1991

The upholstered, wood household furniture industry in North America: A spatial equilibrium analysis

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Published by the Department of Information Services, Division of Agriculture, Forestry, and Veterinary Medicine, Mississippi State University. Edited by Keith H. Remy, Publications Coordinator. Cover designed by Mary Frances Dillard, Artist.

Preface

Factors influencing the location of the upholstered, wood household furniture industry in North America are undergoing many changes. This publication presents a linear programming approach to determining furniture shipment patterns that minimize the combined costs of production and transportation. Modifications of the base model attempt to forecast possible shifts in the optimal distribution during the next 5 to 10 years.

The East South Central region of the United States is well-poised to increase its role in the North American market. Comparative advantages will allow this region to increase market area as manufacturing and transportation costs increase. Mexico also has the potential to capture a larger share of the U.S. market as the population moves westward, away from the established household furniture production regions in the eastern United States.

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Introduction

Upholstered, wood household furniture production has become an increasingly important part of total furniture production in the United States. From 1982 to 1987, employment in the upholstered furniture industry grew 16 percent, and in 1987, the industry's 82,100 employees represented about 30 percent of U.S. household furniture industry employment (USDC Bureau of the Census 1990). Over the same 5-year period, value added for the upholstered furniture industry increased by 52 percent to more than $2.6 billion.[1]

While the 1980's were prosperous for the U.S. upholstered furniture industry, many changes are currently occurring that relate to furniture production or supply, as well as to consumption, or demand. Influences of the baby-boom generation, for example, provide examples of changes that are occurring in furniture demand. One-third of the U.S. population is between the ages of 25 and 44—ages where major consumption decisions are made. More than one-half of the consumers in this age group own their own homes and many have two incomes (Standard and Poor's 1988). In the 1990's, therefore, demand for higher quality household furniture should be significantly higher than in the 1980's.

Other changes, particularly those that relate to production, have the potential to geographically shift the furniture industry's location within North America. Federal regulations, varying state laws, and changing foreign trade agreements are examples of production-related factors that are becoming extremely important in the competitiveness of furniture producers in different regions of the United States, Canada, and Mexico. An increased awareness of the environment's limited ability to absorb waste in the United States, for example, has resulted in stricter air quality regulations, particularly in California (Bullard 1989). Wood furniture producers in the Los Angeles area are currently experiencing the strictest air quality regulations, and due to the high cost of meeting emissions requirements, many wood products producers are moving their manufacturing facilities outside of California (Herrin 1989). Movement of production facilities within the U.S. is only a short-term solution, however. As the Environmental Protection Agency (EPA) adopts nationwide laws, firms may be looking for possible locations in Mexico or other countries.

Hourly wages and Worker's Compensation are also extremely important factors when firms compare regions for relocation or expansion; hourly wages in the United States range from $9 to $19, for example, while in Mexico they are $.95 to $1.50 per hour. Also, while California firms in the furniture industry pay $21 in Worker's Compensation for every $100 paid in wages, North Carolina firms pay only $1.90 (Evans 1989a).

Another production-related factor that has the potential for change in furniture industry location is the recent "Free-Trade Agreement" between the United States and Canada. Tariffs on furniture shipped between the United States and Canada will be completely phased out by 1993. In the past, Canadian tariffs on household furniture ranged from 12.6 to 15.3 percent while U.S. tariffs ranged from 2.5 to 9.6 percent (USDC International Trade Administration 1989). Some Canadian manufacturers are either building new plants in the United States or purchasing existing plants in an attempt to "reduce freight charges, hedge against exchange-rate fluctuations, and serve our dealers better" (James 1989).

Objective

Given the many changes occurring in the manufacturing environment in the 1990's, the overall objective of this study was to assess the potential for geographic shifts in the manufacturing of upholstered, wood household furniture in the U.S., Canada, and Mexico. Specific objectives were to: (1) identify all geographic areas that currently are important producers of upholstered, wood household furniture, (2) identify areas where demand is currently

[1] Throughout this report, "furniture and fixtures" refers to Standard Industrial Classification (SIC) 25, the "household furniture industry" is SIC 251, and "upholstered, wood household furniture" refers to SIC 2512. In the present report, therefore, references to "upholstered" furniture do not include mattresses or dual-purpose sleep furniture, SIC 2515 (see Office of Management and Budget 1987).

concentrated, and (3) investigate potential shifts in the geographic distribution of production during the next 5 to 10 years.

Literature Review

Two of the specific objectives involved determining areas that are currently production centers and areas that have the potential to become production centers. Regional analysis is the study of the regional growth and distribution of industries. Researchers have used several approaches to analyze patterns of industrial growth; two of the most important approaches are locational analysis and spatial equilibrium analysis.

Locational Analysis

Different industries locate and prosper in specific geographic areas for a variety of reasons. The proximity and availability of specific types of raw materials have had major impacts on where many industries have developed. The early softwood plywood industry, for example, was concentrated in the Pacific Northwest because of a preference for large diameter Douglas-fir as the raw material. However, when technology was developed that allowed southern pine timber to be used in plywood production, many mills became established in the South (Dane 1970).

Transportation costs have long been recognized in location theory as important determinants of industrial location (Hopkins 1972). Transportation costs of both the raw materials and the final product must be evaluated to determine the location that minimizes total transportation costs. Wood-based industries, for example, often incur relatively high transportation costs for raw materials because of the relatively high green weight of timber products. After processing and drying, however, shipping weights for most forest products are much lower. This generally favors locating wood-based processing plants near raw materials sources. Products like upholstered furniture, meanwhile, are relatively bulky, and distance to final demand centers is an important consideration in total transportation costs.

The availability of a labor pool may also have a major influence on location decisions. A firm benefits by locating in an area where firms in the same industry or very similar industries already exist—an important "economy of agglomeration" (Moomaw 1988). Firms locating in such regions benefit from the fact that a skilled labor force is already present, and higher labor costs due to competition are generally offset by reduced training times for workers.

Lower wage rates are an obvious locational advantage for certain states and regions of North America. An analysis in Indiana, for example, found that manufacturing employment in rural nonmetropolitan areas grew faster than in metropolitan areas during the 1970's (Haynes et al. 1987). It is suggested that this may have been due to a rural low wage advantage. Furniture production in Mexico is increasing due to lower wage rates than in the United States. Location based on wage rates may only be a short term cost reduction, however, since labor prices typically increase as more firms move into an area to capitalize on the low wage rates.

The general issue of labor, of course, is much broader than wage rates alone. High technology firms employing many professional and technical workers may find it favorable to locate near a major university complex (Brown et al. 1980). The educational and recreational opportunities provided by the university will also aid in recruiting employees. High technology firms are also relatively free to move about since they are not tied to a resource base. Proximity to major research and development centers or areas where employees can find attractive housing, schools, and recreational facilities is playing a major role in locational decisions (Office of Technology Assessment 1988).

