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A LEAST-COST ANALYSIS OF TRANSITION IN
NORTH AMERICA'S UPHOLSTERED, WOOD
HOUSEHOLD FURNITURE INDUSTRY^{1/}

Eric J. Todd and Steven H. Bullard^{2/}

Abstract.--Factors influencing the location of the North American upholstered, wood household furniture industry are undergoing many changes.^{3/} This paper presents a least-cost linear programming approach to determining optimal furniture production and shipment patterns. The results suggest that Mexico and the East South Central region of the U.S. are well-poised to increase their shares of the North American market as consumption patterns and factors of production change in the next decade.

INTRODUCTION

The furniture industry is an important part of the manufacturing sector in the United States. The upholstered, wood household furniture industry in the U.S. grew 16 percent from 1982 to 1987 to 82.1 thousand employees, approximately 30 percent of total U.S. household furniture employment (USDC Bureau of the Census 1990).^{4/} The furniture industry is the largest consumer of hardwood lumber in the U.S. (Koch 1985). In 1987 alone, U.S. upholstered, wood household furniture manufacturers used over \$375 million in wood-based raw materials.

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^{3/}For the purposes of this study, North America does not include Alaska, the Yukon, or the Northwest Territories.

^{4/}Throughout this paper, "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 (see Office of Management and Budget 1987).

During the 1980's, the baby-boom generation entered the 25-44 year old age bracket, where many major consumption decisions are made. This age bracket now accounts for one-third of the U.S. population, and will continue to be an important consumer group in the 1990's. More than half of these consumers own their own homes and many households have more than one income (Standard and Poors 1986). The growth of this segment of this population, coupled with the economic prosperity of the 1980's, led to an increased demand for upholstered furniture. North American producers enjoy the benefits of this expansion, since shipment costs keep foreign manufacturers from being competitive.

Three factors have played a role in the historic location of the furniture industry in the U.S. As noted, upholstered furniture is expensive to ship so the industry has tended to locate near the consuming population. Also important are a plentiful hardwood supply and low-cost labor pool. Total payroll results in nearly 50 percent of the value added by manufacture (USDC International Trade Administration 1985). Each of these factors has played a role as the industry has shifted from Jamestown, NY, to Grand Rapids, MI, and then to High Point, NC. While High Point is still the major production center, we are seeing significant shifts in production westward into Mississippi, Tennessee, and even into Mexico.

Other changes, particularly those that relate to production, are resulting in geographic shifts in the furniture industry's location within North America. The free trade agreement between the U.S. and Canada, for example, is changing the

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relative cost of doing business in the two countries as the tariffs are reduced. Because of an advantage in economies of scale and slightly lower wage rates in the U.S., some Canadian manufacturers are expanding into the U.S. or moving their facilities to the United States.

Mexico is growing in importance as a furniture producing region. The lower wage rates and the lack of environmental regulations are causing some U.S. furniture firms to set up production facilities in Mexico. The maquiladora program also is encouraging expansion into Mexico.^{5/} This program is especially benefitting California firms who otherwise would encounter environmental regulations and worker's compensation costs that may be prohibitive.

The U.S. population is expected to shift from the northeast and midwestern sections of the nation to the western and southwestern regions (USDC Bureau of the Census 1989b). Combining regional population projections with known furniture consumption patterns based on age (Epperson 1989) will yield forecasts of consumption patterns as the population ages and concentrations shift. Similar information for Canada and Mexico allow forecasts to be made for the entire continent (Statistics Canada 1989, Direccion General de Estadistica 1980).

OBJECTIVE

The overall objective of this study was to assess the current potential for geographic shifts in the manufacture 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 currently is concentrated, and (3) investigate potential shifts in the geographic distribution of production during the next 5 to 10 years.

METHODS

The transportation algorithm of linear programming was used to evaluate optimal patterns of upholstered furniture production and shipment in North America. The model was designed to estimate the patterns of shipment 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.

