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# Substitution among capital, labor, and raw materials in upholstered household furniture manufacturing

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Steven H. Bullard  
Barry J. Seldon

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## Abstract

The potential for substitution among capital, labor, and raw materials is relatively low in the U.S. upholstered household furniture industry. In general, therefore, the industry prospers in areas where all the input factor costs are relatively low, and efforts to attract upholstered furniture producers to specific areas must consider all the inputs to production. Based on these results, and considering nationwide trends in demand, foreign competition, and regional comparative advantage, the upholstered furniture industry should continue as an important source of demand for forest products in the southern United States.

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The U.S. upholstered household furniture industry is an important source of demand for forest products. The importance of wood as a raw material in upholstered furniture is reflected by the industry's Standard Industrial Classification (9) title "Wood Household Furniture, Upholstered" (SIC 2512), and by the industry's total value of wood-based inputs. In 1987, for example, U.S. upholstered wood household furniture producers purchased nearly \$400 million of hardwood and softwood lumber, hardwood dimension and parts, and wood furniture frames (17). In Mississippi alone, estimated expenditures on wood frames for upholstered furniture production were over \$50 million in 1989 (4).

Wood products are an important input in upholstered furniture production, but other raw materials and inputs such as capital and labor are also essential. We examine the relative importance and extent of substitution possible between broad categories of important inputs: capital, labor, and raw materials. We present elasticities of substitution and also discuss other results for these inputs, based on a recently completed cost function analysis of annual data for 1958 to 1987. Although our data and analysis did not delineate patterns of substitution among specific

wood products, our findings have important implications for trends in industry location and thus for longer term demand for wood products in general.

## Substitution among capital, labor, and raw materials

The technology of production and specific producing units can be generally described by a production function, or equivalently, by expressing production inputs in cost terms (7). We used the latter approach, incorporating a flexible form of the cost function, the translog model, to estimate substitution elasticities for capital, labor, and raw materials for the U.S. upholstered household furniture industry. The translog model has been used to evaluate production relationships and technology in U.S. and Canadian lumber industries (1,8), U.S. pulp and paper industries (11,14), as well as for 10 U.S. forest products sub-industries in the lumber and paper SIC groups (13). These applications and others were included in a recent thorough review of cost function studies of forest industries in North America (15). However, none of the applications reviewed included the upholstered wood household furniture industry.

We included capital, labor, and raw materials as inputs to upholstered furniture production in a translog cost function, with factor share equations as side conditions. This specification allowed us to estimate own-price and cross-price elasticities of derived demand, as well as elasticities of substitution among the input groups. Coefficients in our system of equations were estimated using aggregate data for the United States for 1958 to 1987. Seldon and Bullard (12)

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provide a complete discussion of the model specification, data, and estimation procedures and results. Here, we discuss the subset of results from the cost function analysis that relate specifically to the relative importance of the input factors. These results have direct implications for trends in industry location and, thus, for regional demand for wood products and standing timber.

Elasticities of substitution reflect the degree to which input factors can be substituted in a production process (5). Elasticities less than 1 indicate a relatively low degree of potential substitution, and our estimates for upholstered furniture inputs were less than 1 throughout the 30-year period of analysis (Fig. 1). Further evidence of the relatively low degree of potential substitution was provided by estimated cross-price elasticities of demand; they followed a pattern that was almost identical to the substitution elasticities in Figure 1 throughout the 30-year period.

Other important characteristics of the upholstered furniture production process are also evident in Figure 1. The relative importance of labor is clearly indicated, for example, because both capital and raw materials appear to be poor substitutes for this input (although not perfectly symmetric, the elasticity of substitution of raw materials for labor was very similar to the pattern displayed by the lower line in Fig. 1). We also found relatively low rates of productivity growth (12), consistent with Henneberger's (6) results for the industry from 1958 to 1977. Henneberger concluded that productivity growth was limited by style changes

and short production runs that require "largely hand-crafted" operations.