Industries often arise in order to serve other industries. An example is the U.S. auto parts industry, which serves the auto assembly industry (Glasmeier et al. 1987). Firms which produce the original equipment for autos are highly competitive, have narrow profit margins, and work very closely with the assembly plant. They are generally located close to the assembly plants, thereby decreasing transportation costs and shipping time on orders. The aftermarket producers are less dependent on the major auto producers, however, and operate in a more competitive market. Location is therefore more critical, and these facilities generally locate nearer to their final market, the public.

In the United States, the federal government affects every industrial plant location decision (Will 1964). Initial or partial government ownership of many firms set up to supply defense-related goods has determined where industries such as aluminum and rubber production have developed. Regional development plans of the U.S. federal government also influence industrial location by providing incentives for firms to locate iu areas experiencing economic hardships.

The policies and regulations of state governments also affect industry location decisions. The growing market for furniture in California and the attendant increasing production in Nevada serve as an example. The California market comprises 14 percent of the total U.S. market for furniture and home furnishings—a larger share than 23 states and

Washington, D.C. combined (Bullard 1990). Many large furniture companies are therefore locating plants in the West to better serve the California market. More to the point, many are locating in Nevada because of lower production costs and the relative proximity to population centers in California. An important factor in Nevada's lower costs is the state's tax system—the state has no corporate income tax, no inventory tax, no personal income tax, no franchise tax, and no inheritance or gift tax (Anonymous 1990a).

Labor laws also differ between states, regions, and countries. This may affect how much a plant spends on Worker's Compensation or required employee safety, for example. More industrialized areas also tend to enforce stricter pollution laws, which can greatly increase the setup and operating costs for new manufacturing facilities.

Spatial Equilibrium Analysis

Spatial economics is concerned with the geographic allocation of resources and the location of economic activity (Arnott 1987). This allocation is largely the result of the uneven distribution of natural resources, including natural transport routes and climate. The purely economic factors that determine the spatial distribution of an economy can be grouped as: (1) external and internal economies, (2) the demand for land inputs, and (3) transport costs (Dean et al. 1970). Factors such as state laws and regulations that affect optimal location of the furniture industry were discussed previously. This section looks at methods that have been used to forecast geographic shifts in the distribution of manufacturing, with examples from various forest industries.

The transportation algorithm of linear programming can be used in spatial analyses. The technique provides the minimum distributional costs of transporting goods from a number of sources to a number of destinations. A more complete picture can be developed by looking at the costs of transporting the raw materials to the mill, the costs of manufacturing, and the transportation costs of the product from the mill to the final market. A spatial equilibrium analysis of the southern Appalachian hardwood lumber-using industry was done in this manner (Davis et al. 1972). The study area was divided into 22 regions and costs were estimated for intermediate processing, shipping the raw materials, and shipping the final products through the spatial network. The most cost-efficient regions for production were then identified.

Other linear programming techniques have also been used in determining optimal plant location. Mixed-integer programming lends itself well to this application by recognizing that a plant either is or is not located on a site. The technique does not consider non-integer plant numbers. Mixed-integer programming has been used to identify the optimal location of an oriented strandboard (OSB) plant in Alabama (McCauley et al. 1990). Ten sites within Alabama were included as possible mill locations. Costs of transporting raw materials from several different supply regions to the sites were added to the costs of shipping the OSB to various demand points to determine those sites with the lowest total costs. The study then examined how changes in factors such as wood costs, stumpage availability, and market distance affected the location decision. The optimal mill location was defined as the site that minimized the sum of wood procurement costs and OSB shipping costs from the mill to the product markets.

Future changes in industry location depend on the current distribution of the industry, but not all previous distributions. Markov chain models depend only on the present state of the system or on the immediately preceding state, not on how that state was achieved. Consequently, Markov chains can be used to forecast changes in the spatial distribution of an industry. These methods were used to forecast changes in the size and location of the wood products industry in northwestern California (Cullen 1985). Northwestern California was divided into seven regions and the number and size of wood products firms in each region was determined for 1966 and 1976. Distributional changes in the industry resulted from the relocation of capital and varying rates of plant arrival and departure within a region. By looking at the actual number of plants and the proportion of plants in each region in 1976 compared to 1966, forecasts were made of future shifts in the geographic distribution.

Methods

The transportation algorithm of linear programming was used to evaluate optimal patterns of upholstered furniture production and shipments in North America. The model was designed to estimate the overall pattern of shipments between production regions and consumption regions that minimized the combined costs of production and transportation. This section will explain how the source and destination regions were determined and how the relevant costs were calculated.

Regions

Twelve regions were used to represent production and twelve regions were defined for consumption of

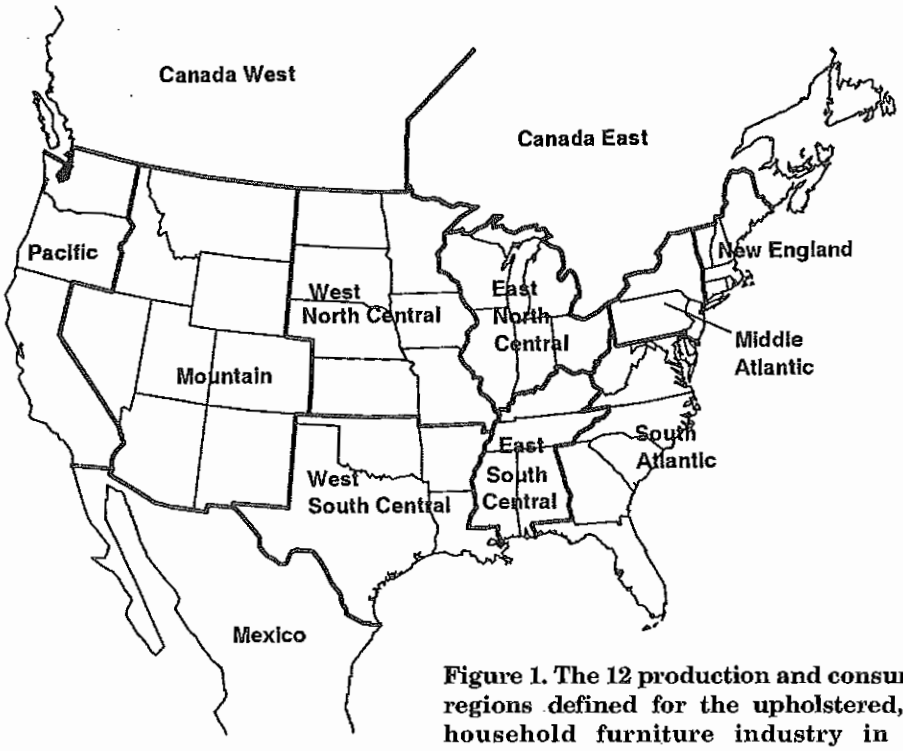

Figure 1. The 12 production and consumption regions defined for the upholstered, wood household furniture industry in North America.

upholstered furniture in North America (Figure 1).[2] The nine regions of the U.S. Department of Commerce, Bureau of the Census, were used to represent production and consumption regions for the United States. Canada was divided into two regions, with the division occurring along the Manitoba-Ontario border; this is near the middle of the country and passes through a relatively unpopulated area, so it does not divide a major population center. Mexico was included as a single region since the only area of concern is the border region, the region of the country where the furniture maquiladora firms are located (National Institute of Statistics et al. 1988).[3] The maquiladoras are the only furniture plants in Mexico that affect the U.S. furniture market; furniture plants in the interior of Mexico are entirely oriented to the country's domestic market (Evans 1990).

