An Optimal System for the Distribution of Frozen Concentrated Orange Juice (FCOJ)

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Abstract

The high profitability of frozen concentrated orange juice as a commodity sold to the United States, has recently introduced new developments in the marketing and distribution of the product. New methods for the transportation and storage of FCOJ have mainly benefitted the eastern and western coasts of the United States. The growing per capita income of midwestern and southern cities has induced me to consider the implementation of a system for shipping the commodity from Brazil to the Gulf Coast, and in turn distribute it to inland markets.

The first part of my work consisted in studying the frozen concentrated orange juice industry in Brazil and evaluate its structure, behavior, and reliability as a supply source. The second part of my work dealt with identifying the different costs involved with shipping, unloading, storing, and transporting the commodity to its final destination. I then had to estimate the magnitude of these costs and finally obtain an optimal location for locating the port facilities that will receive, store, and distribute the product inland.

I have determined that, based on the different variables involved in the system, the port of New Orleans was the least costly alternative for the location of the receiving facilities. The results therefore show that the optimal system for the distribution of FCOJ from Brazil to

the markets chosen in this project, includes the port of New Orleans as a location for the receiving terminal.

The two parts of this research are each distinctive in their character; the first part is a description of a current situation with an attempt to evaluate its conduct and reliability in the future. The second part is a more technical approach; it examines the cost consequences of locating a terminal for receiving the commodity in the Gulf Coast and distribute it to various markets.

Introduction

The importance of frozen concentrated orange juice (FCOJ) as an agricultural commodity in the realm of international trade has dramatically increased during the last decade. Successive freezes in Florida have opened new market opportunities for developing countries, Brazil in particular. New processes for the storage and distribution of the commodity have been developed in an attempt to achieve a level of maximum efficiency. Since this project focuses on production of the commodity in Brazil, it is worth examining the current state of production in this South American country.

Brazil's citrus industry has expanded significantly in the twenty years since frozen concentrated orange juice production started in the early part of the 1960's. According to the Food and Agriculture Organization of the United Nations, Brazil produced one-third of the world's orange crop in 1984. Orange production in Sao Paulo State, the center of Brazil's commercial citrus industry, reached an estimated record production of 230 million boxes in the 1985-86 season.

Sao Paulo's citrus industry is geographically concentrated in an area about 150 miles in length and 50 miles in width with the center of production being around the city of Araraquara. There are an estimated 22,000 citrus growers with 1.6 million acres devoted to orange production. The

Instituto de Economica Agricola (IEA) in Sao Paulo estimated the commercial tree inventory as of November 1985 to be 129 million trees with 20.6 million less than three years of age. In 1980, Brazil's commercial inventory in Sao Paulo was 106 million trees. Industry sources suggested that plantings in the last two seasons were 10 to 12 million trees per year with 2.5 million trees being resets. Brazil has clearly shown to possess the capability of expanding citrus production in a significant manner if market demand expands.

There are 17 processing plants in Sao Paulo with capacity for processing 274 million boxes. Four firms directly control almost 80% of the processing capacity, and through joint ownership agreements control almost all the processing capacity in Sao Paulo (Table I).

Brazilian firms have invested heavily in plants, transportation and handling equipment. Brazil's processing industry is state-of-the-art and very efficient. Brazilian producers and processors introduced bulk tanker shipping which replaced the shipping of the commodity in drums, a more expensive and time-consuming process. The first tank ship went into operation in 1980. In the last three years three additional ships have been put into operation with a fifth ship expected to be in operation some time this year.

Brazil has tanker receiving storage facilities located in Europe (Rotterdam, Ghent) and the northeastern United States (Newark, NJ), as well as California. All the U.S.

Table I. Orange Processing Plants, Sao Paulo, Brazil, 1986.

