characteristics of that industry are said to follow sequentially. However, economists have been largely unsuccessful in their attempts to demonstrate this empirically.

Many of the U.S. grain export industry's structural characteristics, such as the high degree of market concentration, the multinational operations of the large grain exporting firms, and informational and other barriers to entry, lead to an identification with a typically oligopolistic system. Con-

[1] U.S. Department of Agriculture, Farmers' Cooperative Service, *Improving the Export Capability of Grain Cooperatives*, FCS Research Report 34, June, 1976.



sequently, market structure analysts would conclude that the performance of this industry is suboptimal.

This is reflected in the popular literature which depicts the industry as secretive and powerful. Since the world grain shortage of 1973/74 that caused unusually high grain prices, there have been numerous attempts to expose the workings of the U.S. grain export industry. Newspapers such as *The Washington Post*[2] and the *Des Moines Register*[3] have run series of articles that generally leave the impression that the industry is dominated by firms powerful enough to manipulate food prices and food supplies around the world. This sort of publicity is common and is partially responsible for the continued public interest in the grain export industry, even in years of low grain prices and grain surpluses. Other publications have depicted the grain export industry as leaders of a food cartel whose control of world food supplies is unrivaled and exploitive. The title of one such article, "The Great Grain Robbery," indicates this conclusion.[4] It reflects an attitude of fear and distrust of the large U.S. grain exporting firms also popular today.

[2]Dan Morgan, "Giant Global Commodity Firms Losing Cloak of Obscurity," *The Washington Post,* January 2, 3, 4, and 5, 1976.

[3]George Anthan, "Big Grain Exporters Shrouded in Secrecy," *Des Moines Register,* June 15, 1975.

[4]Roger Burbach, "The Great Grain Robbery," *The Progressive,* July, 1976, pp. 24-27.

The classic market structure approach usually places more emphasis on market structure than on market performance. This study takes an alternate approach by placing its major emphasis on the measurement of the performance of the industry and by focusing upon those aspects of market organization that pertain to performance. This is a performance-oriented approach as suggested by Bressler and King.[5]

Although performance is difficult to measure in any industry, two dimensions of market performance, (1) pricing efficiency and (2) productive efficiency, can be researched effectively as described by Bressler and King. By first studying the price behavior and pricing relationships of the grain export industry over time and at various locations in the export marketing channel, some conclusions can be drawn as to the pricing efficiency of the industry. Secondly, the industry's productive efficiency can be researched by examining (1) the extent to which firms in the industry make reasonably full use of their available facilities (the "load" factor or the amount of excess or unutilized capacity) and (2) the extent to which firms and/or plants are organized to take advantage of economies of scale — the "scale" factor.[6] Such an analysis of productive efficiency relies heavily upon

[5]Raymond Bressler and Richard King, *Markets, Prices, and Interregional Trade,* John Wiley & Sons, New York, 1970, p. 408.

[6]*Ibid.,* p. 409.

a knowledge of market organization of the industry. The relationship of both productive and pricing efficiency to market organization will be analyzed in this study.

Analysis of Pricing Efficiency

A set of pricing efficiency criteria is established to measure the pricing efficiency of the U.S. grain export industry. These criteria are based upon the price behavior expected to prevail in perfectly competitive markets. Then, the actual price behavior of the industry is compared to theoretically efficient price behavior. Specifically, actual grain prices at different locations in the export marketing channel are compiled to test for (1) the strength of the relationship between prices and (2) whether the difference between prices at different locations approximates the minimum cost of moving grain between markets.

The data used for the analysis of pricing efficiency are the weekly prices of corn at five different locations in the export marketing channel between 1975 and 1977. These locations, or markets, include a country elevator, a terminal market, two port locations, and a foreign destination.

Corn is chosen because it is an important export grain and is regularly exported through at least two port locations, the East Coast and Gulf. Also, the same grade of corn, U.S. #2 Yellow, is usually traded at most markets in the U.S.

Data on minimum costs in transporting corn between these locations are also needed to determine whether the difference in prices reflects transportation costs between markets. Rail, barge, and ocean transportation costs were obtained from a large grain exporting firm. Trucking costs from a country elevator to a river elevator were obtained from a country elevator.

Analysis of Productive Efficiency

The productive efficiency of the U.S. grain export industry is analyzed by examining the industry's load and scale factors. The load factor is measured by comparing the amount of available port elevator capacity to the amount of grain put through these elevators, excess or unutilized elevator capacity can be detected.

Unfortunately, detecting the extent to which firms in the industry are organized to take advantage of scale economies is a more difficult task. Scale economies in the grain export industry are analyzed in a nonquantitative manner. Qualitative evidence of scale economies in the industry is examined. Market structure characteristics of the industry, such as operation of port and terminal elevators, are also described.

Pricing Efficiency of the Industry

Pricing Efficiency Criteria

Price differentials between spatially separated markets induce the flow of grain from surplus to deficient areas. The pricing efficiency of the grain export marketing system can be measured by comparing the actual price differentials in spatially separated markets throughout the export marketing channel with the optimal price differentials expected in perfectly competitive markets.[7]

Economic theory dictates that the price of a commodity at different markets should differ at most by the minimum cost of transfer between markets. Most simple models consider only the minimum transportation costs between markets. In more complex models, other costs incurred in bringing a commodity from one market to another are included in the transfer cost. These costs may include interest, insurance, elevation (loading and unloading), and storage at points between markets.

If prices for the same commodity at two locations, or markets, differ by less than the cost of transfer from one market to the other, there should be no financial incentive to move commodities from one to the other. If the difference is greater, commodities will move to the market with the higher price net of transfer costs. Eventually, as commodities move to the market with the highest net price, the market with the higher price becomes oversupplied and the price of the commodity at the location must fall. The opposite happens at the market that originally had a lower price: as commodites move out, supplies dwindle, and prices must rise. This process (arbitrage) keeps prices between markets in line with each other so that they differ at most by the cost of transfer between markets. These relationships should exist if there are no artificial barriers, such as legislated pricing, or barriers imposed by imperfect competition, which would prevent spatially separated markets from reflecting transfer cost differences. Therefore, by testing whether prices for grain at different locations in the export marketing channel differ only by the cost of transfer from one market to the next, judgments might be possible as to whether or not the pricing performance of the industry is efficient and approximates the conditions of perfect competition.

If price differences between market locations in the export marketing channel deviate from an average transfer cost, these differences should, if price behavior is competitive, be randomly distributed around zero. These deviations should reflect random, exogenous supply or demand shocks at one market or another. Further, if arbitrage is prevalent between these markets, deviations should be corrected quickly so that prices differ again at most by minimum transfer costs.

The only transfer cost used to test for efficient and competitive pricing in this analysis is the cost of transportation between markets. While there are other costs involved in moving grain from one market location to another, the cost of transporting grain between markets is typically the largest single transfer cost. The principal reason for using only the transportation cost between markets as the transfer cost is the difficulty in obtaining other costs on a per-bushel basis. However, it should be mentioned that elevation costs are significant and should be included in a more exact approximation of total transfer costs. Hence, prices at different markets net of transportation costs will not be equal, even if the industry's pricing performance is efficient and competitive. Therefore, in this analysis the mean difference between prices at different markets will not equal zero. Instead, there will be an average difference in prices adjusted for transpor-

[7]For a more thorough treatment of price behavior in spatially separated markets, see Bressler and King, *op. cit.*

tation costs that should approximate elevation costs and other small per-bushel costs, such as interest and insurance, incurred in bringing grain from one market to another. Nonetheless, the deviations from this positive average difference should behave the same as the deviations would from an average difference of zero.

The Data

Prices. The price data used in this analysis are the weekly prices of corn at five different locations in the export marketing channel between 1975 and 1977. The locations chosen — country, terminal, port, and foreign market — are typical of those in the marketing channel for grain exports.

The prices paid for corn at a country location are taken from the prices paid to farmers at the Farmers Elevator Company in Stewartville, Minnesota. The Stewartville elevator in southeastern Minnesota is typical of many country elevators that buy grain from farmers and ship it by truck or rail to a variety of destinations. Frequently, the Stewartville elevator trucks its corn to Winona, Minnesota, or other locations on the Mississippi River, where it is loaded on barges and sent to the Gulf for export. Roughly 60 percent of the corn bought from Minnesota farmers by the Stewartville elevator is sent down the Mississippi River. However, from December to March, when the Mississippi River is frozen and not navigable between Minneapolis and the mouth of the Missouri River, the Stewartville elevator either stores its grain or sells it to local buyers, such as nearby processors, for various uses other than export. However, Stewartville prices for corn should move with corn prices throughout the marketing channel year round, regardless of whether the Mississippi River is frozen or not. This assertion is based on the assumption that the export market for grain is interwoven with the domestic market until the grain reaches a point in the marketing channel where substitution between markets cannot be economically justified. In other words, grain can be sold and resold for a variety of purposes other than export throughout the export channel until it reaches port. Hence, all markets should be linked year round.

The Chicago market is chosen as the terminal market against whose prices export prices at the Gulf and East Coast ports are compared. Much of the corn that is eventually exported is produced in the Midwest, loaded on barges or multicar unit trains, and transported directly to ports such as New Orleans or Baltimore. Chicago, an important terminal market for corn sold both for domestic use and for export, has an active cash and futures market for corn.

Both the East Coast and Gulf port prices for export corn are used in this study because it is possible that prices at one market reflect efficient pricing behavior and another does not. *Grain Market News,* a USDA weekly publication, is used in this report as the source for the weekly price quotations at Chicago, the Gulf, and East Coast. Both the Gulf and East Coast prices are "on track" prices; that is, the corn at these locations has not been put in or through an elevator. The Gulf comprises those ports principally at or near New Orleans or along the east Texas shore, such as Galveston or Corpus Christi. The East Coast comprises mainly Baltimore, Philadelphia, and Norfolk.

The foreign market price for corn used in this study is the price of U.S. #3 Yellow Corn sold C.I.F. (cost, insurance, and freight) at Rotterdam. Rotterdam is an important market for grain, a substantial amount of which is imported from the U.S. for delivery at Rotterdam. Rotterdam prices are frequently cited as being representative of world prices. But, while the price of corn in the U.S. is usually reported for U.S. #2 Yellow, the most common grade of corn in the U.S. domestic commerce, Rotterdam prices are reported for U.S. #3 Yellow, the most common grade of corn imported by Western European countries. Rotterdam prices, consequently, must be adjusted for quality to make them comparable to domestic U.S. prices for U.S. #2 Yellow Corn.

Transportation costs. The transportation costs used in this study include the following:

1. The cost of trucking grain from Stewartville to the Mississippi River, a constant 8.96 cents per bushel between 1975 and 1977.
2. Monthly weighted averages of the cost of moving corn by barge between a river elevator near Stewartville and the Gulf in those months when the Mississippi River was open and navigable.
3. Monthly weighted averages of the cost of moving corn by barge between a central Illinois river elevator and the Gulf.
4. In the few instances where the barge rate is not used as the cost of moving corn between a central Illinois terminal and the Gulf (usually during periods of great demand for barge transportation), the less costly rail rate from Illinois to the Gulf is used in the analysis.
5. The cost of moving corn by rail between Chicago and the East Coast.
6. Weighted weekly averages of the cost of moving corn by ocean freight carrier on an F.I.O. basis (free in and out, *i.e.,* not including loading and unloading costs) between the Gulf and Rotterdam.
7. Weighted weekly averages of the cost of moving corn F.I.O. by ocean freight carrier between the East Coast and Rotterdam in those weeks when rates between the East Coast and Rotterdam were quoted.

The barge and rail rates used in this study are actual costs of moving grain through the export marketing channel experienced by a large exporting firm. It is likely that this firm's cost of transporting grain is close to the minimum cost of transportation between markets because of the large volume of grain moved by this company and the cost economies associated with unit trains and barge shipments. For instance, the rail rates used in this study, based on this exporter's least expensive multicar unit train rates, are probably the least expensive rail rates available for moving corn. Thus, the rail rates and barge rates experienced by this firm should approximate the least-cost, profit-maximization requirements that are the basis for the analysis.

The ocean freight cost data, however, are not based upon the costs experienced by this one firm alone. Instead, they are based upon the average cost experienced by all firms that shipped grain in varying tonnages between the Gulf or East Coast and Rotterdam. Thus, the ocean freight rates used in this study do not necessarily approximate the least cost of shipping grain between the U.S. and Rotterdam.

The corn prices used in this analysis are plotted on a weekly basis in Figure 1. The rail and barge rates to the Gulf and East Coast are plotted in Figure 2.