Furniture production and consumption centroids were identified within each of the 12 regions, and the nearest city was later used in determining trucking and rail costs for each region (Figures 2 and 3). For the nine U.S. regions, centroids were established using a computerized mapping program (SAS Institute Inc. 1985). The program weights the geographic center of each region based on a user-defined criterion. For U.S. production centroids, the number of SIC 2512 employees in each state in 1987 was used; for consumption centroids, retail sales of furniture stores in each state in 1987 were used. Numbers of employees by state were obtained from the *1987 Census of Manufactures* (USDC Bureau of the Census 1990), and retail sales were obtained from the *1987 Census of Retail Trade* (USDC Bureau of the Census 1989b). Since U.S. data for 1987 were readily available, 1987 was used as the base year for the initial model.

Upholstered furniture production and consumption centroids for Canada were also located by using furniture production employees and retail sales in each province as weights (Statistics Canada 1989). These centroids were visually located and were biased towards the U.S.-Canadian border since weighting the geographic center of the provinces would have placed the centroid too far north to be truly representative.

For Mexico, Tijuana was used as the centroid for both production and consumption. Most of the fur-

[2] Alaska, the Yukon, and the Northwest Territories were not included in the analysis. The overall impact of these regions on the relative location of the upholstered furniture industry in North America was considered to be minimal.

[3] A maquiladora is a U.S.-owned plant built in Mexico to assemble U.S.-made parts. When the finished product is shipped to the United States, the manufacturing company is only taxed on the value added in Mexico.

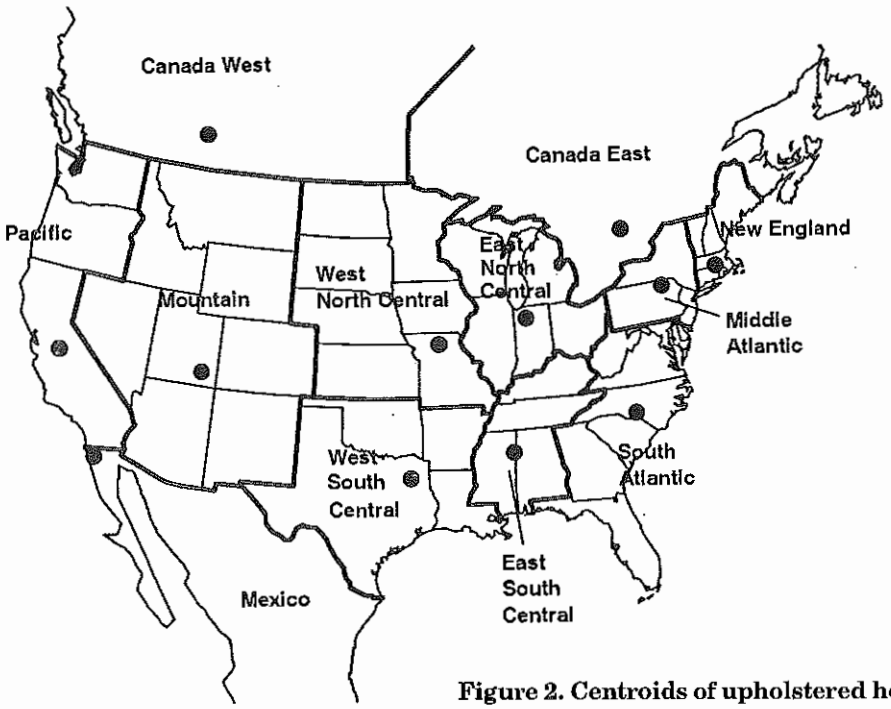

Figure 2. Centroids of upholstered household furniture production, based on regional employment.

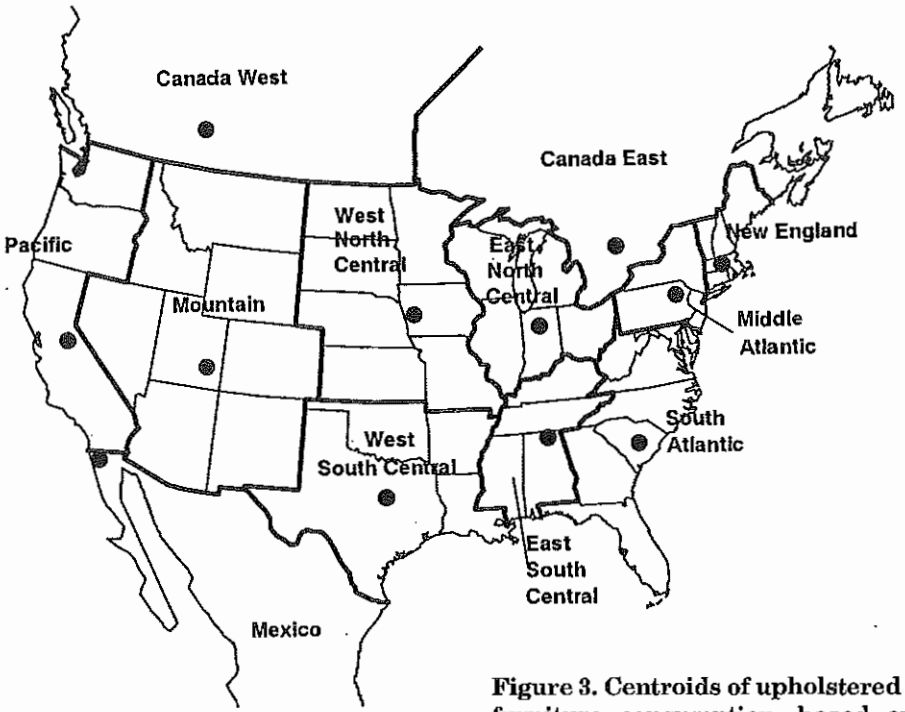

Figure 3. Centroids of upholstered household furniture consumption, based on regional retail sales.

niture maquiladoras are located in Tijuana since many of the firms were originally located in California. The consumption centroid was also located in Tijuana because of the influx of Mexican laborers working at these maquiladora plants.

Production Cost Indices

Analyzing the total dollar costs of manufacturing in each of the 12 regions was beyond the scope of this study since many of the actual costs would have been difficult to determine. For this reason, *The Seventh Annual Study of the General Manufacturing Climates of the Forty-Eight Contiguous States of America* was selected as an index of production costs in the United States (GrantThornton 1986). This specific index was selected because states traditionally associated with furniture production score quite well with this index (Kunkel 1989). The index includes 22 factors that are important to industries such as furniture manufacturing.[4] The seventh annual index report (1986) was used since more recent reports use a combination of factors that are less representative of furniture manufacturing costs.

