LOGISTICS TRENDS AND THEIR IMPLICATIONS FOR COMEPETITIVE STRATEGY: THE CASE OF DOMESTIC WHEAT FLOUR MILLING

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Research Purpose and Scope

Purpose of Research

The purpose of this research was to examine the impact of transportation and logistics trends on the wheat flour milling industry and project the effect these trends will have on the future configuration of the industry. There are several concurrent trends in transportation and logistics which are affecting processors of agricultural commodities, but the one which has probably had greatest impact is the relaxation of railroad regulation. Railroad deregulation has had a variety of effects on shippers and receivers of agricultural commodities. The impact has depended on the relative bargaining power of rail users, the degree of intrarail and intermodal competition existing in grain transportation markets, and the extent to which rail carriers take advantage of rate-making freedoms granted in the legislation. Section 212 of the Staggers Rail Act has had a significant impact on the transit rate system used by inland flour millers, as this provision allows railroads to establish separate rates for distinct rail services, i.e., transit privileges.(1) To the extent that railroads take advantage of this exemption from the antidiscrimination provisions of the Interstate Commerce Act, flour milling companies may be seriously affected by changes in the rail grain rate structure. The expected results include a reconfiguration of the physical facilities network as well as a revision in mode selection decisions.

Scope of Research

The scope of this research was limited to an analysis of typical, but hypothetical milling situations. A typical situation faced by a small, medium, and large firm in the wheat flour milling industry was to project the effect logistical trends will have on industry structure. The size of the firms will be delineated by the total milling capacity of their plants, where capacity is defined in terms of hundredweights (cwts.) per day. The strategic capacity decisions faced by the firm in each size group will be modeled with a simulation technique. Primary data sources include interviews with flour milling executives and rail industry executives. Secondary data sources include census publications and reports. The emphasis was on the interaction between commodity production, transportation, and storage costs. The simulation model was used to evaluate the effects on the relative cost position of different size firms, with size being measured in terms of capacity to produce. Implications for future industry structure, including further concentration and mill location changes, were projected.

Study Objectives

Logistical Trends in the Wheat Flour Milling Industry

The purpose of this research can be factored into two objectives. The first objective is to examine logistical trends in the wheat flour milling industry. Trends were researched in the procurement-transportation of wheat and in the production-transportation of wheat flour. The structure of the wheat flour milling industry was examined, with emphasis on changes in location of mills and a trend toward industrial concentration. Trends were examined in the institutional and bakery markets for wheat flour. Finally, the elements of competitive strategy in the commodity business were discussed to aid in the explanation of changes in the market structure of the industry.

Implications of Strategic Decisions for Industry Structure

Strategic decisions in the wheat flour milling industry focus upon capacity expansion, economies of scale, and costs. The second objective of this research is to project the impact of these strategic decisions on the future structure of the industry. The relative cost position of the small, medium, and large-size firms will be criterion used to project future industry conditions. Costs included wheat flour production costs, wheat and flour transportation costs, and inventory carrying costs. Since costs are important to the success of a commodity firm, these costs can be used to examine the effects of the strategic decisions on the relative position of firms in the industry. Firms with a significant cost advantage are likely to succeed, while those at a disadvantage will fail or be acquired by larger firms.

Summary of Approach

Situation Analysis

The approach used in this research was to model typical situations faced by flour milling companies. The model simulated conditions faced by a small, medium, and large-size firm in the industry. A logistics network consisting of wheat supply sources, mills, and bakery/institutional markets was developed for each situation. Production areas in New York, Minnesota, Kansas, and California were important focus points in the analysis, as much of the wheat is milled within these states. Primary data were obtained through direct contact with the shippers and rail carriers of relevance to the study in order to evaluate their reaction to logistical trends affecting the industry. The study included an examination of secondary sources of information, such as the 1977 Census of Transportation, with the data to be used in the estimation of relative market shares for rail, truck, and barge movements of wheat and wheat flour. This information was used as an input into the network simulation model which will consider new transportation policies, i.e., changes in mode choice and shipment sizes, resulting from changes in the rail freight rate structure.

Comprehensive data on freight rates and tonnages of wheat shipped by modes other than rail are unavailable, which means that estimates of prevailing rates will be made using ordinary least squares regression analysis or that data will have to be obtained from a secondary data source. In the past, rail rates on grain shipments have been regulated by the Interstate Commerce Commission (ICC), and changes in rates have been petitioned by the carriers in the form of *ex parte* level increases. However, the ICC has recently moved in the direction of exempting grain traffic from rate regulation, which may limit the data availability of rail rates for these commodities in the future. In addition, the effects of restructuring grain rates have not been fully determined. It is expected that outbound proportional rates for wheat flour movements will increase as rates begin reflecting the cost of providing service. Barge rates for wheat were obtained from shippers located on the Mississippi River and from a secondary data source.