Plant	Location	Year Opened	Capacity (1,000 boxes)
Cutrale	Araraquara	1963	28,000
Cutrale	Colina	1979	37,000
Citro Mojiana	Conchal	1980	6,500
Citrovale	Olimpia	1980	8,500
Branco Peres	Itapolis	1980	3,300
Sucorrico	Araras	1973	4,000
Tropisuco	Posse	1974	2,200
Citral	Limeira	1971	4,000
Citrosuco	Mirassol	1964	62,000
Bascitrus	Bebedouro	1967	22,000
Cargill	Uchoa	1984	10,200
Cargill	Matao	1965	29,000
Brascitros	Matao	1985	13,000
Frutropic	Matao	1979	1,700
Futesp	Bebedouro	1978	9,500
Citropectina	Limeira	1965	26,000
Citrosuco	Limeira	1974	6,700
TOTAL			273,600

facilities have been built since 1984. It is my belief that similar facilities could be built in the Gulf Coast area of the United States. I have therefore concentrated my project on establishing a distribution system between Brazil and this part of the U.S., thereby satisfying the growing demand for the commodity.

Brazil's processed orange industry exports almost the totality of its production. The domestic market typically absorbed less than 3% of the total market volume. The principal export markets for Brazilian frozen concentrated orange juice are the United States, Western Europe, and Canada. The United States is now Brazil's most important market accounting for 60% of the export volume. Shipments to Europe accounted for 30% of the export volume with shipments to Canada accounting for 4% of the total volume.

Brazil's citrus industry is tightly controlled with the government licensing exports, setting minimum export prices, establishing quotas and overseeing fruit price negotiations between growers and processors. Government involvement is primarily justified by the willingness to repatriate earnings obtained as a result of export activities. Frozen concentrated orange juice is one of Brazil's major export items generating revenue of $1.425 billion in 1985 and accounting for 5.3% of Brazil's export revenue.

It is important to consider the general structure of Brazil's economy; this will help us determine the future feasibility and reliability of our transportation system. On February 28th, 1986, the Brazilian government announced a sweeping plan to stabilize the national economy. The principal objective of the stabilization plan is to control inflation. Brazil's inflation rate averaged an estimated 230% in 1985, reflecting the continuation of a long-term problem that the Brazilian economy has faced. Inflation rates have been well above 200% during the last three years. The stabilization plan will move the Brazilian economy to a de-indexed environment, dismantling an index system Brazil introduced twenty years ago. The key features of the stabilization plan are:

1. a general price freeze
2. introduction of the cruzado to replace the cruzeiro
3. establishment of a fixed exchange rate
4. establishment of free floating interest rates
5. establishment of fixed wage rates with salary adjustments when inflation exceeds 20%.

The stabilization plan fixed the exchange rate at 13.77 cruzados per dollar. The Brazilian government had offset the impact of inflation and indexing by continually devaluating the cruzeiro. As an example, the exchange rate was 65.5 cruzeiros per U.S. dollar in December 1980 and 10,490 cruzeiros per dollar in December 1985. On the other hand, interest rates will not be indexed or frozen but instead will be allowed to float. Nevertheless, if the free rate is out of the line with expectations, steps will likely be taken to control it. The economic stabilization plan is a major action directed at dealing with a serious problem for every facet of the Brazilian economy. The impact of the change will very likely affect Brazil's export activities, and in turn the reliability of our system.

In 1986, the Brazilian government lowered the importance of minimum export prices by introducing export licenses. Along with the issuing of licenses, the authorities have established a guideline price of $800 per metric ton in order to prevent exporters from selling their product below this price level. The $800 price is a dramatic change from the January 1985 price of $1,800 per metric ton, which was a direct consequence of the freeze that affected Florida's production in the winter 1984-1985.

Table II. Brazilian Export Prices for FCOJ.

