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Economic Feasibility of an Air Cargo Handling Facility at Fargo, North Dakota

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Highlights

Exports to Taiwan in 1990 via air freight were approximately $2.9 billion, and imports via air freight to the United States were $3.1 billion. Total U.S. exports/imports to/from Taiwan in 1990 were $11.5 billion and $22.7 billion, respectively. China Airlines operates three air cargo hubs in the United States: New York, Los Angeles, and Dallas.

The real per capita Gross National Product (GNP) in Taiwan for 1989 was $7,512, up from $3,297 in 1985. This implies that the Taiwanese economy is one of the fastest growing economies in Asia. Trade volume between the United States and Taiwan has increased substantially over the last 10 years and is predicted to grow in the future.

The objective of this study is to evaluate the economic feasibility of Fargo, North Dakota, as an air cargo handling facility for products shipped to (from) Taiwan.

Two static transshipment models were used to determine the economic feasibility of an air cargo hub being located at Fargo. Both transshipment models minimized trucking costs of cargo from (to) customs districts to (from) air cargo hubs and air cargo costs from (to) hubs to (from) Taiwan for exports and imports.

Total savings and market shares for both export and import models are presented by evaluating the feasibility of an air cargo hub at Fargo. The model, excluding Fargo as a cargo hub, results in $47 million in exports and $1.7 million in imports. Including Fargo as a cargo hub at the New York rate saves $2.73 million; at the Dallas rate, $2.84 million; and at the Los Angeles rate, $3.08 million. Fargo's market share is 11.8% for exports and 14.8% for imports. Fargo gains its entire market share for both exports and imports from New York for all models.

In conclusion, this study indicates Fargo has a logistical advantage over New York and Dallas in shipping and receiving air cargo between Taiwan and Northern Plains states (Minnesota, Illinois, and Montana). This does not necessarily mean it would be economically feasible to place an air cargo hub at Fargo. In addition to logistics, economic feasibility depends on investment and operating costs, and a volume large enough to minimize per unit operating costs through economies of scale.

Economic Feasibility of An Air Cargo Handling Facility At Fargo, North Dakota

Theresa K. Golz, Joel T. Golz, and Won W. Koo*

Introduction

Nearly $2.9 billion worth of U.S. products were exported via air freight to Taiwan in 1990, and $3.1 billion worth of Taiwanese products were imported via air freight into the United States. Total U.S. exports/imports to/from Taiwan in 1990 were $11.5 billion and $22.7 billion, respectively.

China Airlines operates three air cargo handling facility hubs in the United States: New York, Los Angeles, and Dallas. Air mileage from New York to Taipei (Taiwan) is 7800 miles, Los Angeles to Taipei is 6800 miles, and Dallas to Taipei is 8000 miles. However, air mileage from Fargo to Taipei is 7500 miles. Therefore, the distance from Fargo to Taipei is less than the distance from New York and Dallas to Taipei, and Fargo may have a comparative advantage as an air cargo handling facility hub over these two cities.

The objective of this study is to evaluate the economic feasibility of Fargo, North Dakota, as an air cargo handling facility for products shipped to (from) Taiwan.

General Overview Of Exports And Imports

Taiwan has one of the fastest growing economies in the world and one of the strongest in Asia. Taiwan is no longer called a developing country but is referred to as a newly industrialized country ("NIC") because of its successful development in industries and the rise in its standard of living. The real per capita Gross National Product (GNP) in Taiwan for 1989 was $7,512, up from $3,297 in 1985 (Table 1). The real per capita GNP of Taiwan is significantly higher than most other countries in Asia (Table 1).

Since Taiwan's currency (called the NT dollar) has appreciated over 51 percent since the end of 1985 (Table 2), its exports are more expensive to U.S. consumers, yet U.S. exports have become cheaper for Taiwan consumers. Therefore, merchandise imports have increased a total of 157 percent from 1985 to 1989 (Table 2). A 46 percent growth in imports during 1986 and 1987 was the largest increase between two years. However, Taiwan's merchandise exports have increased a total of 116 percent from 1985 to 1989 with the biggest increase from 1986 to 1987 of 35 percent (Table 2).

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TABLE 1. REAL PER CAPITA GROSS NATIONAL PRODUCT FOR TAIWAN, THAILAND, PEOPLES REPUBLIC OF CHINA, REPUBLIC OF SOUTH KOREA, AND HONG KONG

Country	Year		
	1985	1987	1989
	----------1986 $----------		
Taiwan	3,297	5,275	7,512
Thailand	709	886	1,111
People's Republic of China	286	253	250
Republic of Korea	2,278	2,977	4,229
Hong Kong	4,252	5,267	5,630

SOURCES: USDA, ERS, Agriculture and Trade Report, Situation and Outlook Series, selected issues and years; and International Monetary Fund, October 1991.