In order to accurately measure the transportation costs of wheat by rail, a rail costing procedure is required. However, it is extremely difficult to estimate the cost of specific railroad services because of the inherent rail cost structure.(2) Formulas to be used in generating trip cost have been published by the ICC. Formulas, along with cost coefficients by region, are available for calculating the average variable cost and average fully allocated costs for operation in various regions. The cost program was designed to be sensitive to distance, number of car switches, and time of car delays in transit at origins, destinations, and/or inspection yards.

The calculation procedures for estimating the variable cost and the fully allocated cost of moving wheat in covered hopper cars will be illustrated in a later chapter. The problem of determining the actual rate for grain shipments has been accentuated by Section 208 of the Staggers Rail Act, which gives contract authority to rail carriers to enter into agreements with one or more shippers subject to filing the contract with the ICC for its approval prior to its effective date and to the ICC making available to the public each contract's non-confidential information.

Design of Logistics Network

The logistics network will be simulated for the various size firms in the wheat flour milling industry. The analysis of typical situations, in combination with various sources of primary and secondary data, will result in the specification of a network simulation model which can be used by an actual firm. The model will be tested in the specific cases under examination in this study. The examination of logistical trends in the industry will aid in determining the strategic decisions which will be followed by individual firms. The model must explicitly consider the joint capacity expansion-location decision. Locating mills to minimize transportation costs can trade off against economies of scale. Scale must be recognized as a separate cost driver in the wheat flour milling industry, and technological change that alters scale economies can alter historical tradeoffs. The network simulation model will consider the effect of the joint capacity expansion-location decision on the relative cost positioning of firms in the industry. Identification of cost dynamics can lead to a significant cost advantage by directing a firm toward those activities that will provide the greatest leverage for achieving an advantage in their future relative costs. The costs of importance to a flour milling firm include the costs of production, transportation, and inventory holding. The results of the simulation will indicate the future relative position of firms competing in the industry. A related strategic decision, the location of plants relative to wheat sources and wheat flour markets, will also be evaluated. The emphasis will be on location theory and the current trend of locating plants in consumption markets. Finally, the strategic decisions concerning plant size scale and costs will be examined. Cost dynamics are important to an industry such as flour milling, where there is strong competition, and the buyers' choice is based heavily on price.

Importance of Research

Strategic decisions will be important to an industry such as wheat flour milling which is undergoing severe structural changes. A network simulation model will be developed to consider the joint capacity expansion-location decision, and the model will have usefulness in real world situations. A major fertilizer supply firm, Agrico Chemical Company, has applied network methodology in the form of an integrated production, distribution, and inventory (PDI) system.(3) The integrated computer-based PDI system has saved nearly $18 million during its first three years of implementation. The PDI system has been used extensively to evaluate the benefit/cost impact of short-term transportation policies and long-term facility location decisions. Network models have allowed for an analysis of much more interactive situations than analyzed adequately in the past.

Logistics strategies have a significant impact on the relative cost position of firms in the wheat flour milling industry. With the aid of a computer-based network model, such as the one developed for Agrico, the effects of these strategies can be examined in an interactive fashion. This research will provide insights into the interaction of strategic decisions and the implications for future industry structure.

Design of the Study

Capacity Expansion Model

A central aspect of the dynamic problem facing a firm in an industry undergoing severe structural changes is the decision about additions to productive capacity. Capacity decisions have long lead times and involve large resource commitments in relation to a firm's total capitalization. If the firm fails to add capacity at the appropriate time, it not only loses immediate market share, but may also reduce its long-run relative cost position. If the firms in the industry add too much capacity, a firm can be burdened with uncovered overhead for long periods of time. From a competitive standpoint, additions to capacity can produce major problems since the matching of capacity to demand is a major determinant of industry rivalry and profits. The problem is most accentuated in industries producing undifferentiated products, where product differentiation does not protect firms against mistaken capacity decisions of other firms.

Capacity decisions in the presence of lead times and lumpiness require expectations about future demand. It also involves the mutual interdependence problem, since the capacity decisions of competitors over the planning horizon will determine the profitability of decisions by a single firm. This suggests that modeling the capacity expansion process in an industry may have a high payoff in understanding the structural conditions which drive it, the nature of equilibria, and the implications for the optimal capacity decisions of individual firms.