Month	U.S. $ Per Metric Ton
December 1983	1,100
January 1984	1,250
March	1,300
July	1,600
October	1,700
January 1985	1,800
June	1,400
November	1,150
January 1986	1,000
March	800

With the U.S. Department of Commerce determination that FCOJ from Brazil has been dumped in the United States at prices below fair value, the export prices have recently been increased to a $1,100 to $1,300 per metric ton. Even with this price increase, demand in the United States should remain consistent. It is now worth examining the demand for FCOJ in this country.

According to current projections, inflation in the United States should continue to be moderate with expectations that the consumer price index (CPI) will increase at an annual rate of 3.2% in 1987. This rate is similar to the ones observed in the past three years. On the other hand, real disposable income is expected to grow at an annual rate of 2.5% in 1987. In comparison, real disposable income grew by 6.7%, 2.3%, and 3.6% in 1984, 1985, and 1986, respectively.

In general, we can say that the anticipated increase in real income will positively impact on the demand for FCOJ in the United States. The impact of inflation on the demand for FCOJ is determined through real prices - prices for frozen concentrated orange juice relative to other prices. Real prices provide an indication of whether or not FCOJ is relatively cheaper or more expensive than other goods. In 1986, orange juice prices began to decrease and this year, the prices are further expected to fall by 15.5%.

If we now consider Brazilian FCOJ availability and movement, we have to say that Brazil began the 1985-86 season with an estimated inventory of 3.8 million gallons. FCOJ pack was 292.4 million gallons and Brazil's domestic market movement was 5.2 million gallons; exports were equal to 206.9 million gallons, thereby resulting in a carryover of 84.1 million gallons. For the 1986-87 season, with a beginning inventory of 84.1 million gallons and a pack reduced to 206.9 million gallons due to the effects of drought on the average field, Brazil will certainly end the year with a low carryover of only 35.8 million gallons. This figure can also be explained by the fact that Brazil will likely increase its exports by 21% from 206.9 million gallons in 85-86 to 250 million gallons in 86-87. This is illustrated in the following table.

Table III. Brazilian FCOJ Availability and Movement.

(millions of gallons)		
	1985-1986	1986-1987
Beginning Stock	3.8	84.1
Pack	292.4	206.9
Domestic Use	5.2	5.2
Exports	206.9	250.0
Carryover	84.1	35.8

As a summary, we must say that conditions for export of FCOJ have improved due to:

a) favorable production conditions in Brazil enhanced by an improvement in general economic affairs.

b) better governmental assistance for producers and processors.

c) technological developments in the area of shipping, especially; i.e. introduction of bulk tankers.

d) favorable demand conditions in the United States.

We can deduct that a cost-effective method for exporting FCOJ to the United States has a rationale in the willingness to increase profitability for Brazilian processors and exporters that heavily rely on the American market. It is with this idea in mind that this research has been performed.

Methodology

Considering that the objective of this project was to determine the optimal method of distributing FCOJ to midwestern and southern states, and in turn establish a least costly location for the receiving terminal, the following steps were followed.

Part I — Estimation of the supply available on an annual basis.

Part II — Estimation of the demand conditions for FCOJ in the eight markets chosen: Chicago, Detroit, Minneapolis, Peoria, Kansas City, Memphis, Saint Louis, and Dallas.

Part III — Identification and estimation of the shipping costs associated with the transportation of the commodity from the port of Santos in Brazil, to the three ports chosen as possible alternatives for the location of the receiving terminal; these were: Mobile, Houston, and New Orleans.

Part IV — Identification and estimation of the costs associated with operating the receiving terminal in the various ports.

Part V — Identification and estimation of the costs associated with transporting FCOJ by truck from the terminal facilities to the various destinations.

Part VI — Decision for the location of the receiving terminal based on the results obtained (least costly alternative for the location of the terminal).