TABLE 2. TAIWAN MERCHANDISE EXPORTS, IMPORTS, AND EXCHANGE RATES, 1985-1989

Item	Year				
	1985	1986	1987	1988	1989
	----------million U.S. Dollars----------				
Merchandise Exports, F.O.B.	30,469	39,552	53,298	60,319	65,875
Merchandise Imports, F.O.B.	19,296	22,635	33,012	46,485	49,672
	----------NT dollar/U.S.$----------				
Exchange Rate	39.85	37.84	31.85	28.85	26.40

SOURCE: USDA, ERS, Pacific Rim Agriculture and Trade Report, Situation and Outlook Series, August 1991.

Because the Taiwan currency has appreciated, Taiwan has evolved from a nation primarily noted for its exports of textiles, toys, footwear, sporting goods, and wooden products to a country specializing in computers, electronics, machinery, electrical apparatuses, iron, and steel (Soderstrom, 1989). The Taiwan Institute for Economic Research reported that for 1986 and 1987, the share of total exports for the most labor-intensive industries dropped from 34 to 28 percent, while the export share of the most technology and capital-intensive industries rose from 25 to 32 percent. This dynamic shift in Taiwan's economic system illustrates the transition to a more industrialized economy.

North Dakota has a small portion of Taiwanese bilateral trade volume with the United States. Since data for specific products were unavailable for air cargo exports from North Dakota to Taiwan, total exports were used. Total exports from North Dakota to Taiwan in 1990 amounted to $3.55 million (Table 3), 94 percent of which was non-electronic machinery (Table 4). North Dakota exports to Taiwan rose from a low of $1.11 million in 1989 to a high of $3.55 million in 1990 (Table 4).

TABLE 3. TOTAL EXPORTS FROM NORTH DAKOTA TO TAIWAN BY PRODUCT, 1990

Product	Amount
Agricultural Products	$ 97,900
Nonmetallic minerals, except fuels	24,300
Fabricated metal products, except machinery and transportation products	7,884
Non-electric machinery	3,356,237
Electric and electronic machinery, equipment, supplies	24,385
Waste and scrap	41,831
Total	$3,552,537

SOURCE: North Dakota Economic Development and Finance, 1991.

Model Development

The economic feasibility of Fargo, North Dakota, as an air cargo handling facility can be evaluated in terms of volume of air cargo the facility can handle, logistics for receiving and distributing cargo between the hub and final destinations or origins, and investment and operating costs for the facility. Our study is based on trade and logistic issues because investment and operating costs are not available. Therefore, investment and operating costs are assumed to be equal for all

TABLE 4. TOTAL EXPORTS FROM NORTH DAKOTA TO TAIWAN, 1987-1990

Year	Value	Non-electric Machinery	Agricultural and Food and Kindred Products
	-million $-	-----percent of total exports------	
1987	1.64	86	8
1988	2.05	74	18
1989	1.11	72	21
1990	3.55	94	3

SOURCE: North Dakota Economic Development and Finance, 1991.

the hubs, including Fargo. Two models are used in this study, an export model and an import model, both of which are static transshipment models based on a mathematical programming algorithm. The objective of the export (import) model is to minimize trucking costs of cargo from (to) customs districts to (from) air cargo hubs and air cargo costs from (to) hubs to (from) Taiwan. The objective function is optimized subject to export (import) volume between these two countries.

The United States is divided into 38 customs districts for both models. Some customs districts are combined as one district. The models include three air cargo hubs and an additional hub placed at Fargo to determine its economic feasibility.

The mode of domestic transportation used to ship cargo between customs districts and hubs is truck. The mode of transportation between hubs and Taiwan is air cargo carrier.

The objective function of the export model is written as follows:

$$\text{Min } C = \sum_{d=1}^{D} \sum_{h=1}^{H} CT_{d,h}\, QX_{d,h} + \sum_{h=1}^{H} XR_h\, XT_h \qquad (1)$$

where

d = index for customs districts
h = index for air cargo hubs
CT = truck transportation rate shipping cargo from customs districts to hubs

QX = volume of cargo shipped from customs districts to hubs
XR = air cargo rate for exports to Taiwan
XT = volume of air cargo exports to Taiwan

The objective function in equation one is the summation of two separate activities. The first summation represents shipments of cargo from customs districts to air cargo hubs, and the second summation is the shipment of air cargo from hubs to Taiwan. All costs of these activities are measured in dollars per 1,000 kilograms.