With regard to raw materials, the elasticities in Figure 1 are relatively stable over the 30-year period. The highest elasticities were those involving substitution of capital for raw materials; if the price of certain materials such as hardwood lumber, dimension, and polyfoam increase significantly, firms may manufacture their own by increasing their capital investment. In general, however, opportunities for cost savings by acquiring raw materials production facilities have been somewhat limited. In our analysis, evidence for this conclusion was provided by own-price elasticity estimates that were in the inelastic portion of the input demand functions throughout the 30 years (12). These results imply that raw materials suppliers did not have significant market power during this period. Although there are large, vertically integrated firms in the U.S. upholstered furniture industry, there are also many competitive producers that do not produce their own inputs. This finding is also consistent with results for 1958 to 1974 for 10 nonfurniture forest products subindustries in the United States (13).

### Discussion

Low substitution elasticities between raw materials and other input categories have important consequences for upholstered furniture industry location and, thus, for regional demand for wood products. If the price of a specific input rises, opportunities to substitute other inputs are relatively limited in this industry. Firms cannot remain competitive in high-wage locations by substituting higher capital investments for labor, for example. Therefore, if production costs related to labor, capital, or raw materials increase in one state or region relative to others, in the long run, firms will either specialize and differentiate their final products (allowing them to charge higher prices), or will move production to areas where all the input factor costs are lowest.

The upholstered furniture industry has been an important target of various state and local economic development agencies in the South, and policies to influence plant location and expansion decisions are currently being considered in several areas of the region (3). Our results are important for economic policy development because they indicate that regional comparative advantage cannot be achieved by relatively low costs for only one or two of the production inputs; policies to attract upholstered furniture manufacturers to an area must therefore emphasize all the capital, labor, and raw materials costs of production.

Past growth and current geographic patterns of production in this industry in the United States are consistent with the conclusion that all inputs must be competitive. In the last 40 years, for example, the industry grew rapidly in North Carolina and Tennessee, and the industry's growth was particularly dramatic in Mississippi. A report published by Mississippi's Research and Development Center in 1966 (10)

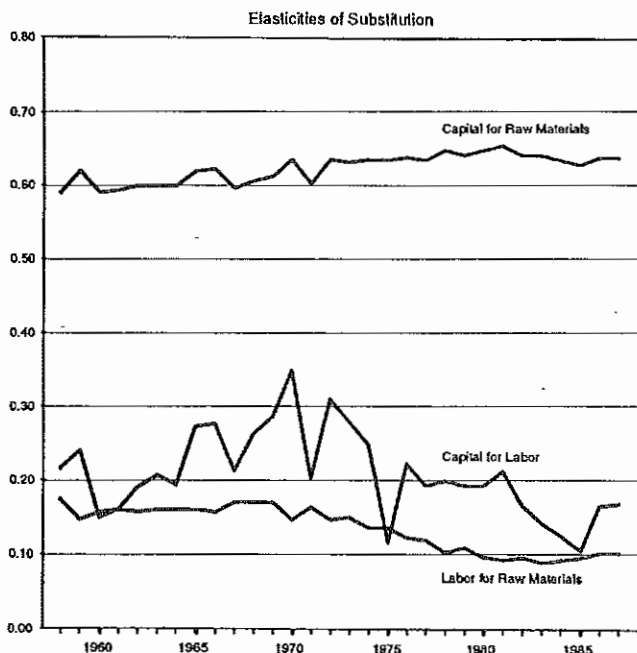


Figure 1. — Estimated elasticities of substitution for capital, labor, and raw materials in the U.S. upholstered household furniture industry, 1958 to 1987.

predicted strong growth for the industry in Mississippi. The report described "eight major advantages that make [the state] an excellent location for the upholstered furniture industry," and the advantages included all three groups of production inputs: labor (availability, productivity, and "climate"), capital (construction costs, financing costs, and tax exemptions), and raw materials (quality and availability).

Although geographic shifts in production are currently occurring in this industry, upholstered furniture producers should continue as a strong source of wood products demand in the southeastern and southcentral United States. The industry has an advantage in being relatively insulated from foreign competition (2), and regional comparative advantages are generally favored by such factors as population shifts, regional trends in manufacturing regulation, and free trade with Canada (16). Our findings of low substitution elasticities lend support to the locational advantages of the southern United States. A relatively high level of geographic concentration is expected where capital, labor, and raw materials advantages are greatest, and availability of wood-based raw materials therefore has been and should continue to be an important aspect of locational decisions in the industry.

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