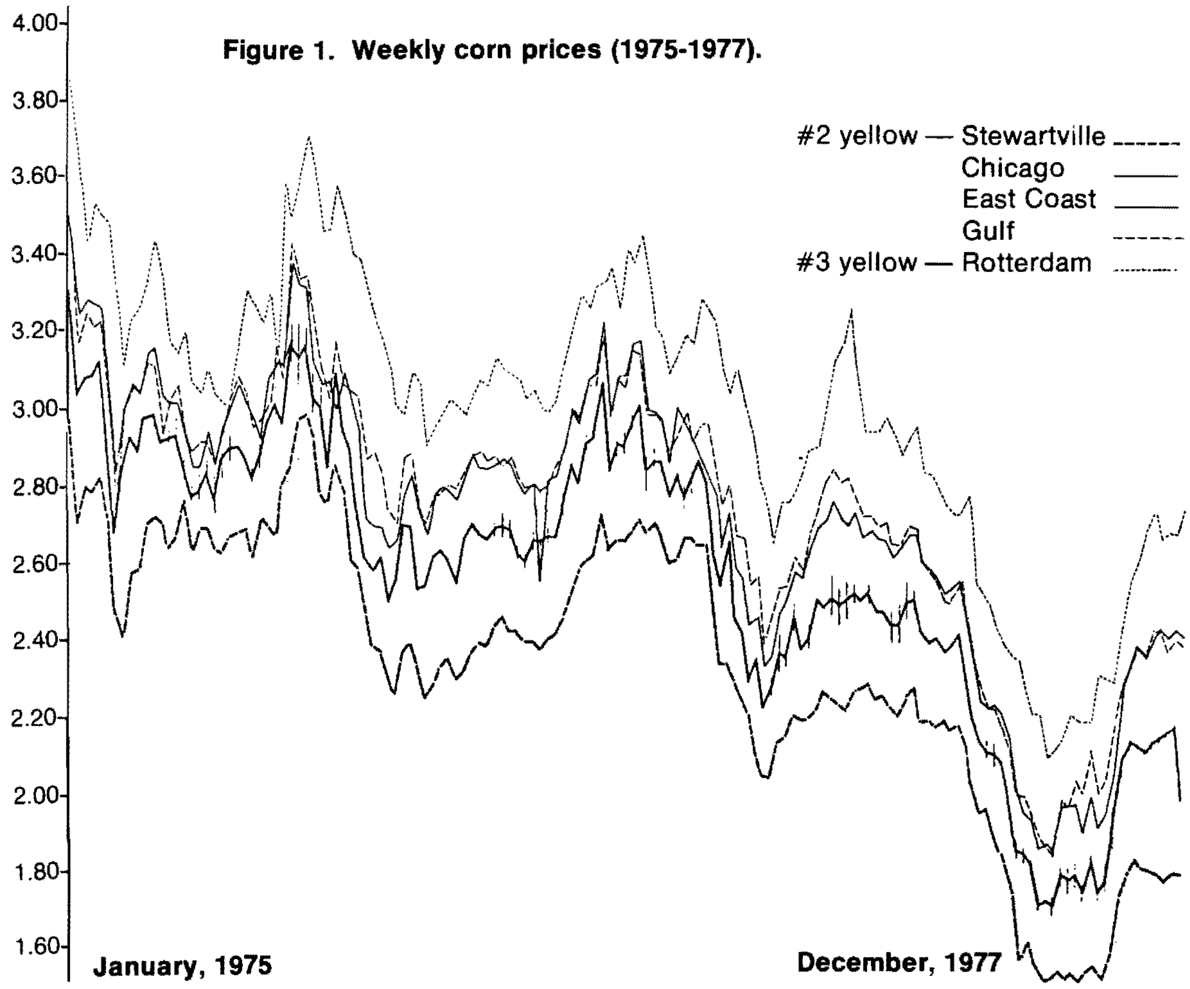


Figure 1. Weekly corn prices (1975-1977).

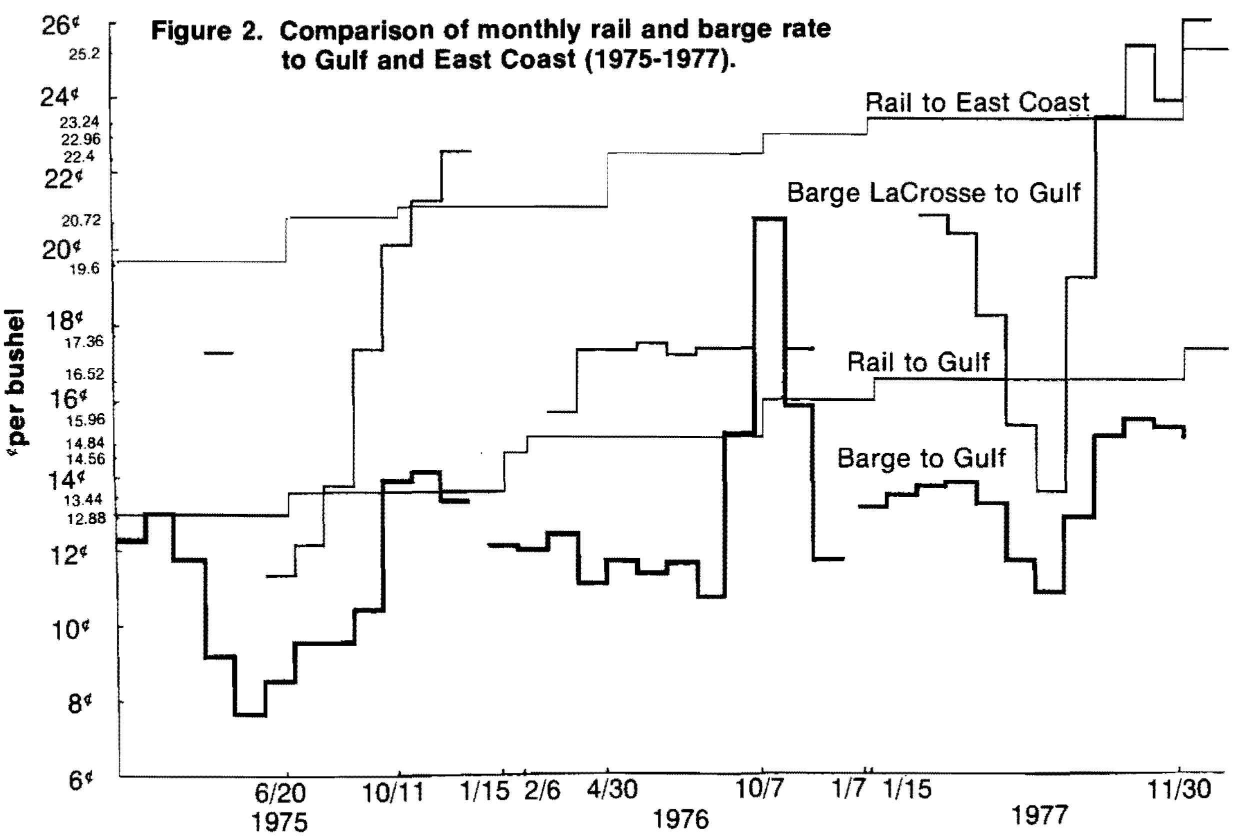


Figure 2. Comparison of monthly rail and barge rate to Gulf and East Coast (1975-1977).

Statistical Techniques Used to Test Price Behavior

Market price differentials adjusted for transportation costs. Simple statistical techniques are used to test for efficient and competitive pricing by the grain export industry. By subtracting the transportation cost between two markets from the destination market's price, the prices for the same grain, U.S. #2 Yellow Corn, at two markets in the same time period can be compared. These prices, if the markets are behaving efficiently, should be highly correlated. To test for efficiency, the price of corn at the destination market is regressed against the price of corn at the original market in the same time period (*i.e.*, the price at the Gulf is regressed against the same week's price for U.S. #2 Yellow Corn at Chicago). The intercept from such a regression should represent transfer costs other than transportation costs between markets. The slope and the coefficient of determination (r^2) measures the strength of the relationship between prices. If the slope is close to one, there is a nearly one-to-one relationship between prices exclusive of transfer costs. The regression's coefficient of determination (r^2), also measures the amount of variability in a price at one location that is explained by the variability in a corresponding price at another location.

These regression techniques are used to compare the following origin and destination prices adjusted for transportation costs:

1. Stewartville and the Gulf.
2. Chicago and the Gulf.
3. Chicago and the East Coast.
4. The Gulf and Rotterdam.
5. The East Coast and Rotterdam.

The East Coast and Gulf prices are also compared to test the strength of their relationship.

Unadjusted market differentials. The above prices, *not* adjusted for transportation costs, are also compared. The regressions of unadjusted prices will differ from regressions made with adjusted prices mostly by the size of the intercept coefficient. The intercepts from these regressions should approximate average, year-round transfer costs between markets, transportation costs included.[8]

Randomness of the residuals. The other statistical techniques used in this analysis will measure the distribution properties of the difference between destination prices of corn and origin prices of corn. This difference, on the average, will approximate transfer costs (other than transportation costs) if transportation costs have been subtracted from destination prices between two markets. If the markets are behaving efficiently and if transfer costs between markets remain constant over time, then the observed variation (deviation between destination and origin prices) in transfer costs should appear to be random, with positive and negative deviations of the same size being equally likely to be observed. In addition, the deviations may behave as if they were normally distributed.

If the differences between destination prices of corn and origin prices of corn are randomly distributed around an average transfer cost, the following relationship holds:

$$P_{D_t} = P_{O_t} + C + E_t,$$

where P_{D_t} is the destination price, P_{O_t} is the origin price, C is a constant transfer cost, and E_t is a random variable with zero mean and drawn independently each period.

If C and E_t are combined to form a single variable, T_t, the relationship may also be expressed:

$$P_{D_t} = P_{O_t} + T_t,$$

where T_t is a random variable with mean T drawn independently each period.[9]

The tests will be applied to this difference (T_t), and will be applied to all differences between prices, both adjusted and unadjusted for transportation costs, throughout typical grain export marketing channels. In tests where destination prices are not adjusted for transportation costs, the average difference between prices at different markets (T_t), should approximate average, year-round transfer costs, transporation costs included. Similarly, in tests where destination prices are adjusted for transportation costs, T_t should approximate an average of those transfer costs, other than transportation, between markets.

To examine for randomness, a few simple tests are applied to all sets of differences, T_t. Since patterns in the T_t would give evidence against randomness, all sets of T_t will be plotted against time. Two other tests will be applied to each set of T_t. The number of peaks and troughs in each chronological series of T_t will be counted and compared to the number that would be expected in a random series. This is known as the "turning point test." Also, the number and occurrence of differences above and below the mean difference will be tested. This is known as the "run of signs test."

After testing for randomness, each set of T_t will be tested for normality. There are several tests that may be applied to each set of T_t, of which four will be used in this analysis. Estimates of skewness and kurtosis for each set will be made to determine if the estimates fall in the range that would be expected of a normal distribution. Each set of T_t will also be plotted against normal probability order statistics, or "rankits." If a set of T_t is normally distributed, then the "rankit plot" (a set of ordered T_t plotted on one axis; normal order statistics plotted on the other) should approximate a straight line from the origin.

It must be stressed that these distribution tests only test the pricing efficiency of the grain export industry when transfer costs (T), remain constant over time. If transfer costs are not constant over time, all of these distribution costs will be inappropriate tests for efficient and competitive price behavior in the grain export industry. Those sets of T_t that have been adjusted for the transportation cost effect are most likely to exhibit a constant average transfer cost between markets. This is due to the fact that transportation costs often vary seasonally over time. Thus, unadjusted T probably also varies seasonally over time. However, it is possible that the

[8] John E. Trierweiler and James B. Hassler employed similar techniques in "Measuring Efficiency in the Beef-Pork Sector by Price Analysis," *Agricultural Economics Research*, 23, January, 1971, pp. 11-17.

[9] Jitender S. Mann and Richard G. Heifner of the U.S. Department of Agriculture made similar tests on futures prices in their Economic Research Service publication, *The Distribution of Short-run Commodity Price Movements*, Technical Bulletin No. 1536, 1976.

average of adjusted T is not constant over time either, due perhaps to seasonality in elevation costs or to some other component of transfer costs that varies systematically over time.

Abbreviations. Lastly, in order to facilitate the analysis, the prices for corn at each market location are referred to in the following manner:

STEW (Stewartville price).
CHIC (Chicago price).
GULF (Gulf price).
BALT (East Coast price).
ROTT (Rotterdam price).

The differences between unadjusted prices will be referred to as:

TSUGULF (GULF-STEW).
DGC (GULF-CHIC).
DBC (BALT-CHIC).
DBG (BALT-GULF).
TUROTT (ROTT-GULF).
TEUROTT (ROTT-BALT).

Transportation costs will be referred to as:

LABR (Barge rate between river elevator in Minnesota and the Gulf).
TRGF (Transportation rate between Chicago and the Gulf).
TREC (Transportation rate between Chicago and the East Coast).
OCGF (Ocean freight rate between the Gulf and Rotterdam).
OCEC (Ocean freight rate between the East Coast and Rotterdam).

The adjusted prices for corn at each market location will be referred to as:

STGULF (GULF-trucking costs between Stewartville and the Mississippi River-LABR).
AGULF (GULF-TRGF).
ABALT (GULF-TREC).
AROTT (ROTT-OCGF).
BROTT (ROTT-OCEC).

The differences between adjusted prices will be referred to as:

TSGULF (STGULF-STEW).
TGULF (AGULF-CHIC).
TBALT (ABALT-CHIC).
TPORTS (AGULF-ABALT).
TROTT (AROTT-GULF).
TEROTT (BROTT-BALT).

