Working Paper Series

The Determinants of State Food Manufacturing Growth: 1982-92

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Working Papers Series
Regional Economic Issues
Research Department
Federal Reserve Bank of Chicago
December 1997 (WP-97-24)

FEDERAL RESERVE BANK
OF CHICAGO

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The opinions expressed in this paper are not necessarily those of the Federal Reserve Bank of Chicago and the Federal Reserve System.

The author would like to thank Dan Sullivan for his comments.

Abstract

This paper examines factors that play a role in the differential growth of food manufacturing among states. A linear multiple regression model is used to relate two measures of growth--value added and employment--to a group of factors that fall into six broad categories: final markets, labor, education, non-labor inputs, policy, and agglomeration. The results suggest that several traditional market factors that affect other types of manufacturers also affect food manufacturing output and employment. Energy prices and education also have an impact. Furthermore, state corporate tax rates are found to have no significant effect on growth, while the existence of right-to-work laws supports more rapid expansion of food manufacturing employment.

The Determinants of State Food Manufacturing Growth: 1982-92

Introduction

Food manufacturing holds an important position in the U.S. food system as well as the larger economy. As one of the principal links in the food marketing chain, the firms in this industry undertake the initial transformation of raw agricultural commodities into the food products purchased by consumers throughout the world. They also play a dual role in the coordination of the food system, utilizing information gleaned from consumers and retailers that exist upstream to develop products with improved taste, nutrition, and convenience; food manufacturers also transfer information downstream to first assemblers, farmers, and farm input suppliers that aids in developing commodities that better meet the needs of manufacturers, and ultimately, the desires of consumers. This coordination, in particular, is critical to those in the farm sector who seek to capture the price premiums associated with production of specialized commodities such as high-oil or white corn, or livestock that meet specific production or quality standards.

Among the 20 major manufacturing groups, food manufacturing ranks second in output and third in employment and value added. In addition, the growth of food manufacturing compares favorably to that of all manufacturing. While the sales growth in this industry tended to lag that for all manufacturing from 1982-92, the gains in value added and employment outpaced those for all manufacturing. Moreover, continued steady growth is all but assured by population gains and rising incomes in the U.S. and elsewhere. Reflecting the international component, exports of consumer foods have experienced faster and steadier growth this decade than those of the more traditional bulk agricultural commodities such as corn, wheat, and soybeans. Demographic trends also aid growth by encouraging a shift away from home preparation of foods towards increased purchases of processed foods.

So it generates little surprise that several observers cite food manufacturing as a driver or potential driver of economic growth. This is especially true for states or rural communities that have been hit with a loss of manufacturing employment or have witnessed a decline in the importance of production agriculture to local economies. Barkema, et al (1990) suggested that food manufacturing is a "critical" source of economic growth for agricultural-oriented states that can no longer depend on the farm production sector to fuel local economies. Furthermore, Testa (1992) noted that food manufacturing firms are more likely to locate plants in rural areas than are other types of manufacturers, and Barfels (1997) claimed that the non-cyclical nature of food manufacturing adds stability to regional economies. Policymakers, state and local leaders, and even farmers have taken note of this. Officials in Iowa recently announced a plan calling for 90% of its farm products to have at least one layer of value added before leaving the state (Fitzgerald).

Given this interest, it is natural to ask what factors encourage food processors to locate a new plant or expand production in a given area. The purpose of this paper is to examine factors that may play a role in the differential growth of food manufacturing among states. The organization of this paper is as follows. The second section discusses previous research into plant location decisions and manufacturing growth. The third section describes the model and data used to investigate state characteristics that influence food manufacturing activity. The fourth section contains results and analysis, while the final section presents conclusions and ideas for future research.

Prior research

Background on location research [1]

Location decisions were initially viewed as a transportation cost minimization problem. Firms considered the combined costs of transporting raw materials to the plant and the output to markets. The relative significance of these costs could easily be responsible for whether manufacturing plants were located near supply points or areas of demand. Eventually, the importance of trade-offs between transportation costs and other costs such as wages and energy was recognized and explicitly incorporated into the plant location decision.

In addition, early studies assumed (as least implicitly) that the goal of profit maximization lay at the heart of the plant location decision. More recently, increasing importance has been given to other factors not so easily or directly related to profits. Examples of these other factors include personal preferences, climate, or quality of life. However, successful locations--even if based upon factors such as personal preferences--probably depend upon those factors with a more direct linkage to a firm's bottom line.

The industrial location or site selection process can be viewed as sequential in nature. The first decision is the choice of a state or larger multi-state region (i.e., the South or Midwest) in which to locate. At this point, firms may focus on characteristics of the labor supply, state tax variables, proximity to markets, or climate. These are factors which likely show little variation within a state, but may show significant interstate or interregional differences. Once an acceptable state or region is identified, attention is then focused on micro-geographic factors,

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[1]This section borrows heavily from Blair and Premus.

such as land costs, access to major highways, or the quality of local schools.