The GrantThornton index ranks U.S. states by their national score, which is a composite of their scores on the 22 separate factors—the higher the score, the better the state's business "climate" ranking. For the present study, the nine U.S. regions were assigned a relative, composite score by averaging the GrantThornton indexes for states in the region and by then assigning the average of all U.S. regions a value of 1.

Since GrantThornton scores apply only to U.S. states, Canadian and Mexican production cost indices were determined relative to the U.S. regional indices. *The Nine Nations of North America* (Garreau 1981) was used as a basis for comparisons between the United States and Canada. The borders of Garreau's "nations" cross the existing political boundaries of North America, and the Canadian regions are therefore grouped with parts of the United States. Since the costs of production in Canada are similar to those in the U.S. (Industry Science and Technology Canada 1988), cost indices for the two Canadian regions were based on the GrantThornton scores of U.S. states included in the "nations" that cross the U.S.-Canadian border.

The Nine Nations of North America could not be used to estimate a production cost index for Mexico, however, because costs of production vary greatly between the countries. Primary factors for Mexico are lower wage rates and the lack of pollution restrictions. Realistically, after accounting for other costs, manufacturers in Mexico can capture 75 percent of the 80 percent labor differential (Evans 1989b). This information was used in calculating the production cost index for Mexico.

The production cost indices used in constructing the model are given in Table 1. Derivation of the other information contained in the Table will be explained in the following sections.

Transportation Cost Indices

Transportation costs were estimated as a weighted average of truck and railroad shipping costs. The percent shipped by each method in the U.S. was obtained from the *1977 Census of Transportation* (USDC Bureau of the Census 1981) and updated with *Railroad Freight Traffic Flows 1990* (US Department of Transportation 1980). Canadian shipment information was received from Canada Pacific Rail.[5] Shipment patterns for Mexican furniture were assumed to be the same as those of the Pacific region.

Trucking costs were provided by P*I*E Nationwide, an authorized new furniture hauler in the United States and for loads into or out of Canada.[6] Trucking costs for shipments within Canada were obtained from Schenker Transport.[7] United States rates were used for shipments originating in Tijuana since it is near the border. Any additional costs incurred at the border were included in the Mexican manufacturing index. Railroad rates for the U.S. were provided by the Tennessee Valley Authority.[8] These rates apply to the minimum available car weight for any given route, due to the high bulk to weight ratio of upholstered furniture. Rail transport rates in Canada were provided by Canada Pacific Rail.[9] As with trucking, U.S. rail rates were applied to furniture shipped by rail from Tijuana.

The weighted transportation costs for each route were indexed the same way as the production cost in-

[4] The 22 factors used in the GrantThornton index are Wages, Unionization, Energy Costs, Workers' Compesation Insurance (WCI), Taxes, Manhours Lost, Value Added, Change in Wages, Unemployment Compensation (UC) Benefits, Change in Taxes, Change in Unionization, Expenditure vs. Revenue Growth, High School Edncated Adults, UC Net Worth, Maximum WCI Payment, Environmental Control, Voc-Ed Enrollment, Debt, Hours Worked, Population Changes, Population Density, and Welfare Expenditure.

[5] Personal communication with Jennifer Allen, CP Rail Marketing Representative, August 28, 1990.

[6] Personal communication with Bette Mills, Rating Services, P*I*E Nationwide, July 11, 1990.

[7] Personal communication with Dennis Moreau, Schenker Transport, September 10, 1990.

[8] Personal communication with Ron Black, Transportation Specialist, Tennessee Valley Authority, August 1, 1990.

[9] Personal communication with Vivian Meslage, CP Rail Pricing Department, August, 28, 1990.

Table 1. Indices for transportation costs and regional upholstered furniture production and consumption percentages. Cost indices were combined to derive the technical coefficients of the transportation model.

	C.E.	C.W.	Pac.	Mtn.	W.N.C.	W.S.C.	E.N.C.	E.S.C.	N.E.	M.A.	S.A.	Mex.	% Prod.
C.E.	.13	.59	1.97	1.82	1.47	1.57	.90	1.19	.93	.81	1.24	1.97	8.35
C.W.	.59	.00	1.28	1.11	1.39	1.77	1.64	1.63	1.78	1.74	1.77	1.28	1.14
Pac.	1.94	1.29	.17	.70	1.04	1.02	1.20	1.15	1.47	1.38	1.29	.34	10.64
Mtn.	1.84	1.15	.76	.00	.85	.90	1.03	1.08	1.31	1.23	1.19	.76	1.38
W.N.C.	1.21	1.45	1.06	.84	.52	.69	.56	.50	.83	.76	.68	1.06	4.02
W.S.C.	1.47	1.67	1.01	.83	.82	.15	.79	.52	1.08	.97	.70	1.01	3.65
E.N.C.	.83	1.66	1.22	1.02	.78	.85	.07	.48	.76	.68	.56	1.22	5.03
E.S.C.	1.26	1.73	1.23	1.05	.67	.57	.52	.35	.81	.72	.55	1.23	22.48
N.E.	1.00	1.87	1.31	1.31	.98	1.19	.77	.75	.00	.56	.68	1.31	.99
M.A.	.81	1.76	1.40	1.22	.88	1.17	.66	.65	.54	.00	.56	1.40	3.60
S.A.	1.08	1.70	1.37	1.14	.83	.77	.56	.52	.55	.50	.32	1.37	35.00
Mex.	1.94	1.29	.34	.70	1.04	1.02	1.20	1.15	1.47	1.38	1.29	.00	3.72
% Cons.	14.51	5.43	11.23	4.19	5.33	7.03	12.29	4.35	4.76	12.60	17.25	1.03	100.00
Prod. Cost Index	1.93	.91	1.09	.84	.62	.81	2.06	.70	1.03	1.08	.75	.40	

Regions are illustrated in Figure 1. The abbreviations above are Canada East (C.E.), Canada West (C.W.), Pacific (Pac.), Mountain (Mtn.), West North Central (W.N.C.), West South Central (W.S.C.), East North Central(E.N.C.), East South Central (E.S.C.), New England (N.E.), Middle Atlantic (M.A.), South Atlantic (S.A.), and Mexico (Mex.).

dices. This was done for every combination of production and consumption regions, resulting in 144 transportation indices (Table 1).

Combined Index

The final step in representing costs was to combine the production and consumption indices into an overall index representing each region's relative costs of manufacturing and shipping to other regions. Rubin and Zorn (1986) state that transportation costs comprise 22.92 percent of total costs in the furniture and fixtures industry, and this percentage was used to determine a weighted average of the two indices for each region. Each production index was combined with 12 separate transportation indices, depending on where the furniture was being shipped. The resulting 12-by-12 matrix is the technical coefficients table of the transportation model.