Results of Regressions on Market Prices

One-to-one correspondence between prices. Table 1 summarizes the results of all the regressions of adjusted and unadjusted destination prices on origin prices. All regressions yield significant results. There is a high correlation between all adjusted and unadjusted prices (the minimum coefficient of determination is .910). However, adjusting destination prices for transportation cost improves the fit of

Table 1. Results of regressions of adjusted and unadjusted destination prices on original prices.

Variables	Fitted regression line	Standard error of slope	Slope significantly different than 1, α = .01	Significance of slope	Significance of intercept	Coefficient of determination (r^2)
x = Stewartville (STEW) y = Gulf (GULF)	GULF = .6551 + .8962 (STEW)	.02256	Yes	α=.00001	α=.00001	.93489
x = Stewartville (STEW) y = Adjusted Gulf (STGULF)[a]	STGULF = .2242 + .959 (STEW)	.01611	No	α=.00001	α=.00001	.96899
x = Chicago (CHIC) y = Gulf (GULF)	GULF = .3612 + .9269 (CHIC)	.01343	Yes	α=.00001	α=.00001	.97124
x = Chicago (CHIC) y = Adjusted Gulf (AGULF)	AGULF = .1491 + .9612 (CHIC)	.02120	No	α =.00001	α=.00001	.97809
x = Chicago (CHIC) y = East Coast (BALT)	BALT = .2665 + .955 (CHIC)	.01332	Yes	α=.00001	α=.00001	.97328
x = Chicago (CHIC) y = Adjusted East Coast (ABALT)	ABALT = −.0268 + .9837 (CHIC)	.01265	No	α=.00001	α=.41798	.97721
x = Gulf (GULF) y = East Coast (BALT)	BALT = −.0713 + 1.0178 (GULF)	.01287	No	α=.00001	α=.04785	.97794
x = Adjusted Gulf (AGULF) y = Adjusted East Coast (ABALT)	ABALT = −.1541 + 1.0137 (AGULF)	.01206	No	α=.00001	α=.00001	.98043
x = Gulf (GULF) y = Rotterdam (ROTT)	ROTT = .2298 + 1.009 (GULF)	.02256	No	α=.00001	α=.00001	.93193
x = Gulf (GULF) y = Adjusted Rotterdam (AROTT)	AROTT = .1579 + .9851 (GULF)	.02375	No	α=.00001	α=.00897	.93330
x = East Coast (BALT) y = Rotterdam (ROTT)[b]	ROTT = .3646 + .9676 (BALT)	.02565	No	α =.00001	α=.00001	.90983

[a]This regression was run only on data from the months when the Mississippi River was open.
[b]Because of the small and irregular number of ocean freight cost observations between the East Coast and Rotterdam, no regression was made of adjusted Rotterdam prices on East Coast prices.

each regression, as indicated by slightly greater coefficients of determination. Also, regressions made with adjusted prices yield slopes that are not significantly different than one. Thus, by removing the transportation effect, corn prices at different market locations move more closely together.

An examination of the regression coefficients suggests that if these corn prices reflect efficient and competitive pricing, then there are sizable transfer costs, other than transportation costs, between most markets. None of the intercepts from regressions on adjusted prices equals zero as would be the case if transportation costs were the only transfer costs between markets. The marketing channel that appears to have the greatest transfer costs is between Stewartville and the Gulf. It is reasonable that this difference is the greatest. Between the time when a farmer delivers corn to the Stewartville elevator and when the corn arrives by barge at the Gulf, the corn must be put through the Stewartville elevator, loaded on to a grain truck, unloaded and put through a river elevator on the Mississippi River, and finally loaded on to a barge and sent down the river. All this handling comprises a sizable transfer cost, excluding transportation.

Examination of Mean Difference Between Prices

Mean differences approximate other transfer costs. Assuming there is, on the average, approximately a one-to-one correspondence between adjusted destination prices and origin prices, the mean difference between the adjusted prices can be used to estimate other transfer costs. Table 2 lists these mean differences as well as the means of other important variables in this study and their standard deviations.

Most of the differences between adjusted prices are within range of what may possibly be other transfer costs associated with moving corn from one market to another. But two differences, the difference between the adjusted East Coast and Chicago prices (TBALT) and the difference between the adjusted Gulf and adjusted East Coast prices (TPORTS), are not in the range to be realistically considered "other transfer costs." TBALT is not in the range simply because it implies that moving grain by rail between Chicago and the East Coast is not economically justified. Nonetheless, corn does move by rail between the Chicago area and the East Coast. TPORTS is not in the logically reasonable range because it would imply that the transfer costs (other than transportation) incurred by moving grain to the Gulf are 11.8 cents greater per bushel than those incurred by moving grain to the East Coast.

Similarly, the differences between unadjusted prices and origin prices appear to approximate an average year-round total transfer cost, including transportation, except for the unadjusted difference between the East Coast and Chicago price (DBC). The average price difference between the East Coast and Chicago is less than the average transportation cost between markets. Another apparent economic irregularity is the difference between the East Coast and Gulf prices (DBG). While the average cost between Chicago and the East Coast is greater than the average cost between Chicago and the Gulf, the average East Coast corn price is 2.2 cents less than the average Gulf price.

Table 2. Means and standard deviations of selected variables.

Variable	Number of observations	Mean	Standard deviation
		dollars/bushel	
Unadjusted prices:			
STEW (Stewartville)	149	2.350	.3750
CHIC (Chicago)	149	2.590	.3703
GULF (Gulf)	148	2.759	.3480
BALT (East Coast)	143	2.730	.3620
ROTT (Rotterdam)	149	3.017	.3640
Differences between unadjusted prices:			
TSUGULF (GULF-STEW)	148	.4112	.0970
DGC (GULF-CHIC)	148	.1710	.0660
DBC (BALT-CHIC)	143	.1500	.0670
DBG (BALT-GULF)	143	−.0220	.0540
TUROTT (ROTT-GULF)	148	.2550	.0950
TEUROTT (ROTT-BALT)	143	.276	.1109
Transportation costs:			
Trucking costs between Stewartville and Mississippi River	149	.0896	0.0000
LABR (Barge rate between river elevator in Minnesota and the Gulf)	115	.1860	.0380
TRGF (Transportation rate between Chicago and the Gulf)	149	.1240	.0209
TREC (Transportation rate between Chicago and the East Coast)	149	.2190	.0146
OCGF (Ocean freight rate between the Gulf and Rotterdam)	126	.1370	.0200
Adjusted prices:			
STGULF (Gulf-transportation from Stewartville)	114	.2438	.3920
AGULF (Gulf-transportation from Chicago)	148	2.6360	.3595
ABALT (East Coast-transportation from Chicago)	143	2.5100	.3721
AROTT (Rotterdam-transportation from Gulf)	126	2.8210	.3540
BROTT (Rotterdam-transportation from East Coast)	47	2.9070	.3970
Differences between adjusted prices:			
TSGULF (STGULF-STEW)	114	.1300	.0710
TGULF (AGULF-CHIC)	148	.0480	.0569
TBALT (ABALT-CHIC)	143	−.0690	.0565
TPORTS (AGULF-ABALT)	143	.1180	.0520
TROTT (AROTT/GULF)	125	.1170	.0920
TEROTT (BROTT-BALT)	45	.1620	.1240

Time Plots of Prices

To understand the relationship between spatially separated prices, time plots of the differences between the adjusted destination prices and origin prices were made. These graphs indicate that, in some instances, the difference between destination prices adjusted for transportation and origin prices clearly is not randomly distributed around a mean transfer cost. In fact, definite patterns appear in some

Figure 3. Range of price differentials between Chicago and Gulf corn prices not accounted for by transportation costs, four-week periods, 1975-77.

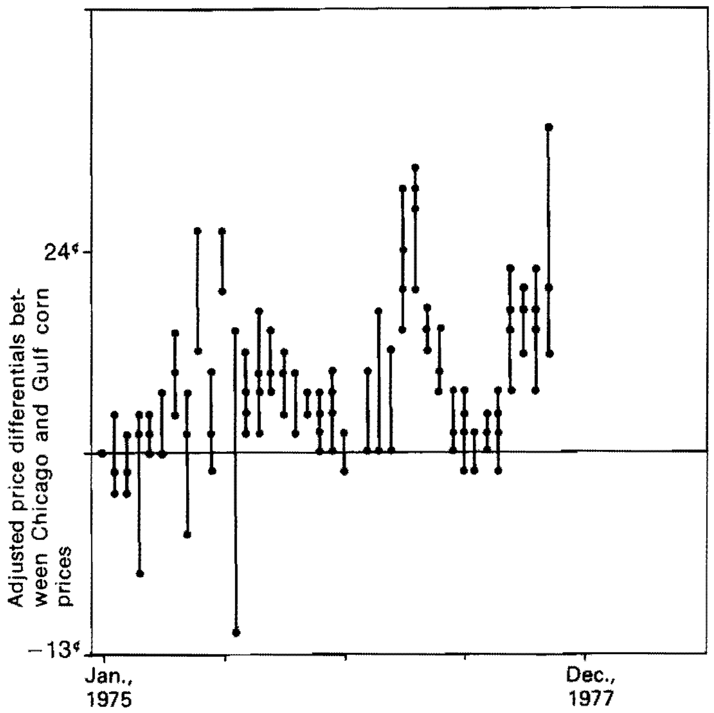
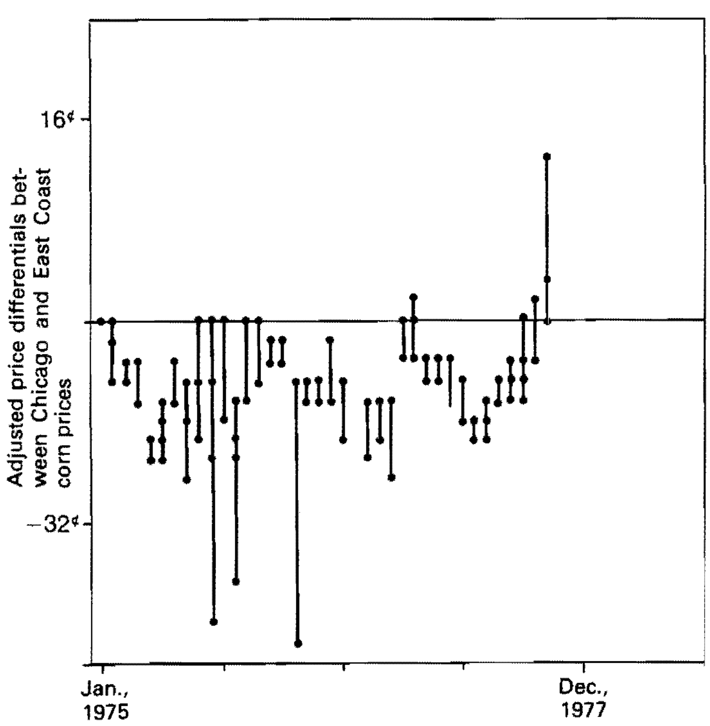


Figure 4. Range of price differentials between Chicago and East Coast prices not accounted for by transportation costs, four-week periods, 1975-77.



differences: namely, the differences between the adjusted Gulf and Chicago prices and the adjusted East Coast and Chicago prices (TGULF and TBALT) shown in Figures 3 and 4. Over the three-year period 1975-1977, both TGULF and TBALT appear to vary seasonally between summer and winter. Another distinct characteristic of some of these graphs is that in this time period, 1975-1977, the variance of the differences decreases over time. The differences between the adjusted Gulf and adjusted East Coast, adjusted Rotterdam and Gulf, and adjusted East Coast prices (TPORTS, TROTT, and TEROTT) exhibit this characteritic.

Tests for Randomness and Normality of Price Differences

Price differences not conclusively random. Tests for randomness were made on sets of adjusted and unadjusted differences between prices. Both the turning point and run of signs tests were applied. Table 3 summarizes the results of these tests for each set of adjusted differences and a few unadjusted differences. These tests together yield conclusive results only for the differences TGULF, TBALT, and TPORTS. They do not behave as if they were random. The other differences may appear to be non-random, depending on the criterion used.

The other distributional characteristic hypothesized in this study is that differences between prices may be distributed normally around a mean difference that should approximate the average transfer cost between markets. Normality (*i.e.*, a normal distribution of differences around a mean transfer cost) is hypothesized to test if the deviations from the mean are more likely to cluster closely around the mean than to deviate greatly from the mean. By (1) obtaining measures of skewness and kurtosis for each set of differences and (2) making rankit plots of each set, the hypothesis of normality can be tested for each set of differences. Table 4 summarizes the results of the tests for skewness and kurtosis for all price differences. Figures 5-10 show the rankit plots for each set of differences in adjusted prices.[10] In each of the plots, normality is indicated if the plotted points approximate a straight line.

Most price differences appear to be non-normally distributed. The tests for normality provide evidence that the differences between Gulf, East Coast, and Chicago prices (TGULF, TBALT, and TPORTS) may not be distributed according to a normal law. However, for the differences between Gulf and Stewartville prices (TSGULF), there is no evidence against normality. Finally, the tests on the differences between Rotterdam and the Gulf and Rotterdam and East Coast prices (TROTT and TEROTT) are inconclusive; they may or may not be normally distributed. However, normality assumes constant variance. As previously noted, the variance of some differences appears to decrease over time. Hence, the probability that the differences TROTT and TEROTT are normally distributed over time is slight.