Blair and Premus review and synthesize several survey studies to identify a group of interregional factors that affect industrial location. Traditional economic factors--those found to be important in earlier industrial location research--are labor, product markets, transportation availability and cost, and access to raw materials. Though still important, their influence has given way over time to other factors, such as educational opportunities, unionization, energy costs, and the local business climate. The studies reviewed also suggest the impact of state and local taxes on plant location has gained importance in the eyes of researchers over time. In addition, an interesting generalization from their survey is that the importance of proximity to raw materials has declined while the proximity to final markets has increased. This is attributed to technical change, which has increased the complexity of the production process and reduced the relative importance of raw materials. The food industry is a good example, where more processing takes place to build convenience into processed foods, and at the same time, farmer's share of the consumer food dollar continues to decline.

Economic factors rated as important by surveys were typically found to be important in econometric studies, even when fiscal and/or other policy variables were accounted for. In general, personal taxes, corporate taxes, tax progressivity, and transfer payments were found to be detrimental to economic growth. Subsidies were seldom effective as locational incentives. In addition, several studies found the level of unionization acted as a deterrent to plant location or employment within a state.

Surveys of food firms

Lopez and Henderson focused on identifying a group of economic and personal factors that affect the selection of a state in which to locate a food manufacturing facility. They did not consider this decision, however, in the context of a two-step, sequential decision process, and did not distinguish between micro- and macro-geographic variables. Though most of the factors used in their study were appropriate for selection of a state, a handful were more appropriate to the selection of a location *within* a state, such as land costs and the existence/adequacy of municipal waste treatment facilities. They viewed the state selection decision as being a function of economic conditions, site characteristics (or in this case, state characteristics), and the industry involved (plant size, the inputs needed, the type of products produced, and the technology used for processing and marketing). Their sample of food manufacturing firms included plants that were constructed in northeastern states from 1981-1987. The manufacturing industries were chosen for their strong links to the region's agricultural commodities: vegetables, fruits, eggs, poultry meat, and seafood. Their survey listed 41 individual location factors the fell into six broad categories: markets, labor, infrastructure, environmental regulation, personal, and state fiscal policy. Additional questions were included to define the characteristics of the individual plants.

In ranking the broad categories, Lopez and Henderson found market factors to be the most important, closely followed by infrastructure. The next three categories, in order of importance, were labor, personal factors, then environmental regulation. Fiscal policies ranked last in importance as a plant location determinant. The top ten *individual* factors are shown in Table 1. Three of these ten were traditional market factors: proximity to input supplies, final markets, and distribution centers. Proximity to inputs ranked relatively low for poultry processing, perhaps reflecting the strong level of vertical integration in that industry. Greater coordination would make the pre-existence of inputs in an area less important. Their results also indicated that proximity to markets and distribution centers were relatively more important to the location of smaller plants, as were the availability and cost of truck and rail services.

Infrastructure also accounted for three of the top ten location factors among the surveyed firms. These were availability of an existing facility (which was the top individual factor overall), availability and quality of water, and the availability of waste treatment or disposal facilities. The availability of an existing plant most likely means that other important factors are a "given", such as input supplies, an existing labor force, and supporting infrastructure. The other two reflect the importance of water in food processing and increasing environmental sensitivity. They also found that infrastructure was relatively more important to larger plants. This probably reflects more intensive demands on infrastructure of larger plants and the potential to increase output through adding shifts or running closer to full capacity in the future. Furthermore, proximity to existing food manufacturers was not important, putting the importance of agglomeration in doubt. Land and construction costs were not important, relative to other factors, which is not surprising given the micro-geographic nature of these items and the state/regional orientation of the survey.

Two factors from the labor category were among the top ten individual factors. These were labor availability and productivity. They were considered to be more important than wage rates, skill levels, or unionization. The key point here is that prevailing wage rates--a direct cost--was not viewed as the most important labor consideration. There were also two factors in the top ten from the personal category. The first was already residing or doing business in a given state; the second was whether the state was considered an attractive place to live. Further down the scale were proximity to relatives and cost of living. Personal factors were relatively more important to smaller plant location.

There were no environmental regulatory or fiscal policy factors in the top group cited by Lopez and Henderson. The most important were the existence of municipal facilities to handle waste water and solid waste, and water pollution regulations. Environmental regulations appeared to be relatively more important in state selection to larger plants and to poultry processors. Furthermore, no fiscal policy factor ranked higher than 33rd out of the 41 individual factors. The highest ranked were state corporate income tax and unemployment insurance taxes.

Whereas Lopez and Henderson surveyed food manufacturing firms in a five-state area regarding plant location decisions, Vesecky and Lins took a different approach. First, they confined their survey to plants located within a single state (Illinois). They contacted input suppliers (to production agriculture) as well as processing firms beyond the farm gate. They also included a broader array of different types of food processors in their sample. Furthermore, rather than look at the plant location decision, they examined the decision to expand or reduce output.