Three linear constraints are placed on the export model as follows:

$$\sum_{d=1}^{D} QX_{d,h} = XT_h \tag{2}$$

$$\sum_{h=1}^{H} QX_{d,h} \leq EX_d \tag{3}$$

$$\sum_{h=1}^{H} XT = XS \tag{4}$$

where

EX_d = volume of cargo at each customs district for export to Taiwan
XS = total volume of air cargo exported to Taiwan in 1987

Equation 2 indicates the total volume of cargo transported from customs districts to a hub should be equal to the volume that hub ships to Taiwan. Equation 3 indicates the total volume of cargo transported from a district to hubs is less than or equal to the volume of cargo supplied at that customs district. Equation 4 indicates the total volume of air cargo exports from all hubs to Taiwan is equal to the volume of these exports in 1987.

The structure of the import model is the same as that of the export model. The objective function of the import model is written as follows:

$$\text{Min } C = \sum_{h=1}^{H} MR_h \, MT_h + \sum_{d=1}^{D} \sum_{h=1}^{H} CT_{d,h} \, QM_{d,h} \tag{5}$$

where

d = index for customs districts
h = index for air cargo hubs
CT = truck transportation rate in shipping cargo from hubs to customs district
MR = air cargo rate for imports from Taiwan
MT = volume of air cargo imports from Taiwan
QM = volume of cargo shipped from hubs to customs district

The objective function in equation 5 is the summation of two separate activities. The first summation represents shipments of cargo from Taiwan to air cargo hubs, and the second summation is the shipment of air cargo from hubs to customs districts. All costs of these activities are measured in dollars per 1,000 kilograms.

The objective function is minimized subject to the following constraints:

$$\sum_{d=1}^{D} QM_{d,h} = MT \tag{6}$$

$$\sum_{h=1}^{H} QM_{d,h} \leq IM_d \tag{7}$$

$$\sum_{h=1}^{H} MT = MD \tag{8}$$

where

IM_d = volume of cargo demand at each customs district
MD = total volume of air cargo imported from Taiwan in 1987

Equation 6 indicates the total volume of cargo transported from a hub to customs districts should be equal to the volume that hub receives from Taiwan. Equation 7 indicates the total volume of cargo transported from hubs to a district is less than or equal to the volume of cargo demanded at that customs district. Equation 8 indicates the total volume of air cargo

imports from Taiwan to all hubs is equal to the volume of these imports in 1987.

A base and several alternative models are developed and compared to evaluate the economic feasibility of Fargo as an air cargo hub on the basis of alternative air freight rates. The base and alternative export (import) models are as follows:

1. Model 1 (base model) is based on the volume of exports (imports) from Taiwan in 1987 destined for each customs district. Truck and air cargo rates are based on 1990 data.
2. Model 2 is the same as Model 1 except for the addition of an air cargo hub at Fargo. The air cargo rate used for Fargo is the same as the New York rate.
3. Model 3 uses the Dallas air cargo rate for Fargo.
4. Model 4 uses the Los Angeles air cargo rate for Fargo.

Data

The models require costs associated with domestic transportation activities (truck rates) in the United States and air transportation activities (air cargo rates) and volume of cargo supplied and received at each customs district.

Truck rates for domestic transportation between customs districts and air cargo hubs were $1.25 per mile and were obtained from the Upper Great Plains Transportation Institute. Air cargo rates were obtained from China Airlines, LTD (Table 5).

TABLE 5. AIR CARGO RATES AT CHINA AIRLINE HUB LOCATIONS FOR EXPORTS AND IMPORTS

Hub	Export Rate	Import Rate
	-------1000 kgs/U.S. $--------	
New York City	12.50	6.30
Los Angeles	10.70	5.31
Dallas	11.93	6.11

SOURCE: China Airlines, LTD.

The volume of air cargo exported to and imported from Taiwan at each customs district is listed in Table 6. The continent of Asia was used as a proxy for Taiwan because air cargo volumes are reported only to and from continents.