[10]For a discussion of rankit plots, see S. Weisberg, *Applied Linear Regression*, John Wiley & Sons, New York, 1980.

Figure 5. Rankit plot of corn price differentials between Stewartville and the Gulf, 1975-77, not accounted for by transportation costs. A plotted • indicates a single point; a plotted number indicates multiple points.

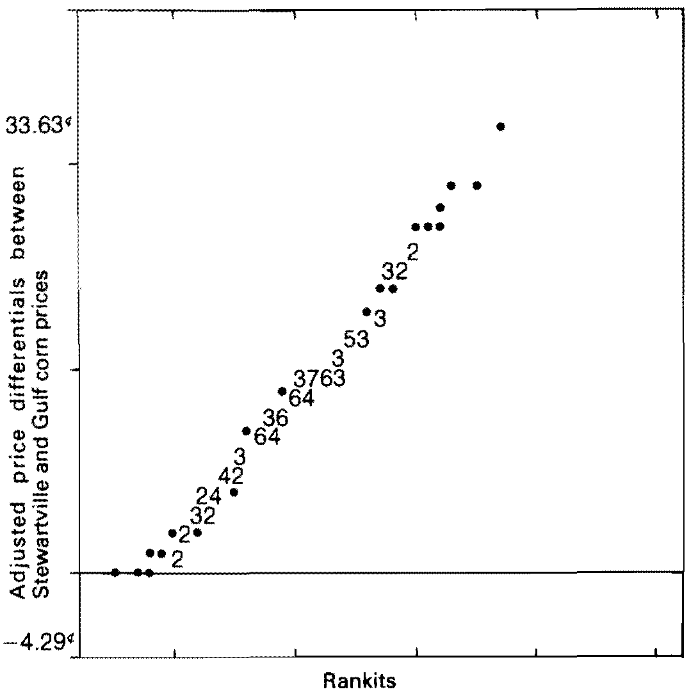


Figure 6. Rankit plot of corn price differentials between Chicago and the Gulf, 1975-77, not accounted for by transportation costs. A plotted • indicates a single point; a plotted number indicates multiple points.

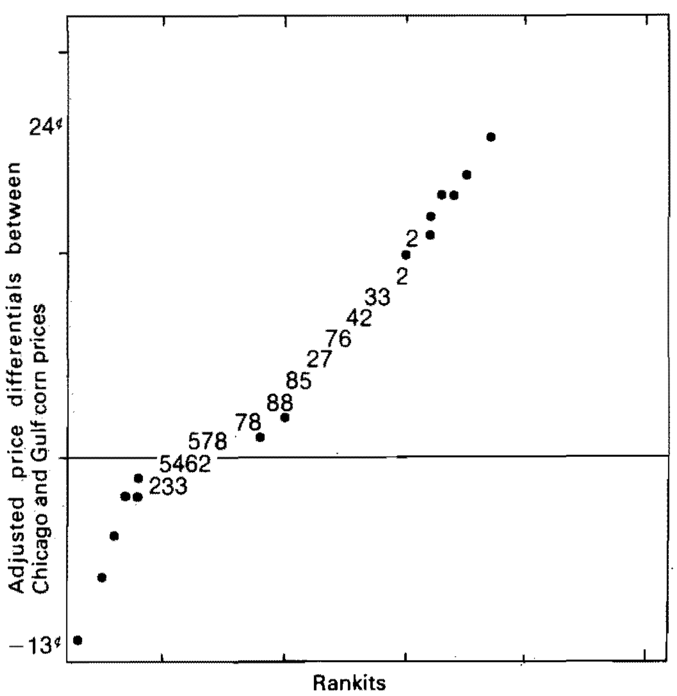


Figure 7. Rankits plot of corn price differentials between Chicago and the East Coast, 1975-77, not accounted for by transportation costs. A plotted • indicates a single point; a plotted number indicates multiple points.

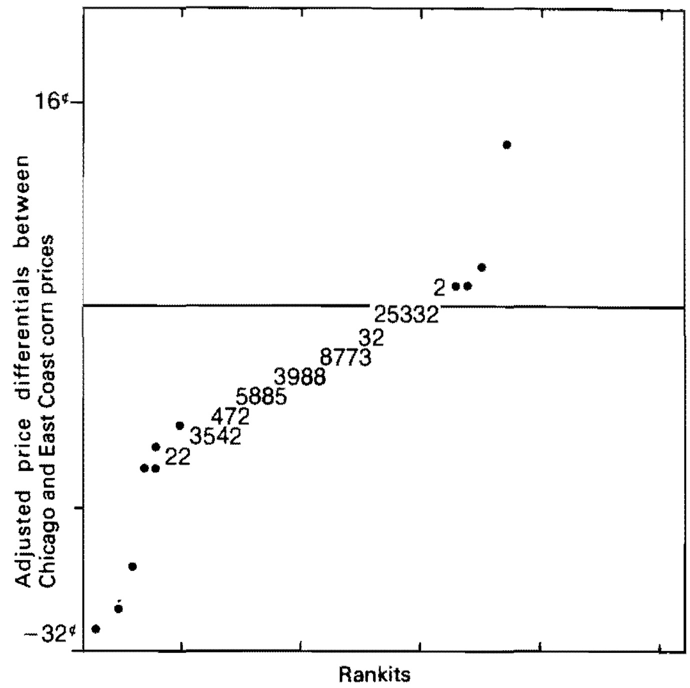


Figure 8. Rankit plot of corn price differentials between the East Coast and the Gulf, 1975-77, not accounted for by transportation costs. A plotted • indicates a single point; a plotted number indicates multiple points.

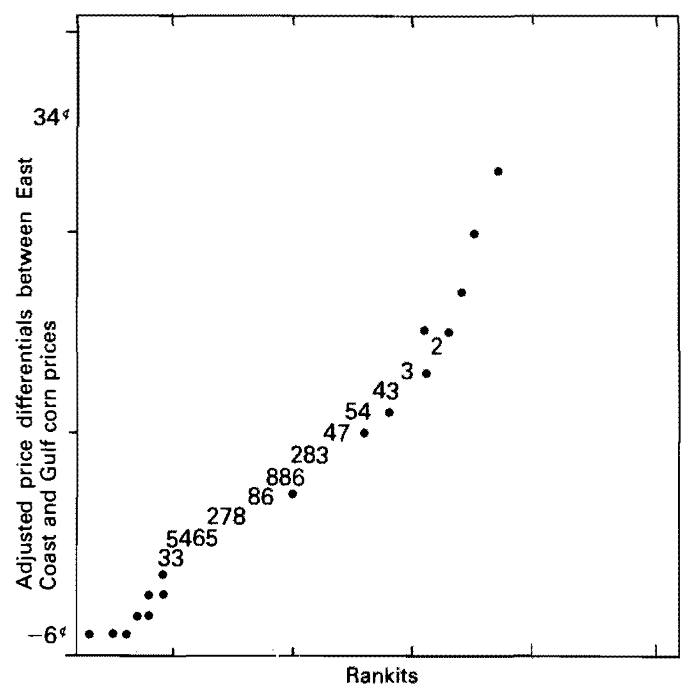


Figure 9. Rankit plot of corn price differentials between Rotterdam and the Gulf, 1975-77, not accounted for by transportation costs. A plotted • indicates a single point; a plotted number indicates multiple points.

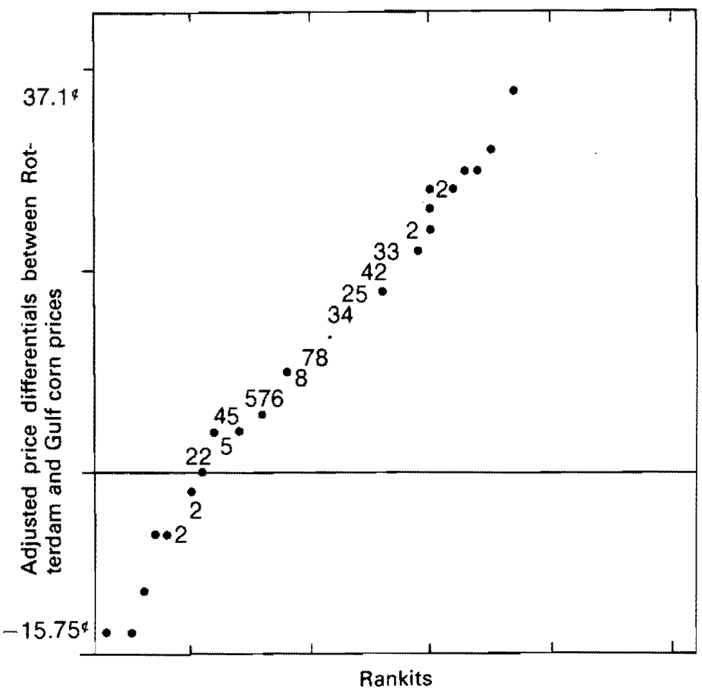
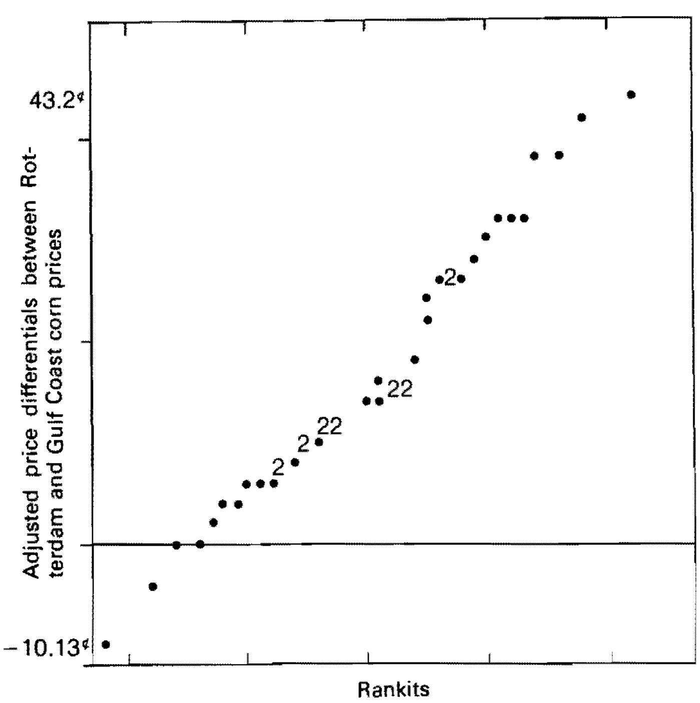


Figure 10. Rankit plot of corn price differentials between Rotterdam and the East Gulf, 1975-77, not accounted for by transportation costs. A plotted • indicates a single point; a plotted number indicates multiple points.



Examination of Extreme Differences Between Prices

Price differences may vary seasonally. To determine the cause of the apparent seasonality in the differences between prices, the extreme differences between adjusted destination prices and origin prices were analyzed separately. Table 5 summarizes the frequencies of extreme differences for the differences between adjusted prices. These frequencies support the conclusion that the differences between both the adjusted East Coast and adjusted Gulf and Chicago prices (TBALT and TGULF) vary seasonally. In winter, TBALT is generally at its maximum, above zero. But during summer and harvest, TBALT is usually less than zero and most likely to be less than −10 cents. Similarly, TGULF is usually at its maximum in winter, above 10 cents, and at its minimum in summer, less than zero. However, no distinct pattern in TGULF appears during harvest. No distinct, seasonal patterns appear in either TSGULF, TROTT, or TEROTT except that all three differences seem to be at a minimum in summer.

Time sequence and rankit plots of TGULF and TBALT were made for 1975-1977 during the months when the upper Mississippi River was open and navigable to investigate whether the seasonality observed in TGULF and TBALT corresponds to the seasonal use of the upper Mississippi River. While the seasonal patterns in both TGULF and TBALT are still easily detected, some of the upper extreme differences in each are gone. The winter of 1976/77 shows the most notable correspondence. However, the closing of the upper Mississippi has no significant effect on the mean of TGULF or TBALT. The mean of TGULF in only those months when the river was open is 4.67 cents. The year-round mean is 4.8 cents. The mean of TBALT in only those months when the river was open is −7.51 cents. The year-round mean is −6.9 cents. Neither mean changes by more than a penny. Furthermore, removing the values TGULF and TBALT in those months when the Mississippi River was closed does not significantly alter the rankit plots or affect the Wilk-Shapiro statistics of TBALT or TGULF. Therefore, the effect of the closing of the upper Mississippi River during winter months on the differences between TGULF and TBALT is questionable.

Summary of Test Results

The results of these tests on corn prices at five different market locations indicate that prices are closely linked and highly responsive to each other throughout the export marketing channel. Most of the differences between destination and origin prices are explained by the transportation cost between markets. But the remaining differences do not appear to be randomly distributed around a constant transfer cost in most cases. In some instances the differences appear to vary seasonally, particularly the differences between both the adjusted Gulf and adjusted East Coast and Chicago prices (TGULF and TBALT). The cause of the seasonality may be linked to the winter closing of the upper Mississippi River.