Production Data

Furniture production in each region was represented as a percentage of the total production in North America in 1987. Since actual production data on a directly comparable basis for all three countries was not available, the number of upholstered household furniture employees in each region was used as a proxy for furniture production. The relationship between the number of employees and level of production was therefore assumed to be identical between regions. The level of technology throughout North America was assumed equal since "no furniture producer has an absolute advantage over another for any long period" (USDC International Trade Administration 1985).

State-level employment estimates for the United States for SIC 2512 were obtained from the *1987 Census of Manufactures* (USDC Bureau of the Census 1990). For Canada, the number of furniture and fixtures employees in each province (from Statistics Canada 1989) was adjusted to reflect the number of employees in the upholstered furniture industry only (Industry Science and Technology Canada 1988). For Mexico, the *1976 Censo Industrial* (Direccion General de Estadistica 1979) was the most recent information available. This report lists the number of upholstered furniture employees in each federal district. Only the six federal districts along the border were included in the study, however, since this is where the maquiladora plants are located. Each of the regional employment figures was divided into the total employment to arrive at a regional production percentage (Table 1 and Figure 4).

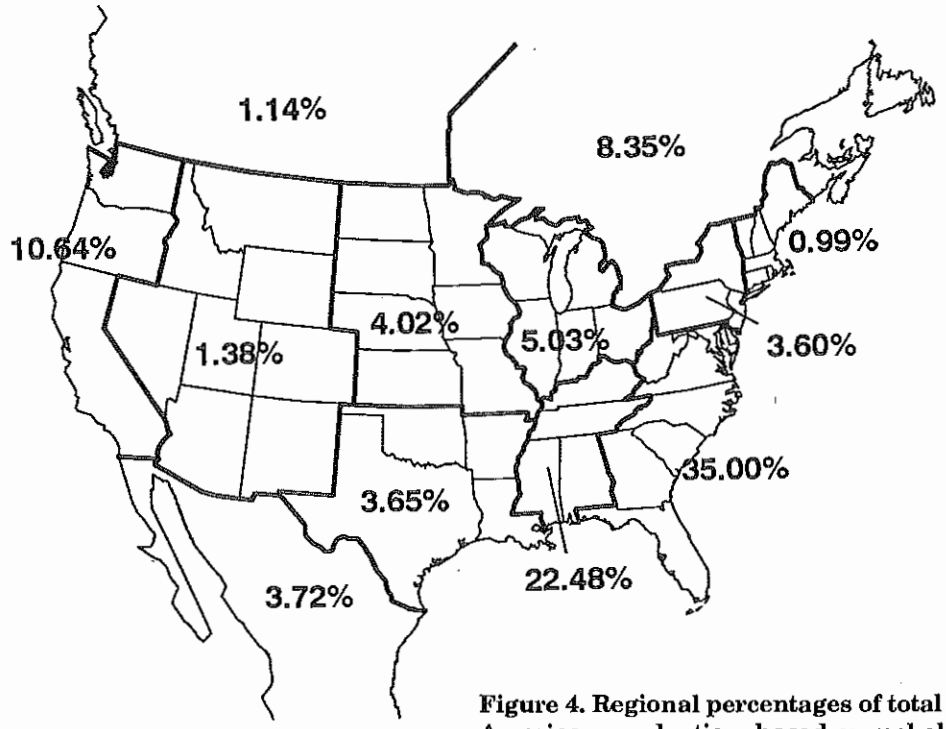

Figure 4. Regional percentages of total North American production, based on upholstered household furniture employment levels.

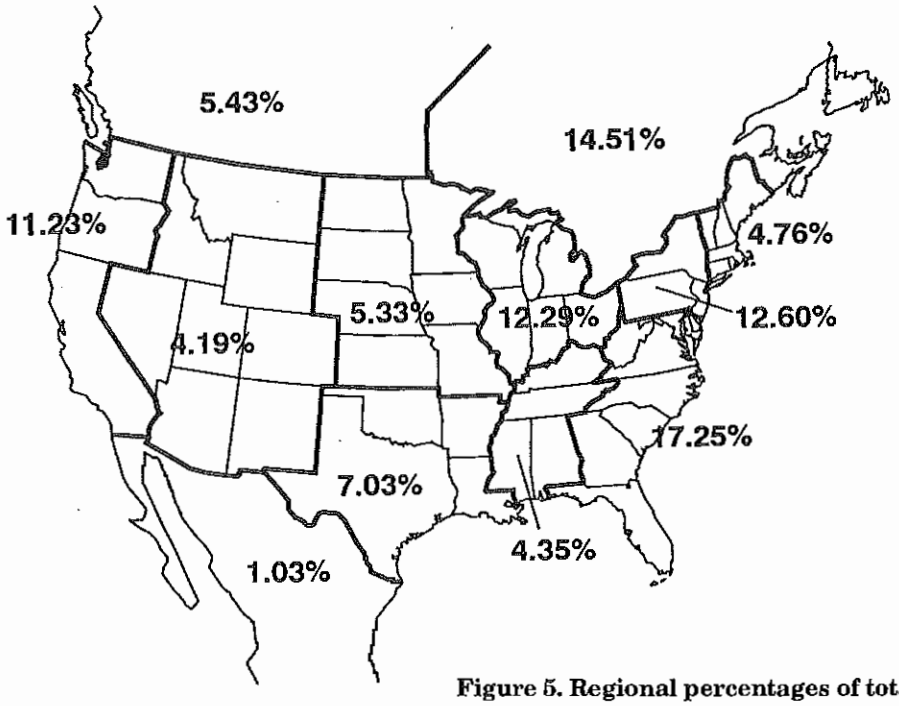

Figure 5. Regional percentages of total North American consumption, based on levels of retail furniture sales.

Consumption Data

Consumption estimates for U.S. states were obtained for SIC 2512 from the *1987 Census of Retail Trade* (USDC Bureau of the Census 1989a), and were reduced to reflect import percentages reported by the USDC International Trade Administration (1989). Canadian consumption estimates were obtained from *Canada Yearbook 1990* (Statistics Canada 1989) and were adjusted to reflect import percentages reported by Industry, Science and Technology Canada (1988). For Mexico, furniture sales were estimated in the border districts with information from the Direccion General de Estadistica (1980). Since Canadian and Mexican sales figures were not for 1987, the sales estimates were inflated using the consumer price index for household furnishings (USDC Bureau of Economic Analysis 1989).

As with the production values, upholstered household furniture consumption estimates for each region were expressed as a percentage of all sales for North America (Table 1 and Figure 5). Percentages allow the model results to be easily examined, and they also obviate the need for assumptions about production estimates (such as dollar value of shipments) versus retail (marked up) consumption estimates.

Results

Factors affecting the costs of production and transportation in various North American industries are constantly changing. New plants are being constructed and others are closing down, changing the regional production percentages; changing demographics and furniture consumption patterns continually influence regional consumption percentages. Several of the initial model parameters and assumptions were altered to help assess the potential changes in the geographic distribution of production in North America. Each of six scenarios are presented separately, although in reality several of these could be acting simultaneously on the industry in the 1990's.