The unit used as a basis for comparison is the metric ton (2,200 lbs). The metric ton is used as a standard measure in international shipping, especially for the shipping of products in bulk. The following analysis follows the procedures of a network flow model where the first element considered is called the source (in this case the supply of FCOJ available) and the second element is called the sink (demand and consumption of FCOJ in the different markets). Between the source and the sink, the different elements of the system are called nodes. Arcs connect nodes and represent, in this case, the different alternatives available for the distribution of the commodity. A network flow model is illustrated at the end of this paper.

Part I - Supply Available

Bulk tankers currently in operation carry between 8,000 and 14,000 metric tons of frozen concentrated orange juice.

We estimate that the construction and operation of a bulk carrier with a capacity of 9,000 metric tons constitutes a feasible investment. On the other hand, based on industry procedures of annual ship operation, we can say that the ship shall operate twelve trips a year (once a month) between the port of Santos and the port chosen for the location of the receiving terminal.

We can therefore estimate an annual supply available of 12 x 9,000 = 108,000 metric tons.

Part II - Demand Conditions

Based on estimates of the U.S. Department of Agriculture for the consumption of FCOJ and based on the figures regarding inflation and income growth, we have determined the weekly consumption of the commodity in the different markets as well as the percentage of the total consumption as being the following:

Weekly Consumption of FCOJ

Market	Metric Tons	% of Total
Dallas	141.8	16.32
Memphis	66.07	7.61
St. Louis	84.56	9.73
Chicago	316.03	36.38
Peoria	8.8	1.01
Minneapolis	61.47	7.08
Detroit	138.61	15.96
Kansas City	51.37	5.91
TOTAL	868.71	100.00

Observing the table, we can notice the fact that the cities of Dallas, Chicago, and Detroit together represent 68.66% of the total consumption in the eight target markets. On the other hand, the range of weekly consumption figures varies from 8.8 metric tons in Peoria to 316.3 metric tons in the Chicago market. Finally, we can say that five markets individually absorb less than 10% of total consumption.

Part III - Shipping Costs Identification and Estimation

The costs associated with the ocean shipping of the commodity are divided into three main categories. First of all, the fixed capital costs. These are involved with the building and subsequent amortization of the bulk carrier. The second category of costs are the operational costs, which are directly associated with the daily operation of the ship. The third category is represented by the variable costs; these vary depending upon the port where the ship is operating and unloading its cargo. The table below summarizes the main shipping costs.

Shipping Costs

A) Fixed Capital Costs
   a. vessel cost
   b. amortization
   c. interest on debt

B) Operational Costs
   a. crew
      1. salaries
      2. compensations & travel expenses
      3. insurance
      4. food

b. maintenance
c. fuel
d. shipping insurance
    1. cargo
    2. vessel

C) Variable Operation Costs
a. dockage
b. pilot fees
c. port fees
d. agency fees
e. stevedore charges

These costs are computed on a per metric ton basis; the main differentiating factors between the ports of Mobile, New Orleans, and Houston are the fuel costs (directly associated with the distance between the two ports) and the variable operation costs. Taking these factors into consideration, we conclude that the costs of shipping the commodity from Brazil to each of the three Gulf Coast ports are the following:

1) Santos-Houston: $384/metric ton
2) Santos-Mobile: $384/metric ton
3) Santos-New Orleans: $375/metric ton

Part IV - Receiving Terminal Costs Identification and Estimation

The terminal facilities that will be built to receive the frozen concentrated orange juice consist of:

a) special unloading facilities to transfer the commodity from the ship to the terminal

b) storage tanks of 1,000 metric tons each that can keep the product at a temperature of -19°C for a period as long as fourteen months

c) offices for the management of the terminal

d) a U.S. Dept. of Agriculture laboratory for inspection and grading of the product

e) a U.S. Customs office

f) installations allowing for the transfer of FCOJ from the tanks to the trucks that will distribute the commodity inland.