Porter (4) attempted to model the capacity expansion process through the analysis of the corn wet milling industry. The corn wet milling industry is typical of many large, undifferentiated product industries in the economy. While the model developed uses data from corn wet milling, its structure and principles are applicable to the capacity expansion process for a related industry, wheat flour milling.

Porter and Spence (4) present a capacity expansion model illustrated in Figure 1. An assumption about the expansion of industry capacity over time begins at (A). That, combined with exogenous demand, gives random net cash flows for each possible capacity expansion decision for each firm. The combining of demands, investment decisions by individual firms, and industry capacity expansion into cash flows over time involves an economic model of the industry. The model takes capacity and demand and generates prices, profit margins, and capacity utilization rates. The latter are then used to project cash flows for various possible investment decisions.

The individual firm investment decisions add up in each year to give a time path for industry capacity (B). The entire sequence is conditional on the starting assumption at (A). The consistency check is whether (A) and (B) are the same. A shared assumption about industry capacity which failed to generate the same industry capacity expansion path would not result from rational firm choices. The expected evoluation of industry capacity is that path that reproduces itself in Figure 1. Individual firm decisions and uncertain cash flows are the ones associated with the capacity expansion path.

Competitor analysis is the central feature of this model. The equilibrium is the industry path that will withstand careful competitor

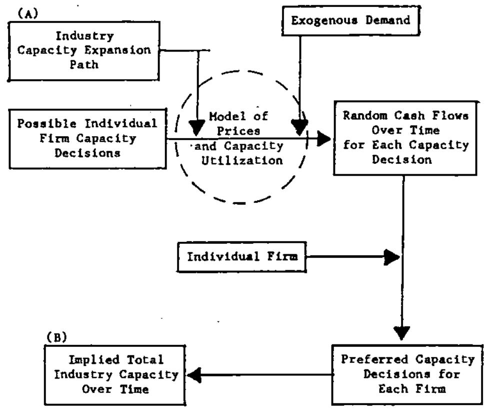

Figure 1. Capacity Expansion Model

SOURCE: Porter and Spence, 1978.

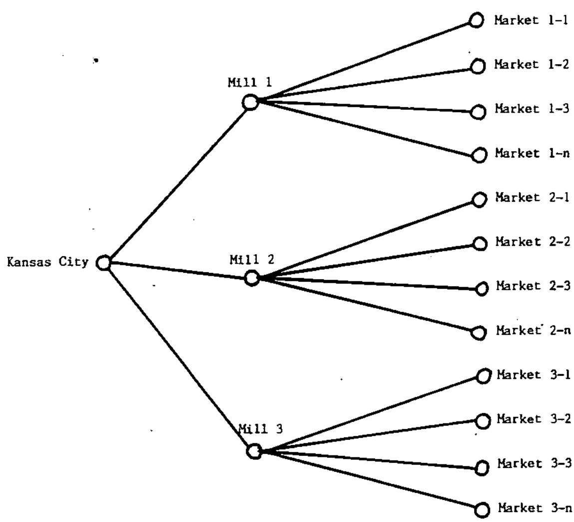

Figure 3. Conceptual Logistics Network of a Typical Flour Milling Firm

analysis. If firms fail to check their assumptions in this way, then other paths could result. The hypothesis is that they do.(4)

The model of the capacity expansion process reveals that the degree of uncertainty about the future is a central determinant of the manner in which the process proceeds.(5) A firm's risk-return tradeoff function is due in part to a wide range of factors specific to is particular situation. There is a sense, however, in which the risk aversion of firms in a market is partially endogenous. Suppose the management of a commodity business has a choice of building capacity or not building it, with future demands either being high or low (Figure 2). If management chooses not to build, the best outcome is satisfactory profits in the event that demand proves to be low. However, if future demand is perceived to be fairly certain, the capacity expansion process becomes a game of preemption.(5) With known future demand, firms will move quickly to get the capacity on stream to supply the demand. If the bandwagon process is present, then a preemptive strategy by one or more firms can be disastrous. A preemptive strategy, accompanied by heavy market signaling about planned behavior, can virtually guarantee substantial capacity additions.