Table 3. Results of turning point test and run of signs test on selected differences between prices.

Variable	Turning point test: Turning points	Expected turning points	Standard deviation	Z-score	Significance probability	Run of signs tests: Z-score	Significance probability
Differences between unadjusted prices:							
TSUGULF (GULF-STEW)	81	98.6	5.1	−3.45	.06%	1.082	28%
TUROTT (ROTT-GULF)	95	98.6	5.1	−.71	48.4%	3.672	.02%
TEUROTT (ROTT-BALT)	91	94	5.01	−.60	54.86%	3.315	.1%
Differences between adjusted prices:							
TSGULF (STGULF-STEW)	68	74.6	4.47	−1.49	13.62%	2.395	1.64%
TGULF (AGULF-CHIC)	78	98.6	5.1	−4.05	0	−6.57	0
TBALT (ABALT-CHIC)	80	95.3	5.01	−3.05	.22%	−6.86	0
TPORTS (AGULF-ABALT)	84	95.3	5.01	−2.26	2.38%	−6.82	0
TROTT (AROTT-GULF)	86	83.3	4.68	.51	56.86%	4.14	0
TEROTT (BROTT-BALT)	27	30	2.77	−1.08	28.02%	1.717	8.54%

Table 4. Tests for skewness and kurtosis on all price differences.

Variable	Skewness	Significance	Kurtosis	Significance
differences between unadjusted prices				
TSUGULF (GULF-STEW)	.113	Not significant	−.308	Not significant
DGC (GULF-CHIC)	.517	$\alpha = .01$	.586	Not significant
DBC (BALT-CHIC)	−.527	$\alpha = .01$	5.793	$\alpha = .01$
DBG (BALT-GULF)	−1.072	$\alpha = .01$	1.886	$\alpha = .01$
TUROTT (ROTT-GULF)	−.013	Not significant	.781	$\alpha = .05$
TEUROTT (ROTT-BALT)	.490	$\alpha = .05$	.509	Not significant
differences between adjusted prices				
TSGULF (STGULF-STEW)	.191	Not significant	.025	Not significant
TGULF (AGULF-CHIC)	.530	$\alpha = .01$	1.483	$\alpha = .01$
TBALT (ABALT-CHIC)	−.822	$\alpha = .01$	6.072	$\alpha = .01$
TPORTS (AGULF-ABALT)	.843	$\alpha = .01$	2.452	$\alpha = .01$
TROTT (AROTT-GULF)	−.200	Not significant	.921	$\alpha = .05$
TEROTT (BROTT-BALT)	.374	Not significant	−.249	Not significant

Source: Snedecor and Cochran, *op. cit.*, p. 552.

Table 5. Frequencies of extreme differences between adjusted destination prices and original prices.

Variable	Winter/December-March: January-March 1975	1976	1977	December 1977	Spring-Summer/April-August: 1975	1976	1977	Harvest/September-November: 1975	1976	1977
TSGULF<.1	River closed			0	4	7	10	5	7	1
TSGULF >.2				5	2	2	0	1	0	6
TBALT <−.1	0	0	1	0	10	3	5	6	7	0
TBALT >0	2	0	3	5	0	0	0	0	0	2
TGULF <0	4	0	0	0	7	2	3	3	4	1
TGULF >.1	0	1	7	4	1	1	0	3	0	4
TROTT >.08	3	3	3	0	9	9	1	0	4	5
TROTT >.2	3	0	3	0	4	1	2	6	5	0
TEROTT <.1	2	1	1	0	2	6	0	0	0	1
TEROTT >.2	0	0	2	0	1	1	1	6	4	0

Implications of the Tests for Pricing Efficiency

It is not possible to say conclusively that these apparent nonrandom differences in corn prices are not a reflection of market imperfections, including imperfect competition among grain export firms. However, the correlations in both the adjusted and unadjusted prices among various points in the export marketing channel were very high. Consequently, the unexplained variation, even if nonrandom, was very small. Furthermore, there are good reasons to support the conclusion that this apparent nonrandom behavior is largely attributable to other market factors which are discussed below.

Rail rates regulated, barge rates unregulated. Two major modes of transportation, rail and barge, are used to ship grain from inland producing regions to port locations for export. Rail rates are regulated by the Interstate Commerce Commission (ICC). Barge rates are market determined and can fluctuate as supply and demand conditions change. In those instances where both rail and barge are available between two locations, such as between central Illinois and the Gulf, the railroads attempt to set rail rates at a competitive level with barge rates. However, if rail transportation is not in direct competition with barge transportation, such as the case between central Illinois and the East Coast, rail rates are not held at levels comparable to those available on barge competitive routes.

Figure 2 shows the variable nature of barge rates over a year's period and the relatively constant nature of rail rates. Also evident is the difference between rail rates that are competitive with barge rates and those that are not, as shown by the difference between rail rates to the Gulf and rail rates to the East Coast. Further inspection reveals that rail rates to the Gulf appear competitive with barge rates only during late fall and winter months. During other periods, a rational firm would only transport grain by barge. Similarly, rail rates to the East Coast may be competitive with those to the Gulf only in winter months. Such a condition would help explain why the difference between the adjusted East Coast price for corn and the Chicago price lies around zero only in winter months. In summer months, the opportunity cost of moving grain by rail may be too great to both the East Coast and Gulf.

Since the East Coast is accessible from Illinois only by rail and the cost of moving grain by rail between Illinois and the East Coast is economically justified only in winter months, grain firms located on the East Coast must procure grain from producing regions east of central Illinois, such as the Ohio River Valley. Further, the difference between the adjusted Gulf and Chicago price may be explained by forward contracting for barge transportation.

The barge transportation costs used in this study may not exactly represent the weekly costs of barging corn between Chicago and the Gulf. Instead, these costs may represent the barging costs between Chicago and the Gulf at various points in time before the actual week in which the corn was barged because grain merchants often purchase barge transportation in forward markets.

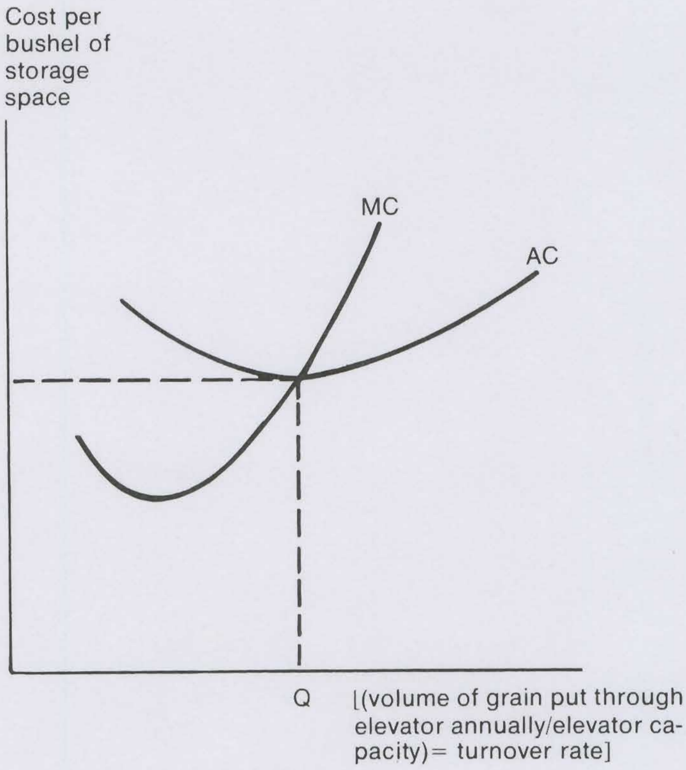
Transfer costs in addition to transportation. The positive difference between most adjusted destination prices and origin prices also reflects transfer costs, other than transportation, between markets. These costs include interest, insurance, and elevation costs along the marketing channel. Elevation costs are important and vary with the supply and demand for storage. The demand for storage space is often greatest after harvest when the supply of unstored grain is greatest. Thus, seasonality in elevation costs may explain part of the apparent nonrandom behavior of the differences between adjusted destination and origin prices.

Export demand stronger at Gulf. The supply and demand for export corn at the Gulf and East Coast may also explain the positive difference between the adjusted Gulf price and the Chicago price and the negative difference between the adjusted East Coast and Chicago price. Much more grain is put through the Gulf ports than through East Coast ports. The "turnover rate," or the ratio of the inspections to capacities, is much higher at the Gulf than at the East Coast. The Gulf can handle larger vessels and elevators there have faster load-out rates. This creates a greater demand for export corn at the Gulf than at the East Coast. To ensure a steady supply of corn to the Gulf, exporters sometimes must offer prices for corn that make the Gulf a more attractive destination than the East Coast to U.S. grain merchants. Hence, a premium over the cost of moving corn to the Gulf may be included in the on-track price of corn at the Gulf that is not included at the East Coast.

Shocks to the grain export market. Finally, some of the differences between adjusted and unadjusted prices and origin prices for corn appear to decrease in variance between 1975 and 1977. This is particularly noticeable in the differences between Rotterdam and Gulf and Rotterdam and East Coast corn prices. Several factors may account for this phenomenon. As hypothesized in this study, deviations from an average transfer cost between markets should represent random, exogenous supply or demand shocks at one market or another. If this hypothesis approximates reality, then decreasing variance in the differences between prices should indicate that either (1) exogenous shocks to the grain export industry decreased in magnitude between 1975 and 1977, or (2) that the industry could respond to these shocks more quickly in the latter part of this period. Well-known shocks to the industry in 1975 will support both explanations: a grain embargo, large grain sales to the Soviet Union, and a drought in Europe. These events may be responsible for the large variance in the differences between the adjusted Rotterdam and Gulf and adjusted Rotterdam and East Coast prices (TROTT and TEROTT) in 1975. The grain surpluses of 1976 and 1977 have probably prevented any such events from disturbing the industry as was possible in 1975.

Evidence of pricing efficiency. The evidence and interpretations presented above indicate that the U.S. grain export industry's pricing performance was efficient between 1975 and 1977. The high degree of correlation between prices alone suggests that markets throughout the export marketing system are closely tied. Most of the differences between prices can be attributed to transfer costs between markets. Competitive arbitrage in these markets appears to be present as especially evidenced by the behavior of the differences between the Chicago and East Coast and the Chicago and Gulf prices. These differences represent the returns of moving corn between one market and another. In some cases the returns match or exceed the cost; in others they do not. Thus, corn moves to those areas where demand

Figure 11. Hypothetical marginal and average cost curves of an hypothetical export grain elevator.



warrants. The price mechanism is thereby efficiently allocating grain flows throughout export marketing channels.

The pricing efficiency in the grain export industry meets efficiency criteria characteristics of perfectly competitive markets. Hence, there is little statistical evidence of oligopolistic exploitation by the small number of large firms that make up this industry.

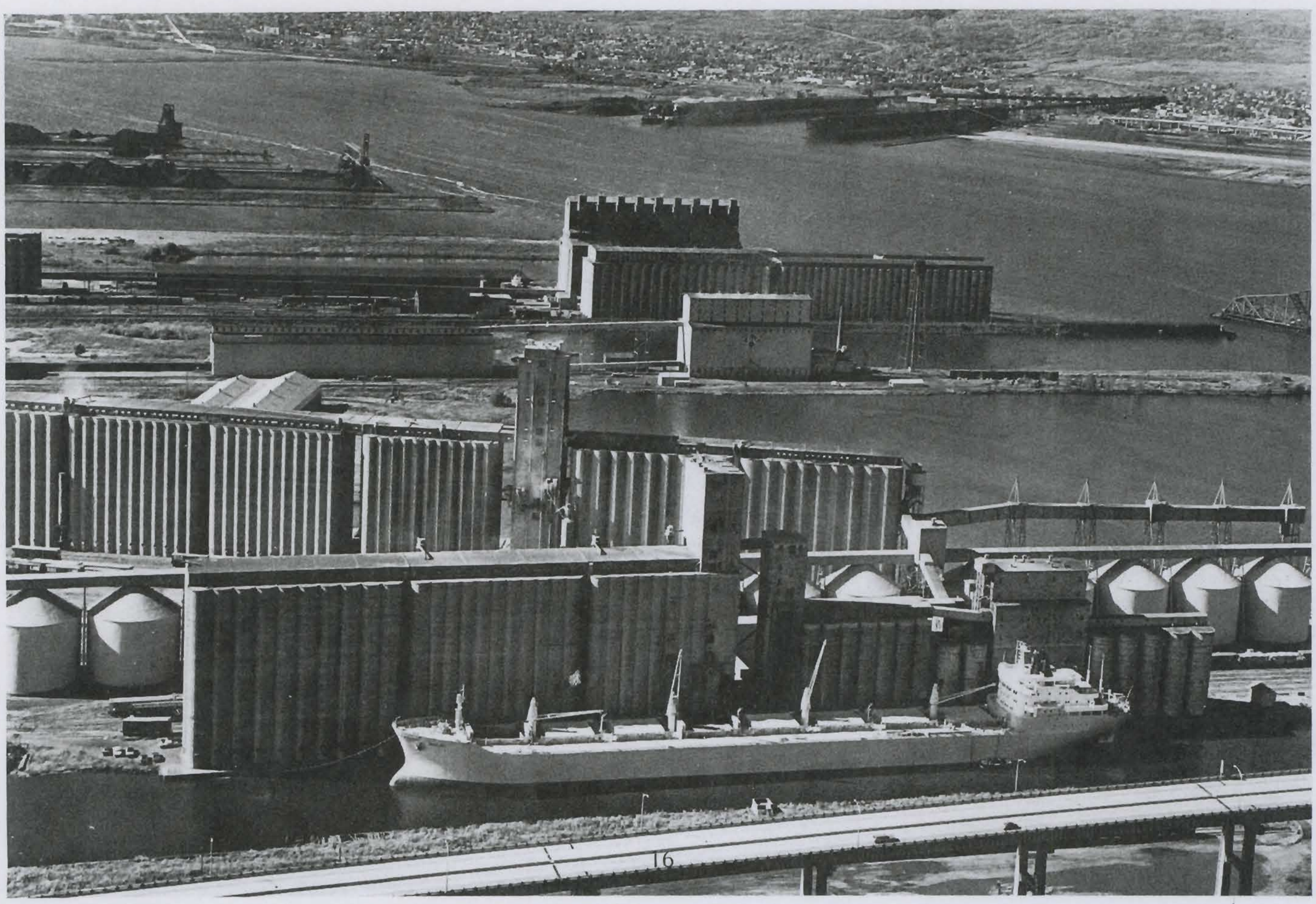
Productive Efficiency of the Industry

Productive Efficiency Criteria

The second dimension of industry performance, productive efficiency, rests mostly upon an industry's load and scale factors. The load factor indicates the extent to which firms in an industry make reasonably full use of their available facilities and reflects short-run productive efficiency. The scale factor indicates the extent to which firms are organized to take advantage of scale economies and reflects an industry's productive efficiency in the long run.[11] Certain characteristics of the grain export industry's market organization and operations will be examined that are indicative of its productive efficiency.