The costs associated with the building and operation of the terminal facilities can be divided into the following categories:

A) Fixed Capital Costs
   a. construction
   b. amortization
   c. land lease
   d. interest on debt

B) Variable Operation Costs
   a. labor
   b. management salaries and compensation
   c. utilities cost
   d. maintenance
      1. building
      2. storage costs

C) Fixed Costs
   a. taxes
   b. insurance
   c. administrative costs

Computing these costs for the three different locations, the following assumptions were made.

1. land costs do not vary significantly from one port location to another

2. construction costs are the same for the three areas

3. being unionized, workers' salaries are similar in all three locations.

The cost per metric ton of operating the receiving terminal facilities is thus considered constant for all three ports.

Terminal cost (per metric ton): $65.00

Part V - Inland Transportation Costs Identification and Estimation

The eight markets chosen as ultimate destination for the frozen concentrated orange juice are widely spread among the midwestern and southern states of the country. Distances from the ports to the eight markets vary greatly and this will obviously result in a wide range of total distribution costs.

The first step in the process of identifying these costs was to develop a per-mile cost figure taking into account the different components of operating a truck for commercial transportation purposes. The different costs associated with inland transportation are the following:

A) Variable Costs
   a. fuel
   b. maintenance
      1. grease and oil
      2. repairs
      3. labor
   c. tires
   d. road tolls
   e. weighing fees
   f. fines

B) Fixed Costs
   a. depreciation
   b. insurance
   c. licenses
   d. taxes

Based on these different categories, a total cost of 41 cents per mile was obtained.

The next step was to estimate the cost of inland transportation from the three ports to the eight markets, taking into account the distance to be traveled and the cost per mile of operating the trucks.

A) From Mobile to:

Chicago:	$ 700.28
Detroit:	$ 781.56
Minneapolis:	$ 966.78
Peoria:	$ 641.24
Kansas City:	$ 665.84
St. Louis:	$ 523.16
Dallas:	$ 482.98
Memphis:	$ 340.30

B) From Houston to:

Chicago:	$ 867.56
Detroit:	$1032.38
Minneapolis:	$1006.14
Peoria:	$ 697.00
Kansas City:	$ 668.30
St. Louis:	$ 633.86
Dallas:	$ 198.14
Memphis:	$ 340.30

C) From New Orleans to:

Chicago:	$ 757.02
Detroit:	$ 895.26
Minneapolis:	$ 993.84
Peoria:	$ 674.04
Kansas City:	$ 658.46
St. Louis:	$ 550.22
Dallas:	$ 405.90
Memphis:	$ 317.34

The last step in the process of estimating inland transportation costs dealt with the development of a per metric ton figure based on the following:

a) truck capacity = 13 tons
b) amount of FCOJ shipped to each market

c) costs of transportation as described in the preceding section

These costs are described first on a total annual basis and then on a per metric ton basis.

Inland Distribution Costs

A) From Mobile

Target Market	Total Annual Cost	Per Metric Ton Cost
Dallas	$ 654,831.71	$37.15
Memphis	187,666.81	22.83
St. Louis	422,890.35	40.24
Kansas City	326,917.20	51.21
Peoria	53,804.96	49.32
Minneapolis	568,645.12	74.36
Detroit	1,036,276.40	60.11
Chicago	2,116,159.00	53.85
TOTAL	5,367,191.60	

5,367,191.60/108,000 = $49.69 per metric ton cost

B) From Houston

Target Market	Total Annual Cost	Per Metric Ton Cost
Dallas	$ 269,048.00	$15.26
Memphis	215,142.90	26.18
St. Louis	512,373.42	48.76
Kansas City	328,125.02	51.41
Peoria	58,483.66	53.62
Minneapolis	591,796.07	77.40
Detroit	1,368,840.60	79.41
Chicago	2,622,060.00	66.74
TOTAL	5,965,869.60	

5,965,869.60/108,000 = $55.24 per metric ton cost

C) From New Orleans

Target Market	Total Annual Cost	Per Metric Ton Cost
Dallas	$ 550,325.46	$31.22
Memphis	200,627.23	24.41
St. Louis	444,763.90	42.32