	Future Demand	
	High	Low
Build	High Profits	Low Profits
Don't Build	Lost Profits	Medium Profits

Figure 2. Risk-return Tradeoff Matrix

The approach used in this research was the simulation of existing and future demand scenarios for the different size firms in the industry in order to project strategic capacity decisions and the implications for market structure. The logistics network, consisting of wheat supply sources, mills, and bakery/institutional markets, was developed for each situation. The major production areas in New York, Minnesota, Kansas, and California were important in the analysis, as much of the wheat is milled within these states. Primary data was obtained through direct contact with the shippers of relevance to the study in order to evaluate their reaction to logistical trends affecting the industry. The study also included an examination of secondary sources of information, including the 1977 Census of Transportation, with the data being used to estimate market shares of wheat and wheat flour for each size firm. The data was input into the capacitated network simulation model, which determined the minimum cost flow of the commodity from wheat supply sources to market destinations along admissible routes. A mathematical model that will evaluate alternative logistics systems for these firms was developed. Application of the model required realistic assumptions and representative cost data for each size firm.

Elements of the Model

The logistics network was simulated for the various size firms in the wheat flour milling industry. The analysis of typical milling situations, in combination with various sources of primary and secondary data, resulted in the specification of a network simulation model which can be tested in a real world setting. The examination of logistical trends in the industry will aid in determining the strategic decisions which will be followed by individual firms. The model must consider the joint capacity expansion-location decision in the future demand scenarios. Therefore, a fixed cost activity (column) was added to consider the cost of expanding mills to meet forecasted demand. The model includes shipping and/or storing points (i.e., wheat supply sources, mills, and markets). Transportation modes involved in moving wheat are commercial trucks, railroads, and barges. The logistics systems of the three firms were simulated using plant data obtained from the 1985 Milling Directory/Buyer's Guide. The wheat supply source for northcentral and northeast mills in a firm's logistics network was assumed to be Minneapolis. The wheat supply source for southcentral and southeast mills in a logistics network was assumed to be Kansas City. Unit train movements were assumed to mills in the northeast and southeast when barge competition was available to a market. In other cases, five-car shipments of wheat were assumed to the mill. Figure 3 presents the conceptual network for the movement from wheat supply source to final markets. Transportation modes involved in moving wheat flour are railroads and private trucks. Rail rates were regressed against distance to obtain an estimate of the rate as a linear function of miles.

The objective is to minimize the total logistics cost of moving wheat to mill and wheat flour to market under separate inbound and outbound rates, rather than a single through rate. The network model can consider the effect of the joint capacity expansion-location decision on the relative position of firms in the industry. The costs of importance to a flour milling firm include the costs of inbound transportation, production, inventory holding, and outbound transportation. The results of each case study will indicate the future position of firms in the industry, allowing conclusions regarding the future course of action to be taken for each size firm. Firms with a significant cost advantage are likely to succeed, while those at a cost disadvantage are likely to be acquired or will fail. Logistics strategies have a significant impact on the relative cost position of firms in the wheat flour milling industry. With the aid of a computer-based network simulation model, the effects of these strategies can be examined in an interactive fashion. Future strategies will then be recommended for each size firm in the industry.

Logistics network design results in one wheat supply source, 13 mills, and 30 markets for firm A (the small-size firm); one wheat supply source, seven mills, and 42 markets for firm B (the medium-size firm); and one wheat supply source, three mills, and 40 markets for firm C (the large-size firm). The markets were determined using the 1977 Census of Transportation Commodity Transportation Survey. Figure 4 represents the configuration for Firm A, Figure 5 represents Firm B, and Figure 6 represents Firm C. Storage capacities were assumed to be fixed at the mills, and inventory carrying costs were based on the lot size quantity of each mode of transportation (safety stock was not included in the calculations). Unit train rates from Minneapolis to Buffalo were quoted at $0.45 per bushel ($15.00 per ton) and barge rates were quoted at $0.35 per bushel ($11.67 per ton). Barge rates from Kansas City to southern ports were drawn from a secondary data source. Unit train rates for southern destinations were approximated using the same secondary data source. Rail rates for five-car rail service and unit train rail service were regressed against distance to estimate the rate as a linear function of miles, and the results are presented in a later section. Market shares by firm were estimated by taking the total market demand as a fraction of U.S. demand and applying the percentages to each firm's markets. Integer variables were assigned to rail and barge shipments, while shipments by truck were assumed to be continuous variables.