The load factor. Figure 11 depicts hypothetical average and marginal cost curves for a given hypothetical export grain elevator, the physical plant of the grain export indus-

[11]Bressler and King, *op. cit.*, p. 411.



try. At point Q, the cost per bushel of storage space is minimized. The ratio of the volume of export grain put through an export elevator annually to the elevator capacity, or turnover rate, at point Q is the least-cost, optimal-use level of operations for which a hypothetical export elevator is constructed. If an export elevator is operating at point Q, its load factor is productively efficient. If most export elevators are operating at the minimum point on their average cost curves, the industry's load factor is productively efficient. Thus, by examining the turnover rates for the grain export industry's export grain elevators, some measure of the industry's short-term productive efficiency can be obtained.

The scale factor. Figure 12 depicts hypothetical long-run average and marginal cost curves (LAC and LMC, respectively) for a hypothetical grain exporting firm. The long-run average cost curve is an aggregation of points on short-run average cost curves for plants designed for various sizes of operation tangent to an envelope-shaped curve connecting them. At point V, the hypothetical grain exporting firm is operating at the least per unit cost possible.

The shape of the LAC curve depicted in Figure 12 implies that a minimum per unit of export grain cost exists at some scale of operation. Per unit costs decrease as the volume of export-related activity increases up to point V. At levels of operation greater than V, per unit of export grain costs increase. Economies of scale occur to plant size V; diseconomies exist beyond this size. However, in some industries, and possibly in the grain export industry, the LAC curve decreases continuously as the volume or scale of the firm's operations increases. Hence, no minimum per unit cost exists as one exists at point V in Figure 12. The dotted LAC' curve in Figure 12 depicts such decreasing per unit costs.

Some economists argue that significant economies of scale exist in grain exporting.[12] They argue that an exporting firm's long-run average cost curve decreases as the scale of export-related activity increases. A number of export-related functions are believed to be responsible for the scale economies in grain exporting. The most important of these functions are (1) transporting grain between markets, (2) establishing and maintaining an information network, (3) the ability to take large financial risks and absorb losses, and (4) operating storage space throughout the export marketing channel. As the scale of these functions increases, the cost per unit of export grain decreases. Thus, measuring the scale factor of the U.S. grain export industry requires detecting the extent to which the industry is organized to take advantage of scale economies in these export-related functions.

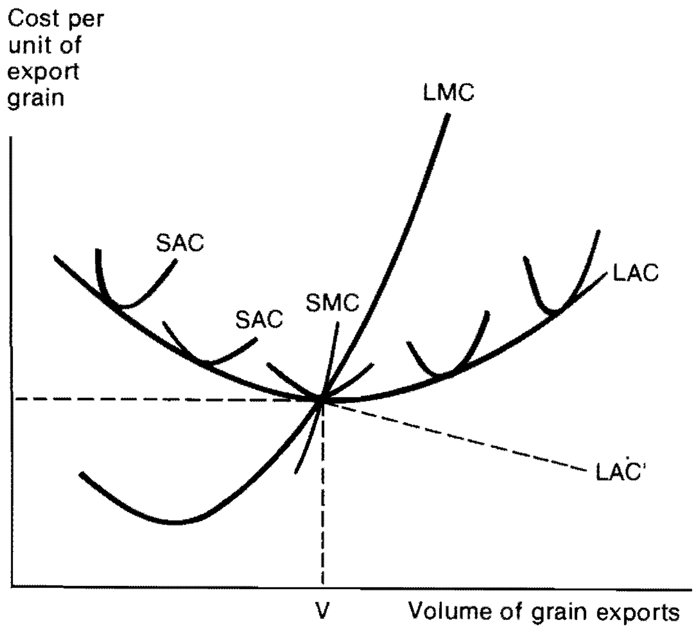
Measuring Load and Scale Factors

In measuring the industry's load factor, cost data on each individual export elevator would have to be obtained so that the minimum point on the short-run average cost curve, or the optimal turnover rate, of each elevator could be determined. Measuring the industry's scale factor would be even more difficult. The short-run average cost curves for exporting firms at various scales of operation would have to be aggregated to construct a long-run average exporting cost curve. Then, an optimal scale of operations might be found by determining a minimum point along the long-run average cost curve. Or, no unique optimal scale of operations may exist because of continuous scale economies associated with exporting grain. In such a case, the larger the scale of an exporting firm's operation, the greater the firm's productive efficiency.

The load and scale factors of the U.S. grain export industry are examined with available data on export marketing facilities, their size, and intensity of utilization. The load factor is determined by comparing the overall turnover rates for export elevators at each port location. The load factors at various ports are also compared. The scale factor is determined by first recognizing and explaining the scale economies that exist in a number of exporting functions. Then, evidence of market organization reflecting the influence of scale economies will be considered.

[12]Richard E. Caves, "Organization, Scale, and Performance of the Grain Trade," *Food Research Institute Studies*, Vol XVI, No. 3, 1978, pp. 107-123.

Figure 12. Construction of hypothetical long-run average and marginal cost curves for a hypothetical exporting firm.



The Industry's Load Factor

Grain inspections for export. Table 6 shows the total inspections for export of wheat, soybeans, corn, and grain sorghum by port area for calendar years 1967-1976. Three and one-half billion bushels of grain were inspected for export in 1976, more than double the 1967 level. Two-thirds were exported via Gulf ports and the remainder divided between Atlantic, Pacific, and Great Lakes ports. The shares of exports from Atlantic ports rose from 9 percent in 1967 to 15 percent in 1976. The shares of Pacific and Lakes ports declined over this period while Gulf ports maintained a relatively constant two-thirds of the total for the entire period.

Table 7 shows port grain elevator capacities, total grain inspections for export, and the ratio of inspections to capaci-

Table 6. Inspections for export of total wheat, soybeans, corn and grain sorghum by port area, calendar years 1967-76.

Port area	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	Percent change 1967-76
	Inspections for export (millions of bushels)										
Lakes	170.3	232.3	239.3	257.4	277.2	278.7	350.2	222.0	302.5	272.5	60.1
Atlantic	147.4	149.4	86.2	102.2	94.3	221.0	382.7	360.2	428.2	531.0	260.3
Gulf	1,054.4	1,020.4	854.8	1,145.9	1,109.8	1,479.0	2,248.4	1,884.6	2,039.0	2,328.2	120.8
Pacific	267.0	202.0	204.8	250.7	165.6	250.3	361.9	330.4	351.1	362.5	35.8
TOTAL	1,639.1	1,604.1	1,385.1	1,756.2	1,646.9	2,229.0	3,343.2	2,797.2	3,120.8	3,494.2	113.2
	Percent of total										Percent change of total
Lakes	10.4	14.5	17.3	14.7	16.8	12.5	10.5	7.9	9.7	7.8	−25.0
Atlantic	9.0	9.3	6.2	5.8	5.7	9.9	11.4	12.9	13.7	15.2	+68.9
Gulf	64.3	67.6	61.7	65.3	67.4	66.4	67.3	67.4	65.3	66.6	+3.5
Pacific	16.3	12.6	14.8	14.3	10.1	11.2	10.8	11.8	11.3	10.4	−36.2
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USDA, *Grain Market News*, Consumer and Marketing Service Grain Division, General Bulletin 1975, Vol. 24, No. 3, Jan. 16, 1976, Vol. 25, No. 2, Jan. 14, 1977.

Table 7. Port grain elevator capacities, grain inspections for export, and ratio of inspections to capacities, calendar year 1976.

Port	Elevators Number	Elevators Capacity	Inspections for export	Ratio of inspections for export to capacity
		(million bushels)		
LAKES				
Chicago	7	50.6	77.8	1.5
Duluth-Superior	10	59.5	95.7	1.6
Toledo	2	18.5	129.6	7.0
Saginaw	0	0	[5.9][a]	
Subtotal		128.6	303.1	2.4
ATLANTIC				
North	1	14.0	110.6	7.9
South	4	18.8	423.9	22.5
Subtotal		32.8	534.5	16.3
GULF				
Mississippi	7	43.9	1,514.7	34.5
East Gulf	1	3.0	146.5	48.8
North Texas Gulf	6	30.4	528.6	17.4
South Texas Gulf	3	15.7	139.0	8.8
Subtotal		93.0	2,329.0	25.0
PACIFIC				
Columbia River	8	28.4	256.6	9.0
Puget Sound	3	12.8	82.3	6.4
California	4	13.0	49.0	3.8
Subtotal		54.2	387.9	7.2
TOTAL	56	308.6	3,554.5	11.5

[a]According to the *Approved Warehouse Lists*, there is no longer any elevator with export capability in this area. The amount of grain inspected for export in the Saginaw area during 1976 is not significant for purposes of this table.

Sources: USDA, ASCS, *Approved Warehouse Lists*, Jan. 1, 1977. USDA, *Grain Market News*, Consumer and Marketing Service, Grain Division, Vol. 25, No. 2, Jan. 14, 1977.

ties for 1976.[13] Not only was much more export grain put through the elevator facilities at the Gulf than at any other area, but, more importantly, the average ratio of inspections to capacity, or turnover rate, is much greater at the Gulf than at any other area. The only port area that approaches the Gulf's high turnover rate is the Atlantic, whose South Atlantic region has recently become a more active exporting center.

Handling Characteristics of Export Facilities

Gulf facilities are newest and most efficient. Certain characteristics of each port dictate the general volume of export grain that may be put through their elevators annually. Some port facilities are better equipped than others for efficiently handling grain for export. Load-out capacities range from 10,000 bushels per hour at older elevators to 80,000 bushels per hour at the newer elevators. The newest port terminals have a much greater speed and efficiency, with load-out capabilities of up to 200,000 bushels per hour. Generally, facilities at Gulf ports are newer, have faster load-out rates, and are designed for higher efficiency and higher inventory turnovers than at the Lakes or on the Atlantic or Pacific Coasts.