Upholstered furniture industry shipments resulting from the initial model specification are shown in Figure 6.[10] Each number is a percent of all upholstered furniture produced on the continent, and since this is a closed system, it is also the percent of all consumption. The North American upholstered furniture market is still largely insulated from foreign competition. The ratio of imports to upholstered furniture apparent consumption was 0.2 percent in 1983, due in part to the high risk of fabric destruction and the high volume-to-weight ratio (USDC International Trade Administration 1985).

The South Atlantic region produces the largest amount of furniture and, in the least-cost solution, supplies furniture to seven of the twelve North American regions. One reason that the South Atlantic region can ship all of its furniture is that it is more efficient for them to consume furniture shipped from the East South Central region than to consume their own furniture. Since data are not available on industry shipments by original source and final destination, actual shipments are obviously somewhat different from those presented in Figure 6. The initial model results demonstrate, however, that if production and transportation costs are truly minimized, and if all regions produced perfectly substitutable products, a significant amount of interregional substitution would take place in the industry. The East South Central region is the second largest production region, and for the most part is shown supplying the South Atlantic region.

Increasing Transportation Costs

Rising fuel costs are increasing the cost of furniture transportation, and as a result, the transportation component of total costs may therefore increase above the 22.92 percent used in the base model. To assess the potential effects of rising relative costs for transportation, the transportation index was increased by 10, 25, and 50 percent. The 10 percent increase resulted in a distribution different from that

Table 2. The effects of a 10 percent increase in transportation costs on U.S. South Atlantic and East South Central shipment percentages.

Source	Destination	Base Model	Increased Costs
South Atlantic	Canada East	10.45	4.98
	Mountain	0.71	–
	W.N. Central	1.31	–
	E.N. Central	7.26	–
	E.S. Central	2.50	–
	New England	3.77	3.77
	M. Atlantic	9.00	9.00
	S. Atlantic	–	17.25
East South Central	Canada East	–	1.18
	Mountain	–	0.98
	W.N. Central	–	5.33
	W.S. Central	3.38	3.38
	E.N. Central	–	7.26
	E.S. Central	1.85	4.35
	S. Atlantic	17.25	–

[10] A transportation algorithm entitled TRANS (developed by Wes Wolfe at Mississippi State University) was used to generate the solution for the initial model and all of the scenarios.

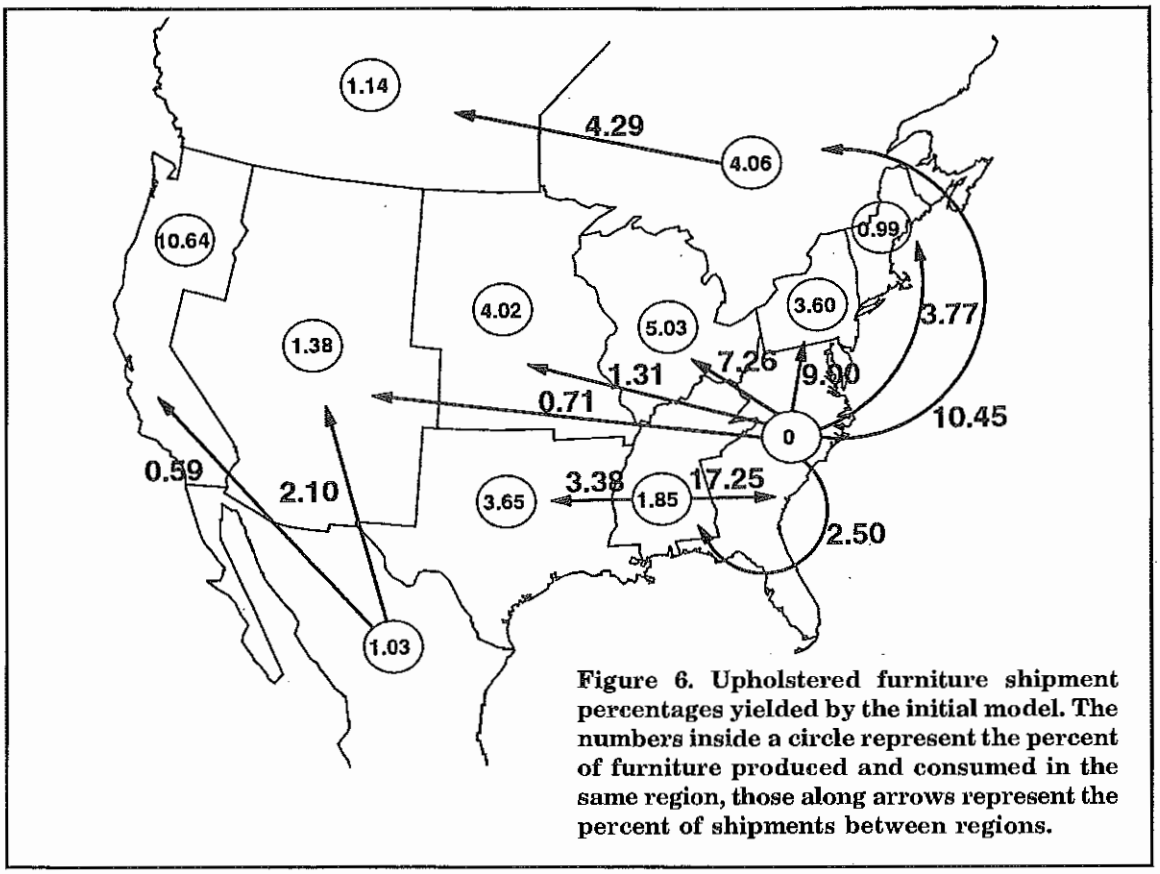

Figure 6. Upholstered furniture shipment percentages yielded by the initial model. The numbers inside a circle represent the percent of furniture produced and consumed in the same region, those along arrows represent the percent of shipments between regions.

of the base model (Table 2). This distribution did not change further when the transportation index was increased by 25 and 50 percent. This suggests that the East South Central region has a transportation advantage over the South Atlantic to the central regions of the United States. The South Atlantic region is shown as most efficiently serving the furniture markets along the East Coast and in Eastern Canada. The stability of this distribution, as transportation costs increase, reveals a potential comparative advantage for the East South Central region that may prove to be extremely important in the 1990's. With rising fuel and transportation costs, even as low as 10 percent, this region becomes the most efficient long-term supplier to central regions of the United States.

Diminishing Transportation Advantage

Seventy-six percent of all U.S. furniture sales in 1987 were in the eastern half of the United States (Bullard 1990), giving producers in this area a comparative transportation advantage over producers in other parts of the country. Recent economic growth, however, is occurring away from the midwestern and eastern metropolitan areas. Rather, the western and southwestern states are growing rapidly (USDC International Trade Administration 1985). As a result, furniture producers in the southeastern United States may lose some of their relative advantage in reaching U.S. markets. To reflect the potential effects of this change on the U.S. industry, the transportation component of the index was reduced to 10 percent. As a result, the transportation component of the total index will be less significant in determining the least-cost distribution, making any current transportation advantages less significant.