Three reference scenarios were simulated for each firm. The reference scenarios were developed using the approach of Ackoff et al.(6) The first scenarios requires optimization of the existing logistics system for each firm. The second scenario requires optimization of the logistics system under a low demand growth rate (1 percent per year). The third scenario requires optimatization of the logistics system under a high demand growth rate assumption (5 percent per year). The growth rate was compounded for a

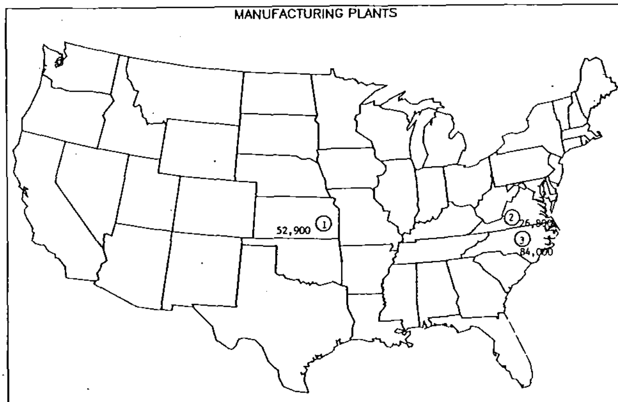

Figure A. Sites and Capacities of Mills - Firm A

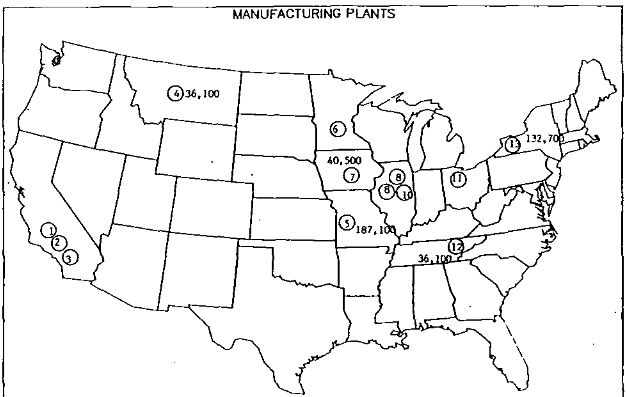

Figure 5. Sites and Capacities of Mills - Firm B

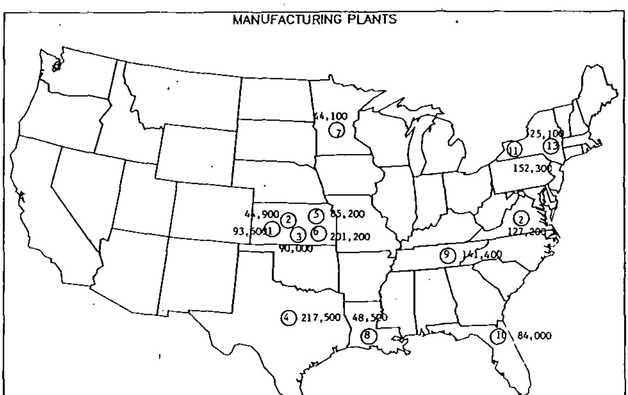

Figure 6. Sites and Capacities of Mills - Firm C

five-year period in order to project the market demand in the year 1990. Both the second and third scenarios required adjustments in the costs of transportation and processing to account for inflation. The adjustments were made using a general producer price index (PPI) obtained from the Survey of Current Business.(7) The low and high demand growth rate scenarios were assumed in order to project strategic capacity decisions and changes in industry structure. With these projections, the future strategies to be adopted by each size firm can be recommended. The capacitated network model must be specified to incorporate the annual fixed cost of operating the existing facilities.

Mathematical Structure of the Model

Mathematically, the model will minimize the total system cost which includes value chain activities necessary to achieve a significant cost advantage. The value chain activities considered in the model include transportation to--and storage at--mills located in each firm's logistics system, production costs at each mill, and outbound transportation to each market. The model can be expressed, algebraically, as below.

Objective function:

$$\text{Minimize } Z = \sum_{i}\sum_{n}\sum_{j}\sum_{m} 1.33\, C_{injm} X_{injm} + \sum_{n}\sum_{j}\sum_{k} C_{njk} Y_{njk} + \sum_{n}\sum_{j}\sum_{k}\sum_{m} C_{njkm} Y_{njkm} + \sum_{n}\sum_{j} FC_{nj} U_{nj}$$

where,

- Z = total logistics system costs,
- i = source index,
- n = plant location index,
- j = plant size index,
- m = mode index,
- k = market index,
- C_{injm} = unit shipping cost to--and storage cost at--plant n, size j, by mode m,
- X_{injm} = quantity of wheat shipped from source i to plant n, size j, by mode m (in tons of finished flour),
- C_{njk} = production cost per unit at plant n, size j,
- Y_{njk} = quantity of wheat flour shipped from plant n, size j, to market k,
- C_{njkm} = unit shipping cost from plant n, size j, to market k, by mode m,
- Y_{njkm} = quantity of wheat flour shipped from plant n, size j, to market k, by mode m,
- FC_{nj} = annual fixed cost of operating plant n, size j,
- U_{nj} = 0-1.