Kansas City	270,149.56	42.32
Peoria	56,557.14	51.85
Minneapolis	584,561.40	76.45
Detroit	1,187,032.10	68.87
Chicago	2,287,970.70	58.23
TOTAL	5,581,987.50	

5,581,987.50/108,000 = $51.69 per metric ton cost

If we compare the results obtained, we must say that distributing the commodity through the port of Mobile is the least costly alternative if we consider only the inland transportation costs. However, for the purpose of considering the entire system from the port of Santos to the various target markets we have to take other variables into account. This is done in the next section.

Part VI - Decision Regarding the Location of the Receiving Terminal - The Least Costly Alternative

At this point we possess knowledge of all the relevant variables that will determine the least costly alternative for the location of the receiving terminal. We now have to develop a figure showing the total cost of shipping the commodity from Brazil to the target markets in the United States. This is done in this section.

A) Cost of shipping the commodity through Mobile

$384.00	shipping cost Santos-Mobile
65.00	terminal operation cost
49.69	inland distribution cost
$498.69	total cost per metric ton

B) Cost of shipping the commodity through Houston

$384.00	shipping cost Santos-Houston
65.00	terminal operation cost
55.24	inland distribution cost
$504.24	total cost per metric ton

C) Cost of shipping the commodity through New Orleans

$375.00	shipping cost Santos-New Orleans
65.00	terminal operation cost
51.69	inland distribution cost
$491.69	total cost per metric ton

Summary:

Mobile:	$498.69/MT
Houston:	$504.24/MT
New Orleans:	$491.69/MT

We can see that New Orleans is thus the least costly alternative for shipping FCOJ from Brazil to inland markets in the chosen part of the country.

It is now worth considering the validity of our solution; to do this, we shall conduct a sensitivity analysis in which we shall alter a variable and consider its impact on the optimal solution.

Sensitivity Analysis

We will consider a change in demand in the markets chosen for the project. Let us assume the following:

a) demand in Dallas rises by 12%
b) demand in Chicago declines by 9%
c) demand in Minneapolis declines by 3%

The new demand considerations resulting from these changes are:

a) new demand in Dallas: 158.8 metric tons per week representing 18.275 of total demand

b) new demand in Chicago: 287.6 metric tons per week representing 33.1% of total demand

c) new demand in Minneapolis: 59.63 metric tons per week representing 6.86% of total demand.

The change in demand in these three markets will have an impact on inland transportation costs.

New figures as a result of the changes have the following configuration:

a) total annual cost from Mobile to Dallas: $733,028.94

b) total annual cost from Houston to Dallas: $300,739.94

c) total annual cost from New Orleans to Dallas: $616,081.26

d) total annual cost from Mobile to Chicago: $1,925,662.30

e) total annual cost from Houston to Chicago: $2,385,656.50

f) total annual cost from New Orleans to Chicago: $2,081,688.50

g) total annual cost from Mobile to Minneapolis: $550,975.36

h) total annual cost from Houston to Minneapolis: $573,406.93

i) total annual cost from New Orleans to Minneapolis: $566,397.06

The new total distribution costs from each port to the eight inland markets as a result of the changes in demand are as follows:

a) From Mobile: $48.49/metric ton
b) From Houston: $53.17/metric ton
c) From New Orleans: $50.21/metric ton

The percentage change in total cost per metric ton can be summarized.

a) The total cost through Mobile decreased by 2.47%
b) The total cost through Houston decreased by 3.89%
c) The total cost through New Orleans decreased by 2.94%