^{5/}The maquiladora program was established in 1965 by Mexico and the U.S. to create jobs for Mexico. The program was designed to encourage U.S. companies to open plants in Mexico and use U.S.-made parts. When the finished product is shipped to the U.S., the company is taxed only on the value-added in Mexico (Evans 1989b).

Regions

Twelve regions were used to represent production and twelve were defined for consumption of upholstered household furniture in North America (Figure 1). The nine census regions of the Census Bureau were used as the production and consumption regions of the United States. Canada was split 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; thus it divides the markets without splitting a major population center. Mexico was included as a single region since the only area of concern in this study is the border region where the furniture maquiladoras are located. The maquiladoras are the only Mexican furniture plants that affect the U.S. furniture market; furniture plants in the interior of the country are oriented entirely toward the domestic market (Evans 1990).

Production Indices

Determining actual production costs for each region is difficult since comparable data are not available for all of the regions shown in Figure 1. For that reason, production costs were represented by manufacturing cost indices. The Seventh Annual Study of the General Manufacturing Climates of the Forty-Eight Contiguous States of America was selected as a source of production cost indices for the U.S. (GrantThornton 1986). This index is based on 22 factors that are pertinent to industries such as furniture manufacturing.^{6/} In fact, states traditionally associated with furniture production score quite well on this index (Kunkel 1989). Since GrantThornton scores apply only to U.S. states, production indices for regions in Canada and Mexico were calculated relative to the U.S. regional scores (Garreau 1981, Evans 1989a). The 12 regional scores then were indexed with the average score being assigned a value of one.

Transportation Indices

Production and consumption centroids were identified within each region to represent the sources and destinations of furniture flow. Transportation costs were estimated from every production centroid to every consumption centroid, resulting in 144 transportation costs. These transportation costs are a weighted average of truck and railroad shipping costs. The weight assigned to each method of transportation varies

^{6/}The 22 factors used to determine this index are: Wages, Unionization, Energy Costs, Worker's Compensation 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 Educated Adults, UC Net Worth, Maximum WCI Payment, Environmental Control, Voc-Education Enrollment, Debt, Hours Worked, Population Change, Population Density, and Welfare Expenditure.



Figure 1.--The twelve regions defining regional production and consumption of upholstered household furniture in North America.

by region (USDC Bureau of the Census 1981, U.S. Department of Transportation 1980).^{2/}

The 144 costs also were indexed by assigning the average cost a value of one.

Total Indices

The final step in representing costs was to combine production and consumption indices into an overall index. Rubin and Zorn (1986) state that transportation costs comprise 22.92 percent of the total costs in the furniture and fixtures industry. We used this percentage to determine a weighted average of the indices for each region. Each production index was combined with 12 separate transportation indices, depending on the furniture destination, resulting in a 12 by 12 matrix that serves as the technical coefficients table of the model.

Production and Consumption Data

Regional furniture production was represented as a percentage of total North American production. The number of upholstered household furniture employees in each region was used as a proxy for production since actual data on a comparable basis for all three countries is not available (USDA Bureau of the Census 1990, Statistics Canada 1989, Direccion General de Estadistica 1979).

^{2/}Percentages of furniture shipments by truck and rail within Canada were provided by Jennifer Allen, Marketing Representative for CP Rail, Toronto.

Regional consumption figures were measured as a percent of total consumption in North America. Retail sales estimates for each region were used as a measure of consumption for the region (USDC Bureau of the Census 1989a, Statistics Canada 1989, Direccion General de Estadistica 1980). Percentages allow easy examination of model results, and they also obviate the need for assumptions about production estimates (such as dollar value of shipments) versus retail (marked-up) consumption estimates.

Comparisons of regional production and consumption percentages reveal that 3 regions are net producers of upholstered furniture. These are the South Atlantic region, the East South Central region, and Mexico. The two U.S. regions contain the two major furniture producing markets in the U.S. These are High Point, NC, in the South Atlantic region, and Tupelo, MS, in the East South Central region.