Subject to constraints:

(1) $\sum_{k}\sum_{m} Y_{njkm} \leq \sum Y_{njk}$ for all n, j

(quantity of flour transferred out $\leq$ quantity of flour produced)

(2) $\sum_{n}\sum_{j}\sum_{m} Y_{njkm} \geq \text{Demand}_k$ for all k

(demand constraints at each market)

(3) $\sum_{k} Y_{njk} \leq PLCAP_{nj}$ for all n,j

(quantity of flour produced ≤ plant capacity)

(4) $\sum_{k} Y_{njk} \leq \sum_{im}\sum 1.33\ X_{injm}$ for all n,j

(quantity of flour produced ≤ quantity of wheat transferred in)

(5) $\sum_{m} Y_{njkm} = Y_{njk}$ for all n,j

(quantity shipped to all markets over all modes = quantity of flour produced)

(6) $U_{nj} =$ 0 if plant n, size j is closed
1 if plant n, size j is open

$\sum_{j=1}^{4} U_{nj} \leq 1$ at most one size is open for all n

and

(a) $\sum_{k} Y_{nik} - U_{n1}\ T_{11} \geq 0$

$\sum_{k} Y_{nik} - U_{n1}\ T_{12} \leq 0$

(b) $\sum_{k} Y_{n2k} - U_{n2}\ T_{21} \geq 0$

$\sum_{k} Y_{n2k} - U_{n2}\ T_{22} \leq 0$

(c) $\sum_{k} Y_{n3k} - U_{n3}\ T_{31} \geq 0$

$\sum_{k} Y_{n3k} - U_{n3}\ T_{32} \leq 0$

(d) $\sum_{k} Y_{n4k} - U_{n4}\ T_{41} \geq 0$

$\sum_{k} Y_{n4k} - U_{n4}\ T_{42} \leq 0$

where T_{j2} = minimum daily ton capacity for plant size j,

T_{j2} = maximum daily ton capacity for plant size j.

Elements of Competitive Strategy in the Commodity Business

Introduction

This section will discuss the important strategic decisions a firm in a commodity business such as flour milling must face. Capacity expansion is probably the central aspect of strategy in commodity businesses.(5) The strategic issue faced in capacity expansion is how to add or rationalize capacity to further improve a firm's relative position or market share, while avoiding overcapacity in the industry. Overcapacity has been a growing problem in the flour milling industry in recent years. Firms in the industry are under pressure to have large plants to be competitive and have sufficient capacity to achieve their target market share. To summarize, the strategic decisions for commodity products such as wheat flour focus upon capacity, scale, and costs. Compared with consumer products or capital goods, the problem is less complicated in that the product policy, marketing, and related decisions are less elaborate.

Capacity Expansion-Location Decisions

Separate models have been proposed for the capacity expansion process and analysis of plant location for the commodity industry. The approach to modeling the capacity expansion process will be presented in this section, with an emphasis on the relationship between capacity expansion and location decisions. A transportation locational model is presented for purpose of illustrating the interrelationship between capacity expansion and location decisions for the flour milling industry.

The decision to expand capacity is interrelated with the plant location decision faced by flour milling firms. Since candidate sites for milling expansion include the locations of existing mills, capacity expansion and location decisions can be highly interdependent.

Babcock et al. (12) employed a transport cost locational model to evaluate the impact of rail transportation rates on the location of flour mills in the eastern half of the U.S. Their model assumes the wheat supply area is the northern and southern central plains and the markets are major population centers in the eastern U.S. Other model assumptions include: (1) the quantity of wheat flour demanded in the market is exogenous, (2) there is no significant spatial variation in the price of other inputs required by milling firms, and (3) the production function is a fixed coefficients production function (12). The effect of these assumptions is to hold demand and nontransport cost constant so that the main determinant is transport cost.

The model employs the ideal weight first developed by Weber. (13) Flour milling is a weight losing production process as it takes 1.33 tons of wheat to create one ton of flour (the remainder is a byproduct, millfeed). The locational pull concept developed by Weber states that weight losing production processes locate close to raw material sources to avoid the high transportation cost of moving materials to the market. Wheat rates which are less than flour rates favor locations which are close to markets to avoid the higher transportation cost of shipping flour.