Lake facilities also used for grain storage. The high turnover rate at the Gulf indicates that the elevators at the Gulf are not used for long-term grain storage. Reserves of grain at inland terminals are easily tapped at short notice if export grain is needed at the Gulf. However, some older elevators

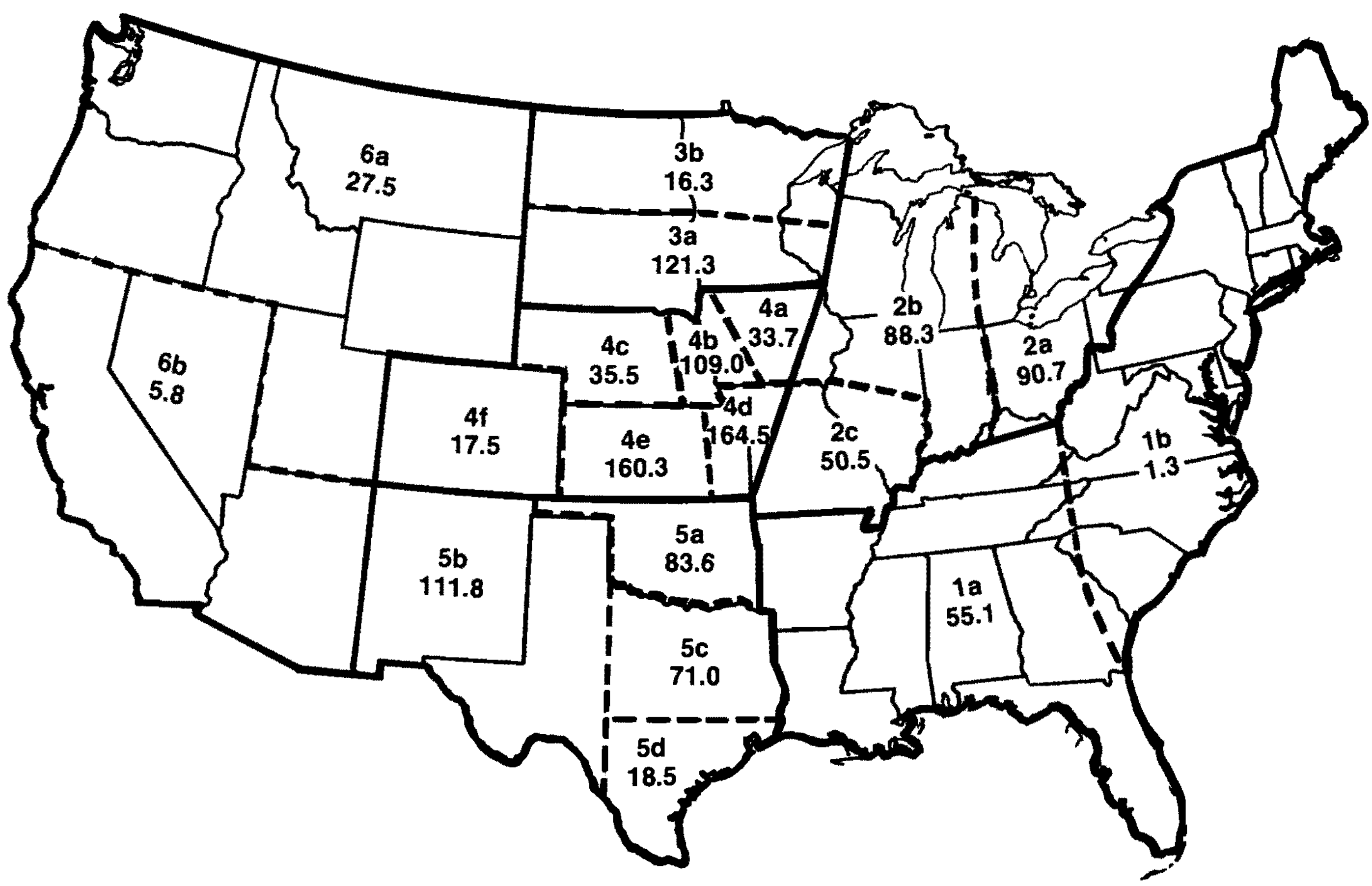
[13]Only elevators located in a position to have grain inspected for export are considered port elevators. However, some exporting companies consider elevators located inland port elevators, such as those in Savage, Minnesota. Adding the capacity to those elevators to the capacities in Table 7 would further lower the ratios of Lake, Atlantic, and Pacific ports.

at other port locations are used to store grain for longer periods of time. This activity was most common when grain firms were storing grain for the Commodity Credit Corporation (CCC). Some of the elevators that were used for CCC storage are now obsolete for export purposes and are rarely used for handling export grain. A few of these elevators remain in the Duluth-Superior area. Generally, export elevators in the Lakes region do not have high turnover rates because the storage space at the Lakes is often used for longer-term storage. This occurs because the Lake area ports are closed by ice between December and March each year.

Excess capacity at Pacific ports. Pacific ports are limited geographically to exporting mainly to Asian markets. It is also possible that some of the storage space in the Pacific area, especially in California where the turnover rate is lowest, is used to store grain for domestic use because of its proximity to Western producing regions. Nonetheless, the amount of grain put through the Pacific ports has not increased at the fast rate of the Gulf or South Atlantic ports. Hence, the load factor at the Pacific is low relative to the Gulf and South Atlantic ports.

Increased use of South Atlantic facilities. The South Atlantic ports have a high turnover rate. Grain exporting from the South Atlantic has been steadily increasing and is responsible for the 260 percent increase in total exports as shown in Table 6. Some of this increase is due to the increased production of soybeans in southern states. Also, export facilities have been constructed or renovated in southern ports such as Norfolk. However, most North Atlantic export facilities are antiquated and have not been

Figure 13. Inland terminal elevator storage capacity by regions and subregions, in millions of bushels, 1977. Source: U.S. Department of Agriculture, ASCS, *Approved Warehouse Lists*, Jan. 1, 1977.



adapted to meet the requirements of modern grain exporting. The inland or shallow water export terminals, such as Albany, cannot accommodate large, ocean-going ships. Hence, grain exporting from the North Atlantic has been waning relative to other areas. The South Atlantic's facilities appear to be operating at the rate of the efficient Gulf facilities. The North Atlantic facilities are not, and their use will probably cease if they are not renovated to compete with the more modern facilities to the south or at the Gulf.

The Industry's Scale Factor

Scale economies in elevator facilities and storage. Scale economies are usually sought in grain elevators and transportation equipment. Most firms that export grain operate both export and inland elevators. About 40 percent of U.S. grain produced is exported each year. Exporters operate a corresponding amount, 37.4 percent, of inland storage facilities. While exporters need not buy grain until it reaches port, they frequently buy or move their own grain from inland locations and transport it to ports for export. Grain export firms may purchase grain from country elevators or at terminal markets such as Minneapolis or Kansas City.

There are advantages in operating storage space and other facilities along export marketing channels. During periods of great demand for grain at ports or during periods of great demand for storage space, such as harvest, only those exporters that operate elevators along export marketing channels can expect to export grain profitably year round. Indications are that sizable returns to scale exist in the operations of both port and inland terminal elevators.

Port Elevator Location, Operation, and Capacity

The top five exporters operate greatest share of port facilities. Grain is exported from ports at the Great Lakes and Atlantic, Gulf, and Pacific Coasts. Large elevators, which store grain until exported, are located at these ports. The port elevators are owned by major exporting firms such as Cargill and Continental, regional cooperatives such as Farmer's Export, flour millers such as General Mills, and by local municipalities. As of January, 1977, the five largest grain exporting companies (Cargill, Continental, Cook[14], Dreyfus, and Bunge) owned or leased more than 50 percent of the port elevators in the U.S.[15] A list of port elevator ownership, capacity, location, and share of export facilities is shown in Table 8.[16] Cargill was the leader in storage capacity, operating 26.3 percent of total port capacity and at least 17.5 percent of the capacity at every port area. Sixty-one percent of the storage capacity on the Atlantic Coast was operated by Cargill. Continental also operated a large share of port facilities, 14.4 percent of the total and at least 8 percent at every port. The other major exporting firms (Cook, Dreyfus, and Bunge) operated much smaller shares of port elevator capacity and none had facilities at all port areas. It should be noted that the capacity figures in Table 8, which are current through 1976, are already out of date. Cook no longer owns a port elevator at the Gulf, having sold it to Farmer's Export. Cargill has built large port elevators at Reserve, Louisiana, and Duluth-Superior, further increasing their capacity. And recent elevator explosions have also reduced elevator capacity, especially at the Gulf.

Individual co-ops have regional importance. As a group, co-ops control the next largest share of port capacity, 11.3 percent as of 1976. Their greatest share of owned port storage capacity, 14.8 percent, is at the Lakes, where the Grain Terminal Association operates 19 million bushels of storage space. Co-ops also operate 12.7 percent of port capacity at the Gulf (their Gulf capacity has grown to 16.1 percent since Farmer's Export bought Cook's Gulf export elevator). But individually, co-ops only have regional importance. As of 1976, no exporting cooperative had facilities at more than one port.

The remaining port elevator storage capacity is divided among a variety of firms. Flour milling companies operate only 6.5 percent of total U.S. port elevator capacity but are

[14]This company is no longer a major grain exporter and has sold most of its port and inland terminal elevators.

[15]The elevator ownership and capacity data were compiled from the U.S. Department of Agriculture's *Approved Warehouse Lists* and is current through January 1, 1977. Certain significant changes of ownership since then have taken place, notably the sale of all of the Cook Industries' elevator capacity. However, no updating changes have been made in this report as updating would require a completely new compilation of elevator data. Nonetheless, the author believes that the small changes in elevator ownership since January 1, 1977, had little effect on the performance of the industry between 1975 and 1977.

[16]As listed in *Grain Market News*, port locations at the Great Lakes are as follows: Chicago area including Chicago and Milwaukee; Duluth, Minnesota, and Superior, Wisconsin; the Toledo area including Toledo and Huron, Ohio; Pennsylvania and Buffalo, New York, and the Saginaw area including Saginaw, Carrollton, and Zilwaukee, Michigan. The Atlantic port locations are divided between north and south. Northern ports include Portland, Maine; Albany, New York; Philadelphia, Pennsylvania. The southern ports include Baltimore, Maryland; Norfolk, Virginia, and North Charleston, South Carolina. The Gulf Coast is divided into four areas: the Mississippi River including New Orleans, Destrehan, Port Allen, Myrtle Grove, Ama, and Reserve, Louisiana; the East Gulf including Mobile, Alabama, and Pascagoula, Mississippi; the North Texas Gulf including Beaumont, Port Arthur, Houston, and Galveston, Texas, and the South Texas Gulf including Corpus Christi and Brownsville, Texas. The Pacific ports are those on the Columbia River, which include Portland, Kalama, and Astoria, Oregon; Longview, Vancouver, Seattle, and Tacoma, Washington, and those on the coast of California: Long Beach, Stockton, San Francisco, and Sacramento.

Table 8. United States port elevator ownership, capacity, and shares of capacity, by port area, 1976.

Port elevator owner	Number of elevators owned	Total port capacity (1,000 bushels)	Percent of total capacity	Lake capacity (1,000 bushels)	Percent of Lake capacity	Atlantic capacity (1,000 bushels)	Percent of Atlantic capacity	Gulf capacity (1,000 bushels)	Percent of Gulf capacity	Pacific capacity (1,000 bushels)	Percent of Pacific capacity
Big Five											
Cargill	12	90,434	29.3	39,891	31.0	20,000	61.0	16,292	17.5	14,251	26.3
Continental	9	44,541	14.4	24,640	19.2	3,500	10.7	7,834	8.4	8,567	15.8
Bunge	4	18,037	5.8					15,933	17.1	2,104	3.9
Louis Dreyfus	3	9,715	3.1			4,862	14.8	3,001	3.2	1,852	3.4
Cook	1	4,385	1.4[a]					4,385	4.7		
Subtotal	29	167,112	54.1	64,531	50.2	28,362	86.5	47,445	51.0	26,774	49.4
Flour Millers											
General Mills	2	5,500	1.8	5,500	4.3						
Pillsbury	1	4,800	1.6	4,800	3.7						
Peavey	1	4,965	1.6	4,965	3.9						
International Multifoods	1	4,778	1.5	4,778	3.7						
ADM	1	60	—	60	—						
Subtotal	6	20,103	6.5	20,103	15.6						

(continued on the following page)

Table 8. United States port elevator ownership, capacity, and shares of capacity, by port area, 1976.

Port elevator owner	Number of elevators owned	Total port capacity (1,000 bushels)	Percent of total capacity	Lake capacity (1,000 bushels)	Percent of Lake capacity	Atlantic capacity (1,000 bushels)	Percent of Atlantic capacity	Gulf capacity (1,000 bushels)	Percent of Gulf capacity	Pacific capacity (1,000 bushels)	Percent of Pacific capacity
Coops											
FUGTA	1	19,012	6.2	19,012	14.8						
Producer's Grain Corp.	1	6,392	2.1					6,392	6.9		
North Pacific Grain Growers Inc.	1	4,152	1.3							4,152	7.7
Farmer's Export Co.	1	5,394	1.7					5,394	5.8		
Subtotal	6	34,950	11.3[b]	19,012	14.8			11,786	12.7	4,152	7.7
Public Elevators											
Public Grain Elevator of New Orleans	1	7,391	2.4					7,391	7.9		
Port Brownsville Public Elevator	1	3,772	1.2					3,772	4.1		
Nueces County	1	5,555	1.8					5,555	6.0		
Port of Houston Authority	1	6,580	2.1					6,580	7.1		
Subtotal	4	23,298	7.5					23,298	25.0		
Others											
Nytco Services, Inc.	1	16,463	5.3	16,463	12.8						
Koppel, Inc.	1	2,126	.7							2,126	3.9
Stockton Elevators	2	9,597	3.1							9,597	17.7
CSY Finance, Inc.	1	4,445	1.4			4,445	13.5				
United Grain Corp.	2	10,121	3.3							10,121	18.7
Bayside Warehouse Co.	1	4,290	1.4					4,290	4.6		
The MacMillan Co.	1	2,565	.8	2,565	2.0						
Duluth Dock and Transport Co.	1	2,884	.9	2,884	2.2						
Great Lakes Storage and Construction Co.	1	3,008	1.0	3,008	2.3						
St. Charles Grain Elevator Co.	1	6,267	2.0					6,267	6.7		
Columbia River Terminal Co.	1	1,469	.5							1,469	2.7
Subtotal	11	63,235	20.5	24,920	19.4	4,445	13.5	10,557	11.3	13,192	43.0
TOTAL	56	308,698	100.0	128,566	100.0	32,807	100.0	93,086	100.0	54,239	100.0

Source: USDA, ASCA, *Approved Warehouse Lists*, Jan. 1, 1977.