TABLE 6. CUSTOMS DISTRICTS' EXPORTS (IMPORTS) OF AIR CARGO TO (FROM) TAIWAN, 1987

Custom District	Exports	Imports
	--------1,000 kgs ---------	
Portland, ME	22.70	18.33
St. Albans, VT	1,057.95	3.96
Boston, MA	38,862.60	652.61
Buffalo, NY	324.65	97.27
New York City, NY	505,154.83	30,290.81
Philadelphia, PA	8,504.46	123.40
Baltimore, MD	143.03	25.23
Wilmington, NC	4,726.72	35.77
Charleston, SC	15.89	16.86
Savannah, GA	15,033.78	578.78
Tampa, FL	138.49	33.02
Providence, RI	0.00	2.43
Ogdensburg, NY	0.00	2.56
Norfolk, VA	0.00	5.68
Mobile, AL	0.00	0.64
New Orleans, LA	29.51	21.72
Laredo, TX	202.06	9.52
El Paso, TX	0.00	3.83
San Diego, CA	106.70	6.13
Nogales, Az	0.00	7.41
Los Angeles, CA	384,659.87	19,669.51
San Francisco, CA	252,752.23	13,778.54
Portland, OR	994.38	87.31
Seattle, WA	38,104.33	1,352.75
Anchorage, AK	20,564.17	531.46
Great Falls, MT	18.16	13.35
Pembina, ND	11.35	3.70
Minneapolis, MN	9,821.22	176.15
Duluth, MN	0.00	0.58
Milwaukee, WI	1,811.68	8.30
Detroit, MI	1,616.44	174.17
Chicago, IL	176,695.67	11,655.79
Cleveland, OH	67,926.69	569.65
St. Louis, MO	372.22	98.61
Miami, FL	9,964.25	290.60
Houston/Galveston, TX	32,998.48	154.82
Washington, DC	2,608.55	0.00
Dallas/Fort Worth, TX	27,697.38	0.00
Total	1,602,940.44	80,501.25

SOURCE: U.S. Department of Commerce, Bureau of the Census, U.S. Airborne Exports and General Imports, 1987.

Empirical Results

Results of this study are presented by evaluating the feasibility of an air cargo hub at Fargo in terms of total transportation cost savings and market shares for both export and import models. The volume of cargo at each air cargo hub for alternative export and import models is also presented.

The objective function values for model 1 are $47 million and $1.7 million, respectively, for the export and import models (Table 7). New York has the largest market share for both

TABLE 7. OBJECTIVE FUNCTION VALUES AND SAVINGS FOR ALTERNATIVE MODELS, EXPORTS AND IMPORTS[a]

Models	Exports	Savings	Imports	Savings	Total Savings
			$		
#1-excludes Fargo	47,006,918	--	1,734,144	--	--
#2-includes Fargo with with New York rate	44,419,782	2,587,136	1,594,801	139,343	2,726,479
#3-includes Fargo with Dallas rate	44,312,418	2,694,500	1,592,548	141,596	2,836,096
#4-includes Fargo with Los Angeles rate	44,080,738	2,926,180	1,583,062	151,082	3,077,262

[a] $1.25 per mile domestic truck rate.

exports and imports at 52.7 and 55.7 percent, while Los Angeles is second at 43.5 and 44 percent, respectively, for the export and import models (Tables 8 and 9). Dallas has 3.8 percent of the market for exports and 0.3 percent for imports. The volume of cargo shipped between each customs district and air cargo hub for exports and imports are presented in Figures 1 and 2.

Model 2 added an air cargo hub at Fargo, using the New York export and import air cargo rates. The result is a cost savings of $2.6 million for exports and $139 thousand for imports (Table 7). Fargo has an 11.8 percent market share for exports and a 14.8 percent market share for imports. Fargo gains its entire market share for both exports and imports from New York, leaving Los Angeles with the largest market share for both exports and imports. Customs districts in Montana, North Dakota, Minnesota, Wisconsin, and Illinois all use the air cargo hub at Fargo for exporting and importing cargo (Figures 3 and 4). These customs districts used the air cargo hub at New York for exporting and importing cargo in Model 1.

Model 3 used the Dallas export and import air cargo rates, which are lower than the New York rates for Fargo. Savings increased to $2.7 million for the export model and $141 thousand

TABLE 8. EXPORT VOLUME AND MARKET SHARES OF EACH HUB IN EACH MODEL

Model	New York	Dallas	Los Angeles	Fargo
	----------1,000 kgm ----------			
#1-excludes Fargo	844,600	61,299	697,140	--
	(52.7%)	(3.8%)	(43.5%)	--
#2-includes Fargo with New York rate	656,000	61,299	697,140	188,360
	(40.9%)	(3.8%)	(43.5%)	(11.8%)
#3-includes Fargo with Dallas rate	656,100	61,299	697,140	188,360
	(40.9%)	(3.8%)	(43.5%)	(11.8%)
#4-includes Fargo with Los Angeles rate	656,100	61,299	697,140	188,360
	(40.9%)	(3.8%)	(43.5%)	(11.8%)

TABLE 9. IMPORT VOLUME AND MARKET SHARES OF EACH HUB IN EACH MODEL

Model	New York	Dallas	Los Angeles	Fargo
	----------1,000 kgm ----------			
#1-excludes Fargo	44,779	288	35,333	--
	(55.7%)	(3.7%)	(44.0%)	--
#2-Includes Fargo with New York rate	32,921	288	35,333	11,857
	(40.9%)	(.3%)	(44.0%)	(14.8%)
#3-Includes Fargo with Dallas rate	32,921	288	35,333	11,857
	(40.9%)	(.3%)	(44.0%)	(14.8%)
#4-Includes Fargo with Los Angeles rate	32,921	288	35,333	11,857
	(40.9%)	(.3%)	(44.0%)	(14.8%)

for the import model; however, neither the market shares nor the amount of cargo shipped through the air cargo hub at Fargo changed. The hub at Fargo services the same customs districts as in Model 2 (Figures 3 and 4).