Babcock et al. (12) conducted an empirical analysis using rail wheat rates and bulk flour rates in effect during July 1980. The analysis compared the locational pull of the wheat supply area to that of eastern markets. The locational pull of the wheat supply area is equal to 1.33 (W_s) x wheat transportation rate per ton-mile (t_s). The locational pull of the market is 1 x flour transportation rate per ton-mile (t_m). The results are summarized in Table 1. This table shows that the locational pull of the market is greater than that of the wheat supply source in all instances. The high flour rates more than offset the weight losing nature of the process. The authors conclude that a decline in rail wheat rates relative to flour rates will result in a locational shift of flour milling away from the central plains and toward eastern markets.

With regard to the effects of rail deregulation on the wheat/flour rate differential, several observations should be noted. First, rail deregulation does not appear to have effected the locational pattern of

Table 1. Ideal Weight Supply Source and Markets.*

Flour Mills at or Near	Ideal Weights-Wheat Supply Source (Kansas City)	
	Wheat Ton-Mile Cost	Ideal Weight**
Chicago	$ .0262	3.48
Cleveland	.0334	4.44
Philadelphia	.0233	3.10
New York	.0239	3.18
Washington, D.C.	.0221	2.94
Winston-Salem, N.C.	.0214	2.85
Tampa, FL	.0204	2.71
Atlanta	.0243	3.23
New Orleans	.0236	3.14
Markets (Bakeries in)	Market Ideal Weights-Flour Mill at Kansas City	
	Flour Ton-Mile Cost	Ideal Weight***
Chicago	$ .0509	5.09
Cleveland	.0579	5.79
Philadelphia	.0477	4.77
New York	.0459	4.59
Washington, D.C.	.0502	5.02
Winston-Salem, N.C.	.0440	4.40
Tampa, FL	.0424	4.24
Atlanta	.0483	4.83
New Orleans	.0495	4.95

*Wheat supply source is Kansas City. Wheat and bulk flour rates are those in effect in July 1980.

**Ideal weight of wheat supply source (Kansas City) is 1.33 x wheat ton-mile cost x 100. One ton of wheat flour requires 1.33 tons of wheat.

***Ideal weight of flour mill at Kansas City is flour ton-mile cost x 100.

flour mills.(12). The ratio of bulk flour rail rates to wheat rates has been declining. The trend toward larger shipment sizes and existence of confidential rail contract rates are both plausible causes of the decline in wheat flour rates. However, the authors state that since wheat can be shipped more efficiently in unit trains, the current locational trend toward the market will continue.

Cost Dynamics: Scale and Experience Effects

The previous section has described the effects of location as a separate cost driver in the wheat flour milling industry. Logistics costs are directly related to location. Location relative to wheat supply regions is an important factor in inbound logistical cost, while location relative to institutional/bakery markets affects outbound logistical cost. Location of facilities relative to each other in a logistics network affects the costs of processing, inventory holding, and transportation. Location also influences the mode selection decisions of a firm, which affects cost. Heskett (14) points out that location of facilities relative to supply sources and markets is one of the most critical factors in business success.

Firms do not always understand the impact of location beyond visible differences such as labor costs and taxes, however. It is important to evaluate tradeoffs involved in the location decision. Locating to minimize transportation costs, as in the example described previously, can trade off against economies of scale. Therefore, scale must be recognized as a separate cost driver in the flour milling industry. Technological change that alters scale economies can alter historical tradeoffs. For example, Cargill and ADM successfully entered the corn wet milling industry with new continuous process plants that embodied recent changes in process technology. They also reduced overhead through streamlined sales forces. These choices allowed Cargill and ADM to gain a significant cost advantage over traditional processors.

There has been little empirical investigation of scale economies within the flour milling industry. However, the Babcock et al. (12) study demonstrated the importance of transportation costs to the industry. Wheat flour milling is not labor intensive, so labor costs have an insignificant locational influence. The process is not energy intensive, so milling location is not pulled toward low cost energy areas. Capital costs such as interest and taxes are insignificant and vary little from region to region.(12) Labor capital, and energy costs account for only 8.7 percent of the 1977 value of shipments in the flour milling industry.(15) These factors indicate that economies of scale in the processing of wheat into flour may not be a significant cost driver, although further research needs to be conducted with regard to this issue.

The tradeoffs between transportation costs, scale economies, and inventory costs were examined more thoroughly with the simulation model. Cost dynamics can lead to significant changes in relative cost position and industry structure. Early identification of cost dynamics can result in a significant cost advantage by directing a firm toward those activities in the value chain that will have the greatest leverage for future relative cost position.