RESULTS

Upholstered, wood household furniture industry shipments resulting from the base model specifications show the South Atlantic region to be the primary furniture supplier to the eastern half of the U.S. and eastern Canada (Figure 2). The East South Central region is the second largest producing region and, given the model's assumptions, most efficiently serves the south central and southeastern United States.

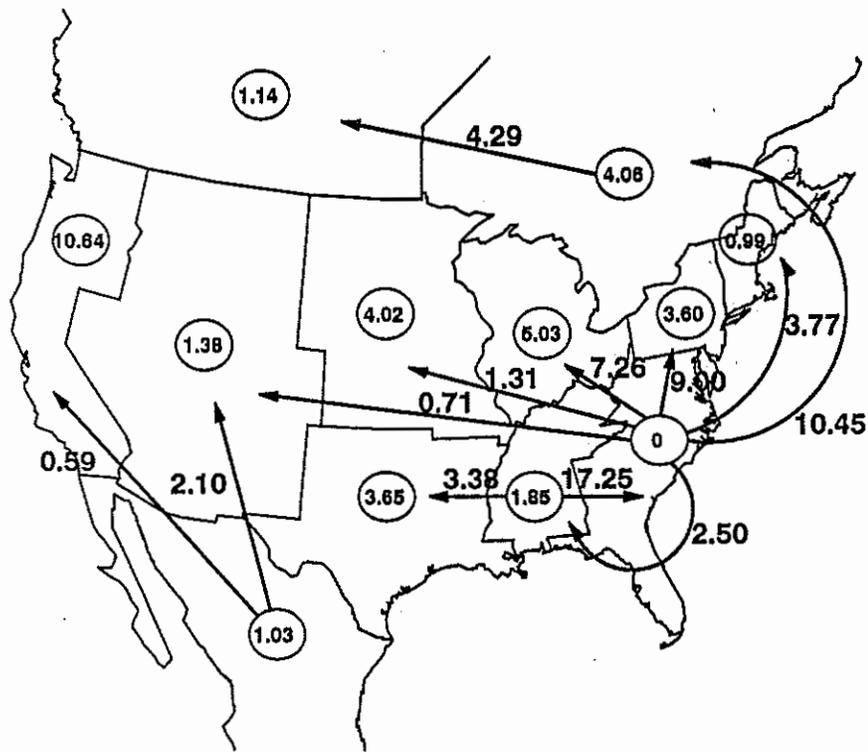


Figure 2.--Optimal furniture shipment pattern yielded by the initial model. Each number is a percent of all upholstered household furniture produced and consumed in North America. Numbers inside a circle represent furniture produced and consumed in the same region, while those along the arrows represent shipments between regions.

Scenarios

Several of the base model parameters and assumptions were altered to help assess potential changes in the geographic distribution of production in North America. These alterations also helped identify any regional comparative advantages that may exist. We present each of the six scenarios separately, although in reality several of these could be acting simultaneously on the industry in the 1990's.

Increasing Transportation Costs

Rising fuel costs are increasing the costs of furniture transportation, and as a result, the transportation component of total costs may increase above the 22.92 percent we used in the initial model. An increase in the transportation index of 10 percent resulted in significant shifts in the least-cost furniture distributions. The South Atlantic region would now most efficiently serve the U.S. markets along the East Coast and those in eastern Canada. The East South Central region is forecast to expand its shipment pattern to include those regions in the central portion of the United States.

This pattern does not change even as the transportation index is increased by 50 percent. This 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, this region becomes the most efficient long-term supplier to the central regions of the United States.

Diminishing Transportation Advantage

The eastern half of the U.S. dominates total furniture and home furnishings sales with 76 percent of total U.S. sales occurring in the Midwest, Northeast, and South (Bullard 1990). The population is shifting, however, away from the Northeast and Midwest to the western and southwestern states (USDC Bureau of the Census 1989b). To reflect the decrease in transportation advantage that these regions may experience in the 1990's, the importance of the transportation advantage was decreased to 10 percent. Any transportation advantage they now enjoy would therefore play less of a role in determining the least-cost shipment pattern.