With diminished importance on transportation, the least-cost pattern of upholstered household furniture shipments is very similar to that resulting from increased transportation costs (Table 3). The South Atlantic region serves the East Coast and eastern Canada while the East South Central region ships to the central portion of the United States. As the transportation index becomes less significant, the South Atlantic region concentrates shipments to eastern markets, suggesting that the optimal distribution from this region is sensitive to any decrease in the transportation advantage. The East South Central region, while not as heavily affected by the decreasing importance of transportation costs, still concentrates shipments to nearby regions. The model does not show the southeastern regions supplying the

western states as a result of this modification. Rather, the East South Central region supplies the demand created when the West North Central region ships to the western states.

Increasing Labor Costs

Low labor costs are a producer's major long-term advantage in a labor-intensive industry such as furniture production. Wages of production workers in North Carolina, Virginia, Tennessee, and Mississippi are below the national average, but in the last 15 to 20 years manufacturing wages in these states have risen as a percent of the U.S. average, reflecting greater competition for labor in the industry (USDC International Trade Administration 1985). To model the effects of increasing wages, the manufacturing indices for the South Atlantic and East South Central regions were increased by 10, 25, and 50 percent.

Increased manufacturing costs significantly change the most efficient production and distribution of upholstered household furniture in North America (Table 4). Changes for the 10 percent increase only are shown iu Table 4 since the distributions for the increases of 10 and 25 percent were identical, and only a slight change occurred with a 50 percent increase. With higher manufacturing costs in the southeastern regions, the most efficient distribution is the same as the one which occurred as a result of increased transportation costs. This result is in part due to the assumption of constant production and consumption percentages in the scenarios examined thus far. When manufacturing costs were increased to 50 percent, the least-cost pattern of shipments included the East South Central region re-routing its eastern Canada shipments to the Middle Atlantic region, and the South Atlantic region sending a portion of its Middle Atlantic shipments into Canada East. This scenario, therefore, paints much the same picture as those summarized previously. The East South Central region is the most efficient producer for the central portion of the U.S. while the South Atlantic best serves the eastern U.S. and eastern Canada.

Decreasing Canadian Employment

The Free Trade Agreement between the United States and Canada went into effect January 1, 1989. Tariffs are to be reduced one-fifth yearly until January 1, 1993, when they will be completely eliminated on both sides of the border (Bricel 1990). There has been concern that the increased competition will force some Canadian manufacturers out of business (Buchanan 1990), and in response to the changing manufacturing climate, some Canadian manufacturers are looking at either expanding their production into the United States, or closing their facilities and moving to the United States (James 1989).

Since the free trade agreement went into effect, an estimated 4,800 jobs have been lost in the Canadian furniture industry (Anonymous 1990b). For this analysis of decreased Canadian employment and production, the estimate was reduced to reflect the impact on upholstered furniture production employees only, using employment percentages from the *Industry Profile* for household furniture (Industry, Science and

Table 3. Changes in the optimal shipment pattern from the U.S. South Atlantic and East South Central regions based on a reduction in the transportation index.

Source	Destination	Base Model	Reduced Index
East South Central	W.N. Central	–	2.02
	W.S. Central	3.38	3.38
	E.N. Central	–	7.26
	E.S. Central	1.85	4.35
	M. Atlantic	–	5.47
	S. Atlantic	17.25	–
South Atlantic	Canada East	10.45	13.37
	Mountain	0.71	–
	W.N. Central	1.31	–
	E.N. Central	7.26	–
	E.S. Central	2.50	–
	New England	3.77	3.77
	M. Atlantic	9.00	0.61
	S. Atlantic	–	17.25

Table 4. Changes in the optimal distribution from the U.S. South Atlantic and East South Central regions based on a 10 percent increase in production costs in the East South Central and South Atlantic regions.

Source	Destination	Base Model	Cost Increase
East South Central	Canada East	–	1.18
	Mountain	–	0.98
	W.N. Central	–	5.33
	W.S. Central	3.38	3.38
	E.N. Central	–	7.26
	E.S. Central	1.85	4.35
	S. Atlantic	17.25	–
South Atlantic	Canada East	10.45	4.98
	Mountain	0.71	–
	W.N. Central	1.31	–
	E.N. Central	7.26	–
	E.S. Central	2.50	–
	New England	3.77	3.77
	M. Atlantic	9.00	9.00
	S. Atlantic	–	17.25

Technology Canada 1988). For this scenario, it was assumed that the upholstered furniture industry employment and production decrease in Canada, 1.75 percent of North America's capacity, would result in a comparable increase in the southeastern United States as suggested by James (1989) and Buchanan (1990).

Least-cost production and shipment patterns change significantly with changes in the production percentages between Canada and the southeastern United States (Table 5). As would be expected, more furniture would be shipped from the United States into Canada; also, rather than receiving all of their furniture from the South Atlantic region, as in the base model, the Canadian markets are served by the South Atlantic, East South Central, West North Central, and Mexico regions. This pattern of production and shipment is especially beneficial for the East South Central region since it allows producers in that region to serve many other regions, giving them a broad consumer base. Shipments are sent to Canada East, the West North Central region (which is shipping to Canada), the West South Central region, the East North Central region and the Mountain region (most efficiently served by Mexico in the base model).

Increasing Mexican Production

The upholstered furniture industry in the United States is losing some of the advantages that have insulated it from foreign competition. The diminishing transportation advantage has already been discussed. Three other advantages that are disappearing are: a superior product, productive and inexpensive labor, and a unique knowledge of the United States market (USDC International Trade Administration 1985). These advantages are being lost as the maquiladora program continues to expand in Mexico. Mexican quality is improving, Mexican production is increasing as labor is becoming experienced and technology improves, and other Mexican firms are gaining experience producing for United States companies (Evans 1990). The USDC International Trade Administration (1985) states that foreign manufacturers will be the major beneficiaries of growth in the United States furniture market. These benefits will be realized by increasing their market share by the year 2000.

Conditions seem to favor the expansion of Mexican production as they work to penetrate the United States market. Additionally, stabilization of the Mexican government and the curbing of inflation have helped prepare the ground for Mexican furniture industry exports (Evans 1990). To examine how this expansion may impact the U. S. industry, a scenario with an increased production percentage for Mexico was included.

With increases of two, three, and four times Mexico's base model employment levels, the model's shipments from Mexico increased to all regions west of the Mississippi River and to Canada West (Table 6). In response, the two other major furniture production regions' shipments were shifted to areas where they have a greater relative transportation advantage over Mexico. The East South Central region, for example, decreased its shipments to the West North Central and West South Central regions as Mexico increased its shipments to those areas. With each incremental increase in production, Mexican shipments to Canada East and the East North Central regions did increase however. The South Atlantic region, meanwhile, showed increased shipments to the Middle Atlantic and New England regions as a result of Mexican increases. By shipping less furniture to Canada East, their shipments to these nearby regions could be increased.