Model 4 used the Los Angeles export and import air cargo rates, which are lower than the Dallas rates for Fargo. Savings increased to $2.9 million for the export model and $151 thousand for the import model; however, neither market shares nor the amount of cargo shipped through the air cargo hub at Fargo changed. The hub at Fargo services the same customs districts as in Model 3 (Figures 3 and 4).

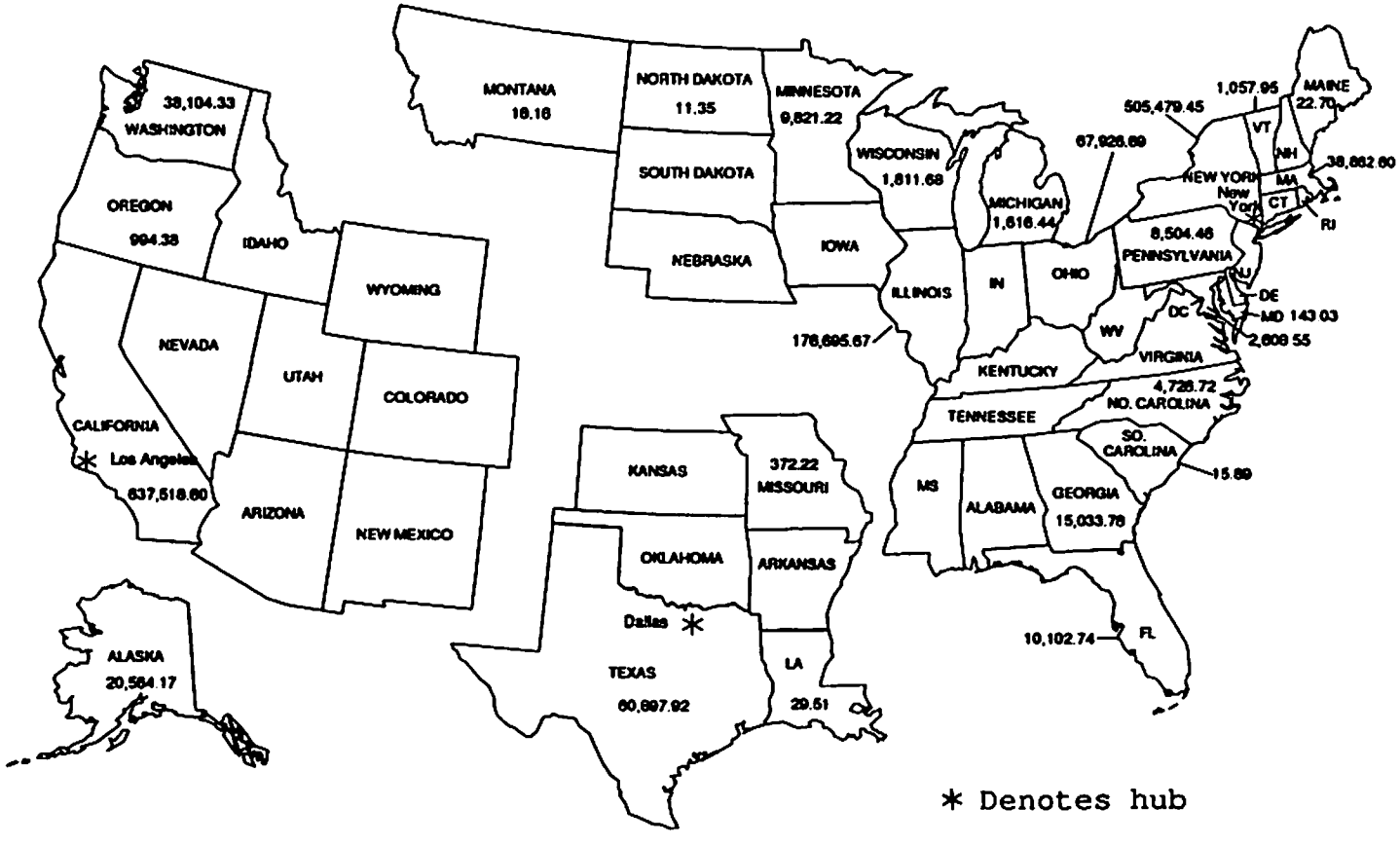

Figure 1. Export Volumes Using the Three-Hub Model, 1,000 kgms

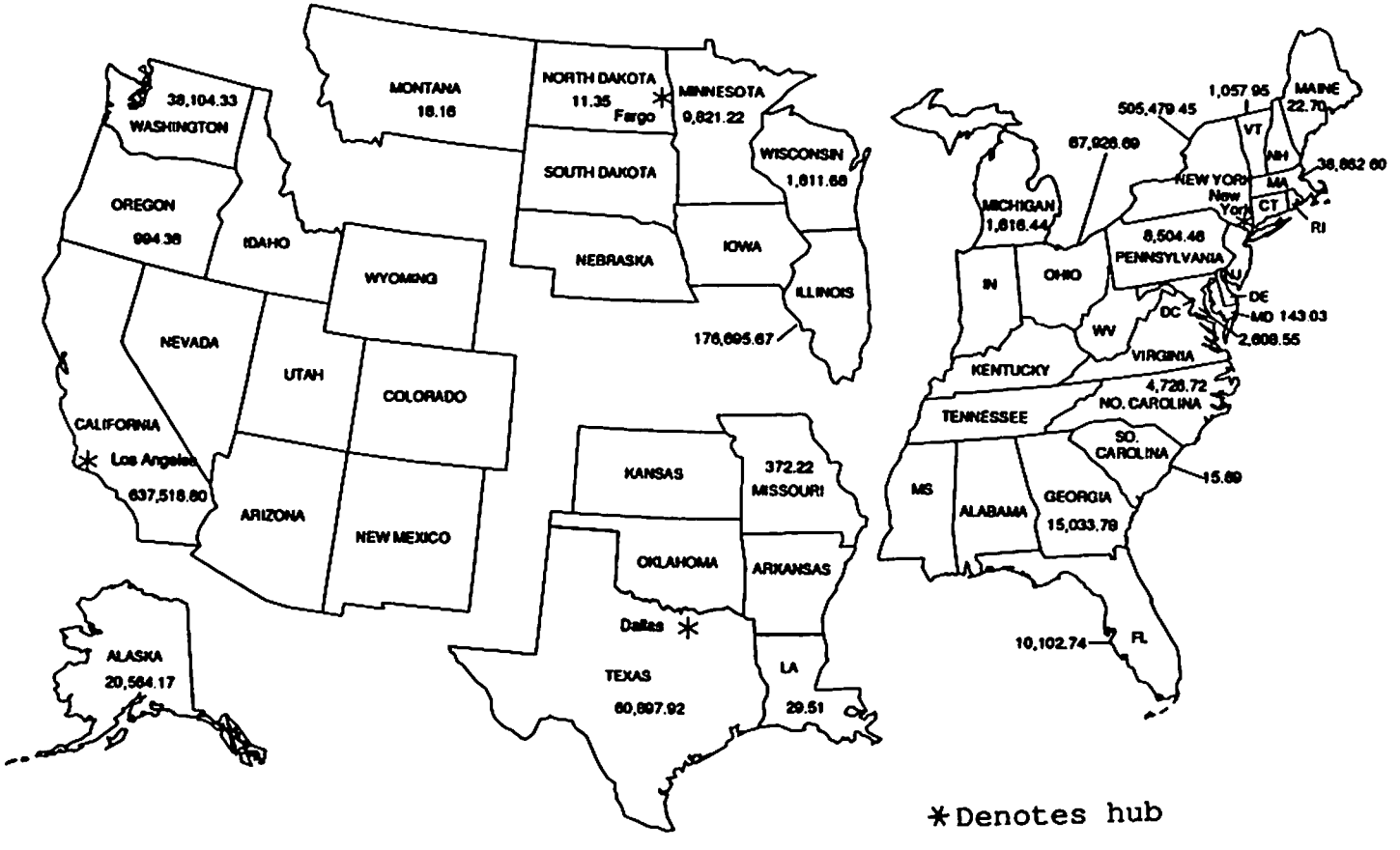

Figure 2. Export Volumes Using Fargo as a Hub, 1,000 kgms

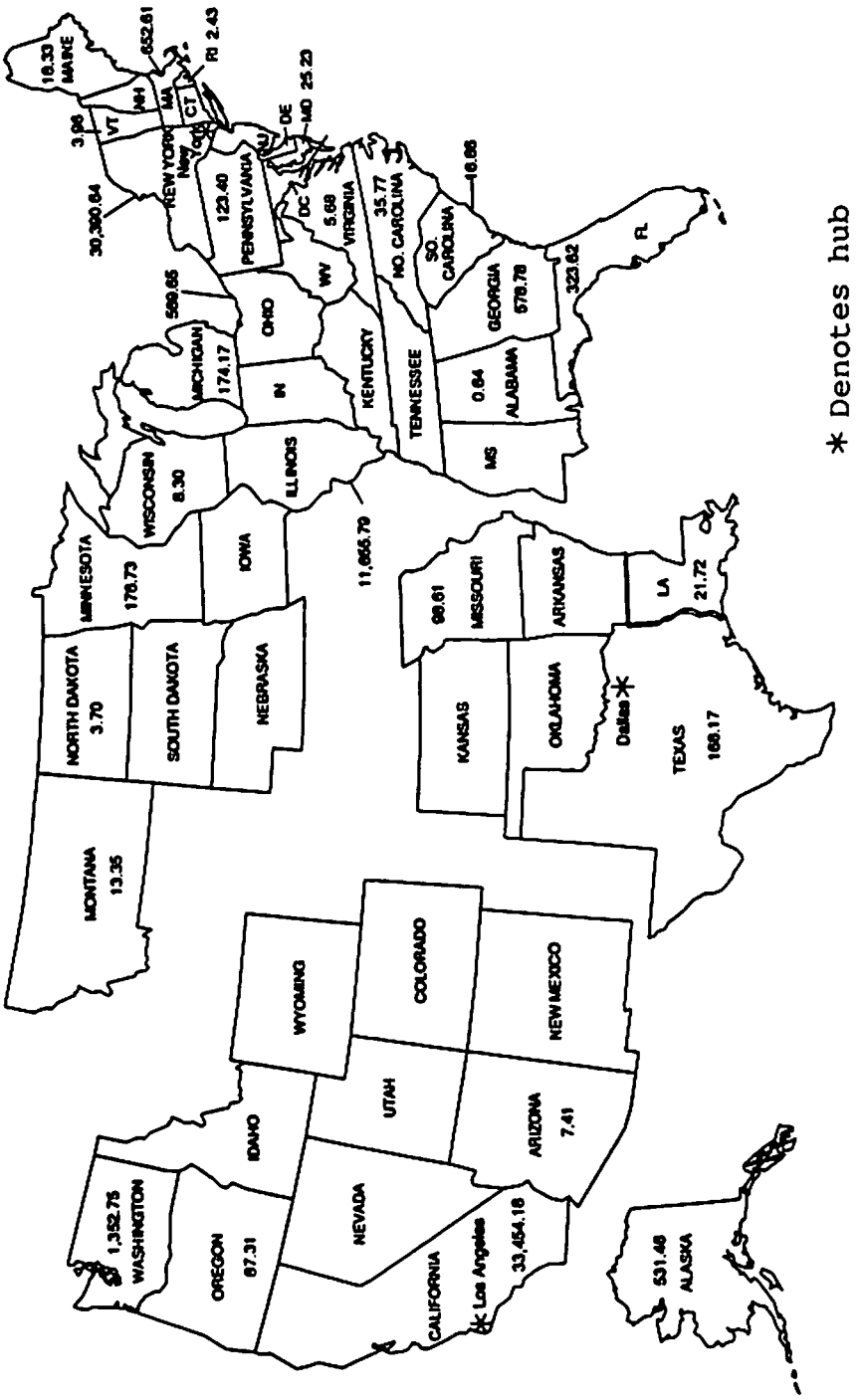

Figure 3. Import Volumes Using the Three-Hub Model, 1,000 kgms

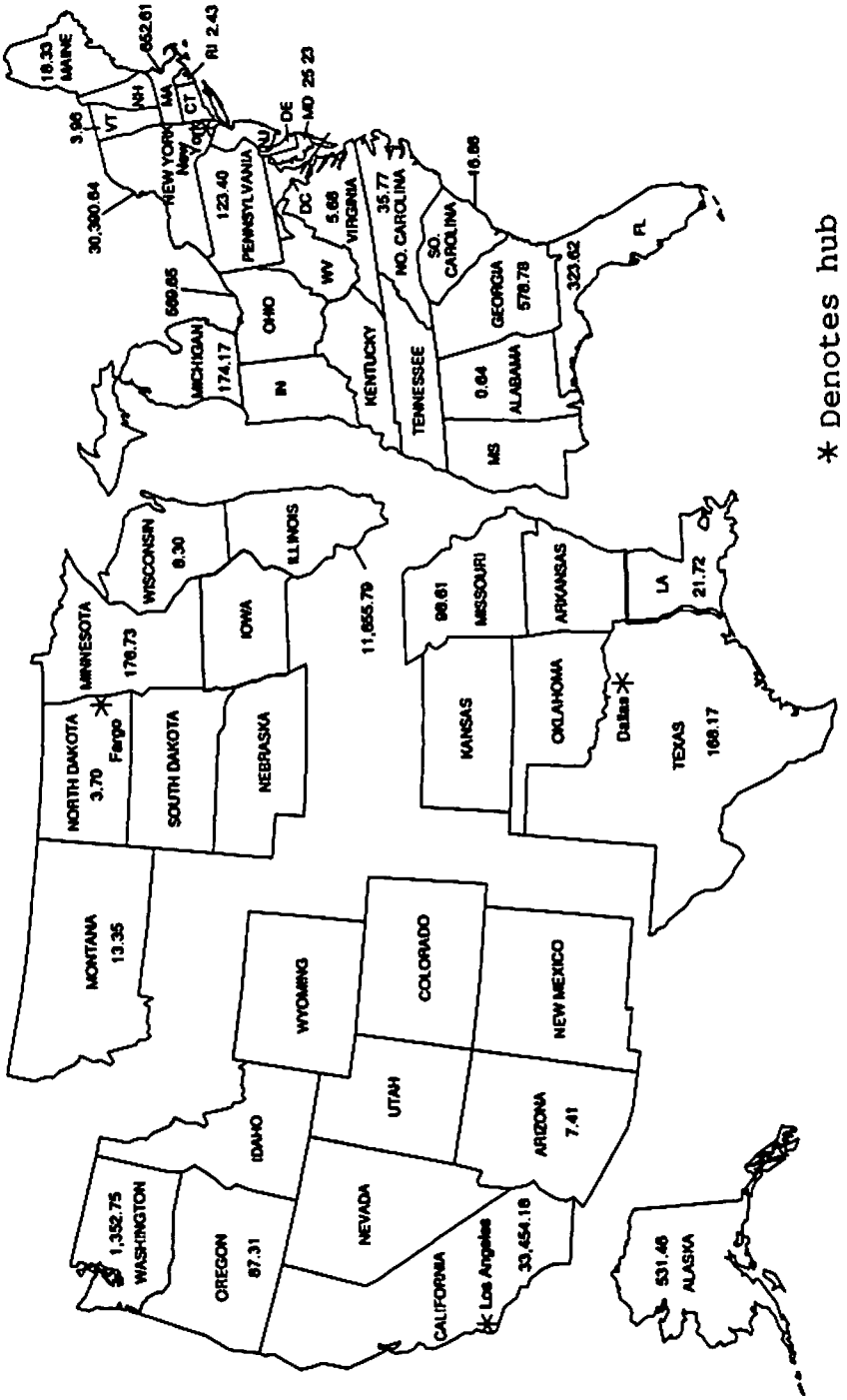

Figure 4. Import Volumes Using Fargo as a Hub, 1,000 kgms

Based on export volume, Fargo could support a total of 2,030 planes annually or 40 planes per week and an import volume of 130 planes annually or 2.5 per week.