The new costs of shipping the commodity from Brazil through each of the ports, to the inland markets have the following configuration as a result of the changes in demand in Dallas (+12%), Chicago (-9%) and Minneapolis (-3%):

a) Mobile:	shipping cost Santos-Mobile	$384.00
	inland transportation cost	48.49
	terminal operation cost	65.00
	total cost per metric ton	$497.49

b) Houston:	shipping cost Santos-Houston	$384.00
	inland transportation cost	53.17
	terminal operation cost	65.00
	total cost per metric ton	$502.17

c) New Orleans:	shipping cost Santos-New Orleans	$375.00
	inland transportation cost	50.21
	terminal operation cost	65.00
	total cost per metric ton	$490.21

The results of the sensitivity analysis show that, despite the changes in demand in three of the eight target markets, New Orleans remains the least costly alternative for the location of the terminal facilities.

We can therefore say that the choice of New Orleans as an optimal solution will remain feasible even in presence of changes in demand. Finally, we can claim that large demand fluctuations would have to occur in the target markets, in order for the solution to change.

Conclusions

After having considered the costs of shipping FCOJ from Brazil to eight American markets, passing through a Gulf Coast port, we have to say that the results obtained are very encouraging.

First of all, the results show that there is a real possibility of establishing a marketing system similar to the one considered in this project. On the other hand, the financial feasibility of integrating the entire distribution system under a single ownership entity is perfectly satisfactory. Retail selling of 12 oz. cans of frozen concentrated orange juice would result in a net profit of a very acceptable level for the vertically integrated firm. Finally, the development of such a system in this project has provided an important amount of enthusiasm, in the sense that it proved the fact that new opportunities have to be exploited, and opportunities for profitability in the marketing of frozen concentrated orange juice (FCOJ) are very present and challenging nowadays.

Bibliography

Ronald W. Ward and Richard L. Kilmer. The United States Citrus Subsector: Organization, Behavior and Performance. North Central Research Publication, 1978.

John H. Wilson. Brazil's Orange Juice Industry. USDA, Foreign Agricultural Service, 1980.

Robert D. Carter. Observations of Citrus Processing in Brazil. The Citrus Industry, January 1986.

Economic and Market Research Department, Florida Department of Citrus. Florida Citrus Outlook, 1986-87 Season. October 29, 1986.

Dan L. Gunter and Gary F. Fairchild. Brazil's Orange Outlook. The Citrus Industry, July 1986.

James T. Kneafsey. The Economics of the Transportation Firm. Lexington, Lexington Books, 1974.

Hugh S. Norton. Modern Transportation Economics. Columbus, Charles E. Merrill Publishing Company, 1971.

James T. Kneafsey. Transportation Economic Analysis. Lexington, Lexington Books, 1975.

Stephen Fuller and Ch. Shanmugham. Network Flow Models: Use in Rural Freight Transportation Analysis and a Comparison with Linear Programming. Southern Journal of Agricultural Economics, December 1978.

Philip C. Cheng. Financial Management in the Shipping Industry. Centerville, Md, Cornell Maritime Press, 1979.

Lane C. Kendall. The Business of Shipping. Centerville, Md, Cornell Maritime Press, 1983.

Hobart S. Perry. Ship Management and Operation. New York, Simmons-Boardman Publishing Company, 1931.

Harold W. Lough. Truck Transportation Costs of Bulk Milk. USDA, Economic Research Service, August 1977.

Patrick P. Boles. Owner-Operator Truck Cost Guide. USDA, Office of Transportation, April 1980.

Lloyd's Ports of the World 1985. Lloyd's of London Press Ltd., 1985.

R.b. Oram and C.C.R. Baker. The Efficient Port. New York, Pergamon Press, 1971.

Tobey L. Winters. Deepwater Ports in the United States. An Economic and Environmental Impact Study. New York, Praeger Publishers, 1977.

W. Webster Jones. Milk Processor-Distributors' Sales, Costs, and Margins, 1980-81. USDA, Economic Research Service, 1983.

USDA Economics and Statistics Service. U.S. Foreign Agricultural Trade Statistical Report, Fiscal Year 1980.

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