Table 5. Changes in the optimal distribution of shipments from the U.S. South Atlantic and East South Central regions based on changes in Canadian employment levels.

Source	Destination	Base Model	Modified Employment
East South Central	Canada East	–	6.81
	Mountain	–	1.19
	W.N. Central	–	5.33
	W.S. Central	3.38	3.38
	E.N. Central	–	7.26
	E.S. Central	1.85	4.35
	S. Atlantic	17.25	–
South Atlantic	Canada East	10.45	5.86
	Mountain	0.71	–
	W.N. Central	1.31	–
	E.N. Central	7.26	–
	E.S. Central	2.50	–
	New England	3.77	3.77
	M. Atlantic	9.00	9.00
	S. Atlantic	–	17.25

Consumption Projections

Long-term demographic trends have led some analysts to refer to 1980-1990 as the golden age of furniture (USDC International Trade Administration 1985). The post-war baby boom children matured to the ages of 25-44 during this period, putting them at the prime home-buying and furniture-purchasing ages. Demand for furniture was expected to increase sharply during the 10-year period, since the population of that age group was projected to grow twice as fast as the total population. As the population ages, the regional patterns of consumption will shift, chang-

Table 6. The effects of increases in Mexican production capacity on the optimal distribution from Mexico and the U.S. South Atlantic and East South Central regions.

Source	Destination	Base Model	2*PP[a]	3*PP	4*PP
Mexico	Canada West	–	4.33	4.37	4.41
	Pacific	0.59	0.97	1.33	1.66
	Mountain	2.10	0.85	2.90	2.95
	W.N. Central	–	–	0.75	1.71
	W.S. Central	–	–	–	1.62
	Mexico	1.03	1.03	1.03	1.03
East South Central	Canada East	–	2.90	4.49	5.98
	W.N. Central	–	3.47	0.84	–
	W.S. Central	3.38	3.51	3.63	2.13
	E.N. Central	–	7.44	7.61	7.76
	E.S. Central	1.85	4.35	4.35	4.35
	S. Atlantic	17.25	–	–	–
South Atlantic	Canada East	10.45	3.56	2.24	1.01
	Mountain	0.71	–	–	–
	W.N. Central	1.31	–	–	–
	E.N. Central	7.26	–	–	–
	E.S. Central	2.50	–	–	–
	New England	3.77	3.80	3.84	3.87
	M. Atlantic	9.00	9.13	9.25	9.36
	S. Atlantic	–	17.25	17.25	17.25

[a] PP = Present Production levels

ing the comparative advantages of producers in North America.

Relationships between consumer age and yearly expenditures on specific types of home furnishings were published by Epperson (1989). Age was considered to be the key independent variable. When considering the changes created by age, one automatically looks at a broad range of sociodemographic changes. Combining this information with regional population projections (USDC Bureau of the Census 1989b) for the United States yields a forecast of consumption patterns. It is important to note that this is not a forecast of the economy, but an examination of changes in the consuming population. A basic assumption is that future consumers will display the same spending patterns as present consumers. Canadian furniture expenditures have remained fairly constant on a per capita basis, and for this reason, growth in consumption has been projected to follow the increase in the number of families, approximately 2% per year (Industry, Science and Technology Canada 1988). Mexico's consumption percentages were assumed to be constant.

Consumption forecasts were made for 1990 and 2000 and the base model was modified to reflect the changes in the consumption percentages (Table 7). The Canadian regions are projected to increase their consumption, as are the Pacific, Mountain, West South Central, and East South Central regions of the United States. This regional growth projection is in line with the statement made earlier concerning the rapid growth of the western and southwestern states.

The shifting concentrations of consumption, as the population migrates and ages, have a significant effect on the least-cost distribution of shipments (Table 8). The East South Central region begins shipping to the Mountain region in the year 2000 to serve the growing market in the West. They also increase shipments to the West North Central region and are forecast to consume more furniture themselves. The West North Central region, while decreasing its own consumption, is serving the increasing consumption

Table 7. Projected changes in regional consumption percentages.

	Consumption Percentages		
Region	1987	1990	2000
Canada East	14.51	15.30	16.93
Canada West	5.43	5.73	6.34
Pacific	11.23	12.05	12.39
Mountain	4.19	4.38	4.54
W.N. Central	5.33	5.49	5.00
W.S. Central	7.03	8.73	8.69
E.N. Central	12.29	13.10	11.80
E.S. Central	4.35	4.85	4.60
New England	4.76	4.08	3.92
M. Atlantic	12.60	11.67	10.76
S. Atlantic	17.25	13.60	14.10
Mexico	1.03	1.02	0.93
Total	100.00	100.00	100.00

Table 8. Changes in the optimal distribution from the U.S. South Atlantic and East South Central regions based on regional consumption projections.

Source	Destination	Base Model	1990 Consumption	2000 Consumption
East South Central	Mountain	–	–	1.07
	W.N. Central	–	4.48	5.00
	W.S. Central	3.38	5.08	5.04
	E.N. Central	–	8.07	6.77
	E.S. Central	1.85	4.85	4.60
	S. Atlantic	17.25	–	–
South Atlantic	Canada East	10.45	10.24	10.81
	Mountain	0.71	–	–
	W.N. Central	1.31	–	–
	E.N. Central	7.26	–	–
	E.S. Central	2.50	–	–
	New England	3.77	3.09	2.93
	M. Atlantic	9.00	8.07	7.16
	S. Atlantic	–	13.60	14.10

of the Canada West and Mountain regions. The amount of furniture consumed by the three regions along the East Coast of the U.S. is projected to decrease as the population moves westward. If the level of production in the South Atlantic region remains constant, an increase in the amount of furniture shipped to Canada East from this region can be expected.

Summary

The least-cost distribution yielded by the base model appears to be quite sensitive to changes in production or transportation costs. Increases in these costs, as low as 10 percent above those of the base model, result in significant shifts in optimal production and distribution patterns. As these costs increase, the East South Central region is forecast to serve a larger market area. Regional comparative advantages favor the region becoming the long-term optimal producer for the central portion of the United States.

The furniture producers in the southeastern U.S. are located near the final markets and thus enjoy a transportation cost advantage over producers in other regions of the United States. The base model distribution is also sensitive to decreases in the importance of this transportation advantage. As a result of such a decrease, producers in the southeast concentrate shipments to the markets of the neighboring regions. While still serving the eastern markets, the shipments are more concentrated than in the base model.

As the U.S. population shifts westward, the South Atlantic region's share of the market is expected to decrease. If the upholstered furniture manufacturing industry follows this population shift, production in this region may decrease. Accordingly, the East South Central region is expected to increase its market share due to a comparative transportation advantage and a projected population growth within the region.

Finally, Mexican production could very well play a larger role in the future U.S. market. The forecast of westward population shift would give it a comparative transportation advantage over the established household furniture producers in the southeastern United States. This, in addition to Mexico's low-cost production advantage, could help the region become a major manufacturer in the North American household furniture market.

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