As the transportation component becomes less significant, the South Atlantic region is able to serve eastern Canada more efficiently. As a result, the Middle Atlantic region receives most of its furniture from the East South Central region. The East South Central region, as before, becomes the least-cost supplier to the central portion of the U.S., suggesting that their comparative shipping advantage to this portion of the nation is quite stable.

Increasing Labor Costs

The upholstered, wood household furniture industry has tended to migrate towards the southeastern U.S. for several reasons. One of the most important of these has been relatively low labor costs. In the last 15-20 years, however, manufacturing wages in these states have risen as a percentage of the U.S. average, reflecting a greater competition for labor (USDC International

Trade Administration 1985). To model the effects of increased wages, we increased the manufacturing indices in the southeastern U.S. by 10, 25, and 50 percent.

The shift in shipment patterns for the East South Central and South Atlantic regions, as a result of a 10 percent increase, is the same as the shift resulting from an increase in transportation costs. This implies that base model distribution is more sensitive to both labor and transportation cost increases. Again, the East South Central region appears to have an advantage that makes it the least-cost supplier to the central portion of the nation. Further cost increases have little effect on this distribution.

Decreasing Canadian Employment

Since the Free-Trade agreement has gone into effect between the U.S. and Canada, the Canadian furniture manufacturing industry has experienced plant closures in response to the changing manufacturing climate. For this scenario, we assumed that the upholstered furniture industry employment and production decrease in Canada would result in a comparable 1.75 percent increase in the production capacity of the southeastern U.S..

As would be expected with this scenario, more furniture is shipped from the U.S. into Canada. Rather than receiving all of their furniture from the South Atlantic region, as in the base model, the Canadian markets also are served by the East South Central region and Mexico. 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.

Increasing Mexican Production

Conditions seem to favor the expansion of Mexican production as they work to penetrate the U.S. market. The expanding maquiladora program, in addition to the stabilization of the Mexican government and the curbing of inflation, have helped increase the level of exports by the Mexican furniture industry (Evans 1990). To examine how this expansion may impact the U.S. industry, we included a scenario with an increased production percentage for Mexico.

In response to incremental increases in Mexican production, the South Atlantic and East South Central regions' shipments were shifted to areas where they have a greater relative transportation advantage over Mexico. The East South Central region, for example, decreased their shipments to the west and increased shipments to the East North Central region and eastern Canada. The South Atlantic region, meanwhile, showed increased shipments to the Middle Atlantic and New England regions as a result of Mexican production increases.

Consumption Projections

Relationships between consumer age and yearly expenditures on specific types of home furnishings were published by Epperson (1989). Combining this information with regional population projections for the U.S. (USDC Bureau of the Census 1989b) and Canada (Industry, Science and Technology Canada 1988) yields a forecast of consumption patterns.

The model was modified to project consumption projections for the year 2000. As a result, the East South Central region increased shipments to the west while decreasing shipments to the shrinking markets in the north. The South Atlantic region increased its shipments into Eastern Canada, which is a growing market, while shipping less to the regions on the East Coast of the U.S., which are projected to have decreasing consumption percentages due to population shifts.

SUMMARY

The least-cost distributions yielded by the base model appear to be quite sensitive. Cost increases as low as 10 percent, in production or transportation costs, result in significant shifts in distribution patterns. As these costs increase, the East South Central region is forecast to serve a larger market area. This region seems to have comparative advantages that favor it becoming the long-term least-cost producer for the central portion of the United States.

As the U.S. population shifts westward, we expect the South Atlantic region's share of the market to decrease. If the upholstered furniture manufacturing industry follows this population shift, production in the South Atlantic region may decrease. Accordingly, we expect the East South Central region 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 forecasted westward population shift would give it a comparative advantage over the producing regions in the southeastern United States. This advantage would be in addition to the low-cost production advantage the region already enjoys.

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