[1] This air cargo export volume could support a total of 8,288 truck shipments annually or 159 trucks per week. The air cargo import volume could support a total of 522 truck shipments annually or 10 trucks per week.[2] This analysis is based on an assumption that all airlines that serve Taiwan use Fargo as an air cargo hub. If only China Air uses Fargo as an air cargo hub, the volume handled at Fargo may be smaller, depending upon the air cargo market share of China Air. For instance, if China Air handles 10 percent of the total air cargo trade volume between these two countries, Fargo can handle about 220 planeloads of cargo annually or four planeloads per week.

Summary and Concluding Remarks

Two static transshipment models were used to determine the economic feasibility of locating an air cargo hub at Fargo. Both transportation models minimized trucking costs of cargo from (to) customs districts to (from) air cargo hubs and air cargo costs from (to) hubs to (from) Taiwan for exports and imports.

Total savings and market shares for both export and import models are presented by evaluating the feasibility of an air cargo hub at Fargo. The model excluding Fargo as a cargo hub results in $47 million in exports and $1.7 million in imports. Including Fargo as a cargo hub, using the New York rate, saves $2.73 million; using the Dallas rate saves $2.84 million; and using the Los Angeles rate saves $3.08 million. Fargo's market share for exports is 11.8 percent and for imports 14.8 percent. Fargo gains its entire market share for both exports and imports from New York in all models.

If all airlines that serve Taiwan use Fargo as an air cargo hub, Fargo could support 2,202 planes annually or 42 planes per week. This is equivalent to 8,910 truckloads annually or 169 truckloads per week. However, the volume handled at Fargo would be smaller if only China Air uses Fargo as its air cargo hub.

The results of this study are based on logistics for receiving and distributing cargo between the hub and final destinations or origins. Operating and investment costs are assumed to be equal for all hubs. Fargo's advantage would increase under the assumption that its investment and operating costs would be lower than existing hubs. This would increase the

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[1]Based on a 747 freighter carrying 100 tons.

[2]Based on 50,000 pound truckload.

total cost savings to the industry. Less air and ground traffic congestion at a Fargo facility could lower operating costs.

Further study should determine operating and investment costs for an air cargo facility. The analysis should determine the cargo volume which would take advantage of economies of scale and thereby minimize per unit operating costs. The potential economic impact should also be calculated based on potential employment opportunities generated by the air cargo facility.

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