Objectives and Conclusions of the Study

The purpose of this study was to evaluate the impact of transportation and logistics trends on the wheat flour milling industry and project the effect of these trends on the future configuration of the industry. The analysis indicates that there is a substantial impact on the optimal location of flour mills for each of the reference scenarios simulated. The effect is especially evident for the large-size firm. Total logistics system cost was used as a major indication of the appropriateness of strategic capacity decisions for each size firm. This study concentrated on the domestic market for wheat which is more than 50 percent of total wheat production in the study area.

Objectives of this study were:

1) to examine logistical trends in the wheat flour milling industry, in particular, location changes and industrial concentration,

2) to project the impact of strategic capacity decisions on the future structure of the industry, and,

3) to recommend future strategies to be followed by various size firms in the industry.

A capacitated network flow model was developed based on the marketing pattern of wheat for each size firm. The logistics network was simulated for the various size firms in the wheat flour milling industry. The model considers the effect of the joint capacity expansion-location decision on the relative position of firms in the industry. Cost dynamics can lead to a significant cost advantage and directs a firm toward those activities that will provide the greatest leverage for achieving an advantage in their future relative costs. With the aid of a computed-based network model, the effects of strategic capacity decisions on future industry structure can be projected.

Many of the effects of railroad deregulation could not be isolated in the analysis, but removal of the transit privilege and allowing separate inbound and outbound rates for rail movements of wheat and flour will have substantial effects on the existing and future location pattern of flour mills. As multiple car and unit train movements of wheat by rail become more common as a result of railroad deregulation, more locational impacts can be expected to occur. However, preliminary indications are that railroad deregulation has not impacted upon the location of the flour milling industry.(12) The ratio of bulk flour rates to wheat rates has actually declined, and the trend toward larger shipment sizes as well as the existence of confidential contract rates are both plausible causes for the decline.

Conclusions reached from this study are:

1) Impact on locational patterns of mills (of each firm) is substantial under separate inbound and outbound pricing structures compared to a single through rate (transit rate),

2) Changes in the logistics structure of moving wheat and wheat flour to domestic destinations will result in more location changes and further concentration in the wheat flour milling industry,

3) Flour mills operating in the Buffalo, New York milling center are especially susceptible to being closed as a result of the changing logistics structure and changes in wheat marketing patterns.

Future Strategies

Future strategies to be recommended for the different size firms in the wheat flour milling industry will be discussed in this section. It is evident that changes in the rail grain rate structure have had and will have substantial impacts on the locational pattern of U.S. flour mills. In order to offset the effect of these competitive changes, several strategies are recommended. First, the small and medium-size firms can merge with larger firms in order to maintain a competitive position in the market. In recent years, this activity has occurred more frequently. (For example, Cargill's purchase of Seaboard Allied Milling Corporation). In addition, the bakery market has become more concentrated in recent years, which has increased the bargaining power of the buyer relative to the small miller with one or several mills. This will result in more acquisition activity as flour millers lose their competitive advantage relative to the more powerful buyer group. Small millers will be able to effectively compete in special regional markets and product market niches. Concentration within the industry will continue as the cost advantage of the larger mills widen.

The trend toward automation will also be a strategy that will be pursued by many flour millers in the future. Foreign competition has necessitated this current trend, as U.S. firms try to remain competitive in global markets. There are major cost differences between domestic wheat flour milling firms and French flour millers attempting to serve major markets such as Egypt. Manufacturing costs differ, with the French having a larger number of more recently built mills with high depreciation rates, lower labor but higher energy and interest costs. Automation of domestic flour mills will become a critical factor to the success of U.S. millers in global markets.

To carry out the above strategies, biogenetic firms are working closely with the industry to improve the raw material, the process, and the product, which may mean even greater advantages to high-density population mills or to developing country mills. Joint ventures between technology firms and flour millers will become more common, and ventures such as the Toepfer-ADM-U.S. Farm Cooperative-European Farm Cooperative will also become more common.

Suggestions for Future Studies

This study focused on the changing logistics structure in wheat flour milling and implications these changes have on the future structure of the industry. There are potential expansions that can be done from this study in the future. One expansion includes combining the international wheat flour market with the domestic market. Many developing countries want their own flour industry and have switched to importing wheat rather than flour whether or not this makes sense economically. Another expansion would be the application of a similar simuation model to the logistics system of a macro-problem of other commodities (e.g., the production of steel with mini-mills). With the objectives of this study already achieved, additional questions can be addressed with the same simulation model.

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