[a]This elevator is now owned by Farmer's Export Co.

[b]Adding the Farmer's Export Co. elevator capacity to the total cooperative owned port capacity increases the total cooperative port capacity to 39,335,000 bushels, 12.7 percent of the industry's total capacity.

strongly represented in the Lakes region where they operate 14.8 percent of storage facilities. Firms that specialize in the exporting of certain grains or exporting from a single location and various other independent elevator companies account for approximately 20.5 percent of U.S. port storage capacity. Nytco Services, Inc. is important in Toledo; Stockton Elevators is important in California. Public elevator companies are important at only the Gulf, where they own, as a group, 25 percent of elevator space.[1]

Cargill important at all ports. A look at the overall picture of port storage location and operation reveals the prominence of the Gulf ports in terms of capacity and the importance of Cargill at all port areas in terms of capacity. But Cargill's importance is somewhat diminished at the Gulf where elevator operation would seem to be more significant. The Gulf area is also the most diverse in terms of port elevator operation.

As shown in Table 9, Continental is one of the top three at the Lakes and Gulf. It operates elevators at every port area, as does Cargill. Cargill operates 61 percent of the port elevator capacity on the Atlantic Coast. At the Gulf, the three largest elevator operators are three of the top five — Cargill, Continental, and Bunge. The Lakes and Pacific ports have the largest amount of storage space owned by cooperatives.

[1]Public elevators lease space to smaller grain exporting companies. These companies are not listed individually in Table 8.

Table 9. The number of exporting companies with port elevators, percent of storage capacity operated by the "Top 5," and percent of capacity operated by the three largest export elevator companies, by port area, 1976.

Port area	Number of exporting companies with port facilities	Percent of storage capacity operated by "top five"	Percent of capacity operated by the three largest export elevators in area		
Lakes	12	50.2	65.0	Cargill	31.0
				Continental	19.2
				Farmer's Union GTA	14.8
Atlantic	4	86.5	89.3	Cargill	61.0
				Louis Dreyfus	14.8
				CSY Finance, Inc.	13.5
Gulf	13	51.0	43.0	Cargill	17.5
				Bunge	17.1
				Continental	8.4
Pacific	9	49.4	62.7	Cargill	26.3
				United Grain Corp.	18.7
				Stockton Elevators	17.7

Source: USDA, A.S.C.S., *Approved Warehouse Lists*, Jan. 1, 1977.

Table 10. Terminal storage capacity by region and type of ownership, 1976.

	Region 1	2	3	4	5	6	Total
		(1,000 bushels)					
Companies w/ export terminals:							
Cargill	5,000	7,365	18,282	63,357	14,931	3,302	112,237
Continental	1,242	15,363	6,663	23,692	11,525	494	58,979
Bunge		7,052	11,950	23,108	4,899		47,009
Louis Dreyfus			4,011	4,700			8,711
Cook	5,039		7,438		21,497		33,974
Big Five subtotal	11,281	29,780	48,344	114,857	52,852	3,796	260,910
General Mills		4,646	5,382	5,698	2,286	2,421	20,433
Pillsbury		15,082	3,683	15,198	2,693	2,537	39,193
Peavey		6,750	7,948	3,482	1,127	1,728	21,035
International Multifoods		6,016	503	450	580		7,549
A-D-M	1,640	13,901	25,964	8,588			50,093
FUGTA			14,204	849		610	15,663
Producer's Grain Corp.					30,847	525	31,372
North Pacific Grain Growers, Inc.						7,449	7,449
Nytco Services, Inc.		16,765					16,765
Koppel, Inc.				2,054			2,054
Other exporters subtotal	1,640	63,160	57,684	36,319	37,533	15,270	211,606
Subtotal (big five and other exporters)	12,921	92,940	106,028	151,176	90,385	19,066	472,516
Other multiple region terminal companies:							
Central Soya		31,946	2,000	1,624			35,570
Ralston Purina		7,415	2,080	7,216	1,781		18,492
Conagra			2,544	3,911	777	1,605	8,837
Early & Daniel Co.		16,379	1,326				17,705
Allied Mills, Inc.	759	1,500			500		2,759
Garvey International, Inc.		2,814		43,467	11,448		57,729
Lauhoff Grain, Inc.		11,700		1,893			13,593
Collingwood Grain				5,731	2,320		8,051
Midwest Grain Co.				1,828	2,313		4,141
Morrison Grain Co., Inc.				10,191	875		11,066
Subtotal	759	71,754	7,950	75,861	20,014	1,605	177,943
Single region terminal companies:							
Overall capacities	42,740	64,820	23,570	293,329	174,457	12,583	611,499
TOTAL	56,420	229,514	137,548	520,366	284,856	33,254	1,261,958

Source: USDA, ASCS, *Approved Warehouse Lists*, Jan. 1, 1977.

Inland Terminal Location, Operation, Capacity, and Number

Terminal facilities located in major grain production centers. Terminal elevators are distributed throughout the U.S. with concentrations along primary transportation channels in major grain producing regions. The U.S. can be roughly divided by terminal locations, transportation channels, and grain production into six regions.

Each region can then be divided into subregions according to geographic areas of terminal concentration.[17] Figure 13 shows the terminal divisions by region and subregion and the amount of terminal capacity in million bushels by terminal subregion. The areas with the greatest amount of storage capacity are the Kansas City, Missouri, and Wichita, Kansas, areas (Subregions 4d and 4e). Besides being centrally located, these two centers are in large grain producing regions along major transportation lines, both rail and barge.

Other areas with a large amount of terminal capacity are Minneapolis-St. Paul (3a), Omaha-Council Bluffs (4b), Lubbock-Amarillo, Texas (5b), Toledo, Ohio (2a), and Chicago (2b).

Operation of inland terminals varies among regions. Companies operating export elevators operate only 37.4 percent of terminal elevator capacity. Table 10 lists the terminal capacities of companies with export facilities, other companies with terminals in more than one region, and the aggregate total of single-region terminal companies by region. Table 11 shows considerable variation in the percentage of terminal elevator capacity operated by grain exporters by region.

[17]These divisions are as follows:

1. Eastern and southern U.S.
   a. Louisiana, Arkansas, Tennessee, southern Kentucky, Mississippi, Alabama, western Georgia, and Florida
   b. Eastern seaboard
2. Lakes Region
   a. Ohio and eastward
   b. Chicago area
   c. St. Louis area
3. North Central U.S.
   a. Minneapolis-St. Paul, southern Minnesota, South Dakota
   b. Northern Minnesota, North Dakota
4. Midcentral U.S.
   a. Mid-Iowa, including Des Moines
   b. Omaha-Council Bluffs area
   c. Grand Island, Nebraska, area
   d. Kansas City (Kansas and Missouri) area
   e. Wichita area
   f. Colorado
5. South Central U.S.
   a. Oklahoma
   b. Lubbock-Amarillo, Texas, area
   c. Fort Worth area
   d. Texas coast
6. Pacific and Northwest
   a. Montana, Wyoming, Idaho, Utah, Washington, and Oregon
   b. California, Nevada, and Arizona

Region 4 (Kansas and Nebraska) and Region 5 (Texas and Oklahoma) are the two largest regions in terms of capacity. Both are areas that store much of the grain bound for export through Gulf ports. Yet in neither region do exporters operate a commanding share of terminal capacity. Both are dominated by "single-region terminal companies." Grain export companies operate the largest share of inland terminal capacity in Region 3, which contains Minneapolis-St. Paul and Duluth-Superior. Here exporters operate more than 75 percent of terminal storage capacity.

Scale Economies in Operating Storage Space

Most grain export firms take advantage of scale economies in operating storage space in export marketing channels. Cargill and Continental, the two largest exporters, each own storage space at the Lakes, Gulf, Pacific, and Atlantic Coasts.

At the time the elevator data were compiled, the top five grain exporting firms (Cargill, Continental, Bunge, Louis Dreyfus, and Cook) each had an export elevator at the Gulf. As a group, they operated 54.1 percent of the total port elevator capacity. They also operated 20.7 percent of total inland terminal capacity and at least 10 percent of the capacity of each of the terminal regions.

The authors agree with Richard Caves, who argues that such concentration of facilities is of little economic relevance:

> The concentration of physical facilities (grain elevators and transshipment facilities) at particular locations is generally of limited economic relevance because of the substitutability between channels of distribution from a production or accumulation point to a consumption point; furthermore, storage facilities at different points along a distribution channel compete with one another. Thus, although a moderately high concentration of facilities at individual inland and export terminals can be observed, little significance can be attributed to it. The concentration of country elevators in the relevant total marketing areas is only moderate.[18]

[18]Richard Caves, *op. cit.*, p. 120.

Table 11. Percentage of regional terminal elevator capacity, by type of ownership, 1976.

	Region						
	1	2	3	4	5	6	Total
Top Five exporters	20.0	13.0	35.1	22.1	18.6	11.4	20.7
Other exporters w/export terminals	2.9	27.5	41.9	7.0	13.2	45.9	16.8
Subtotal	22.9	40.5	77.1	29.1	31.7	51.3	37.4
Multiple region terminal companies	1.3	31.3	5.8	14.6	7.0	4.8	14.1
Single region terminal companies	75.8	28.2	17.1	56.4	61.2	37.8	48.5
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: USDA, ASCS, *Approved Warehouse Lists*, Jan. 1, 1977.

Scale Economies in Transportation, Information, and Risk

Volume shipments are less costly. Sizable scale economies exist in grain transportation. Per-bushel costs are reduced by transporting grain in large quantities whether the mode is rail, barge, or ocean vessel. The advent of multi-car rates and unit trains has allowed exporters to take advantage of the scale economies in rail transportation. Evidence of scale economies in ocean freight can be demonstrated by examining the number and average tonnage of ships booked to carry grain to Rotterdam from the Gulf and East Coast between 1975 and 1977. The Gulf and Rotterdam ports can accommodate large ships with deep drafts. Many of the East Coast ports cannot. Thus, if scale economies in ocean freight costs are significant, more ships should be booked to carry grain to Rotterdam from the Gulf than from the East Coast. Furthermore, the ships originating from the Gulf should carry greater tonnages than the ships from the East Coast. Only 70 ships with an average tonnage of a little over 40,000 long tons were booked on an F.I.O. basis (free in and out) from the East Coast, while 332 ships with an average tonnage of approximately 57,000 long tons were booked from the Gulf. This indicates that grain exporters take advantage of scale economies in transportation costs.

Access to market information is vital. Another area in which scale economies exist is in market information systems. Richard Caves argues that scale economies in information systems are largely responsible for the low number of very large grain exporting firms, resembling an oligopoly, in the industry.[19] The information network required to maintain a successful exporting firm keeps the exporter current with the subtle changes in grain and transportation markets around the world. Maintaining such a network involves a large fixed cost. Branch offices and agents of any exporting firm operating on a large scale must be staffed wherever the firm hopes to do business. Smaller firms cannot support such an extensive network.

Scale economies of this sort are empirically difficult to substantiate. However, some indirect evidence that exporting firms take advantage of scale economies in information is available. The fact that a number of regional grain cooperatives have joined together to form the Farmer's Export Co. demonstrates that cooperatives recognize the economies of scale in exporting. A Farmer's Cooperative Service study urges cooperatives to improve their exporting capability by establishing agents and offices in areas where they hope to gain customers.[20] It urges cooperatives to emulate the market information systems of the large grain export companies.

Risk is inherent in grain exporting. Scale economies also exist in financial risk management of grain export sales, which are made in large units. Each sale involves large sums of money. It is easy for an exporter to lose money on a sale if the market price for a particular grain changes adversely between the time when a sale is made and the delivery time. Consequently, they use futures markets in risk management through hedging, but such markets can be used to compound risks as well as to reduce risks. The failure of Cook Industries as a grain exporter indicates how a firm can fail through improper risk management.

Firms that rely upon exporting grain as their primary source of income must have a large financial base that can absorb losses in the event of default by the importer. The limited ability to take large financial risks and absorb possible losses places the small firm at a competitive disadvantage. Hence, the grain export industry will likely continue to consist of a small number of large, financially secure firms.

Evidence of Productive Efficiency

The above analysis of load and scale factors in the U.S. grain export industry suggests that the industry is productively efficient.[21] The turnover rate at each port suggests that the use of export facilities depends on a facility's level of efficiency and the demand for exports originating from each port.

The market organization of the industry also reflects sizable returns to scale in grain exporting. These scale economies are found in elevator operation, grain transportation, market information systems, and financial risk management. They are prime reasons for the small number of large firms in the grain export industry.

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[19]Richard Caves, *op. cit.*, pp. 120 121.

[20]U.S. Department of Agriculture, *Improving the Export Capability of Grain Cooperatives, op. cit.*

[21]This evidence, however, has not been subject to an analysis that would compare the industry's productive performance with specific efficiency standards.

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