The top ten factors for firms expanding output are shown in Table 1. The list is very similar to that compiled by Lopez and Henderson, with seven factors being nearly identical. Those factors rated as most important were transportation availability, proximity to existing facilities, and high demand in a neighboring state. There were no fiscal variables in the top group, suggesting that state governmental policies have little direct influence on the decision to expand. However, several of the negative factors cited by expanding firms were related to policy, such as workers compensation and unemployment insurance taxes, as well as costs related to environmental regulation. But while these were considered a drag on expansion, their impact was still outweighed by the positive factors for expanding firms.

In comparison, the most important factors cited by firms that *reduced* output are also shown in Table 1. Five of these are identical to factors important to expanding firms, which underscores the impact of these factors on the firm's production decision. These were transportation, proximity to existing facilities, water quality/availability, demand in neighboring states, and availability of existing plant facilities. Other factors that encouraged firms to reduce output were skills of the labor pool, state image, transportation and shipping costs, and the availability of waste treatment facilities. As with expanding firms, state developmental policies had little impact on the decision to reduce production.

A third study of food firms was conducted by Leistritz, who surveyed firms in Nebraska, North Dakota, and South Dakota to examine plant location decisions and to evaluate the economic contribution of new or expanding firms to local communities. The survey was confined to firms in nonmetropolitan areas and small metropolitan areas with populations of less than 250,000. The sample contained both agricultural and nonagricultural firms involved in manufacturing or services. In contrast to the other survey studies, the results showed that several policy variables compared favorably to other more traditional factors. State corporate income taxes, the unemployment insurance rate, workers compensation, and the overall business tax burden were seen as relatively important to the location decision, as was the availability of local financing and financial incentives.

Among the more traditional factors, work attitudes and labor productivity were viewed as more important than wage levels. Water supply and electricity cost and availability were also considered relatively important. Furthermore, proximity to raw materials was deemed an important location factor, but proximity to customers less so. Among personal factors, housing and schools were rated more highly than climate or access to recreational and cultural opportunities.

Econometric studies

Three studies are worth noting in light of their rather broad approach towards examining regional manufacturing growth. As with the survey studies, direct comparisons are somewhat suspect due to different time periods used and different specifications of explanatory and dependent variables. Moreover, the sheer number of potential explanatory variables nearly ensures that differing model specifications will result. However, as with the survey studies, some useful generalizations may be found.

Plaut and Pluta (1983) examined the changes in manufacturing output and employment. Their results suggested that output was influenced by energy costs and availability, labor-related factors, land costs, and climate. In comparison, employment growth was relatively less dependent on energy and land costs, but more influenced by climate and tax/expenditure policies. Unlike most other studies, the final market variable was not significant in the regressions. However, Plaut and Pluta used a somewhat different approach, incorporating a "gravity" indicator to represent final markets. Eighteen explanatory variables were used in their regression, many of which were principal component indices of other variables.

Regarding labor variables, they found that firms tended to expand output in states with relatively higher unemployment and less union activity, as one might expect. But higher productivity was not seen as something that encouraged firms to expand in a given state, nor did lower wages. However, the wage and productivity variables were not significant in the regressions. They also concluded that state and local tax policies had a larger impact on employment growth than on output.

Wheat (1986) studied the change in manufacturing employment over the 1963-77 period. In contrast to Plaut and Pluta, he found that variables representing final markets were the dominant influence in explaining regional manufacturing employment growth. However, Plaut and Pluta's final market indicator incorporated both demand and distance, whereas Wheat kept these variables separate in his regressions. Wheat also suggested that Plaut and Pluta's use of five-year time periods was too short to capture long-term trends; that their results were further confounded by incorporating two five-year periods--employment rose during one period but declined in another. Wheat also thought their market indicator was defective in that it allowed external states to overwhelm a given state's own demand/supply ratio.

Wheat did agree with Plaut and Pluta that climate exerts an influence on regional manufacturing growth; he also found that union activity was negatively correlated with growth; and concluded that wage rates were not an important factor in employment growth. In addition, Wheat took note of the rural-urban migration turnaround of the 1970s decade and questioned whether the "urban attraction" for manufacturing discovered in an earlier study might now be a "rural attraction." Reflecting this notion, he found a positive association between employment growth and the ratio of rural/urban population.

In sum, Wheat examined over 30 explanatory variables. Using a trial-and-error approach to model construction in which a high R^2 was the foremost criteria, and through the transformation (i.e., log, square root, etc.) of several explanatory variables, Wheat was able to achieve a final model with an exceptionally large R^2 and in which all explanatory variables exhibited the expected sign.

Duffy (1994) expanded Wheat's work by examining 19 two-digit manufacturing industries (including food manufacturing) and incorporated a longer time period. In particular, he questioned Wheat's conclusion that climate is more important that labor in providing an explanation of differences in regional manufacturing growth. Like Wheat, Duffy followed a trial-and-error procedure in model construction that focused on obtaining a high R^2. Overall, he concluded that market and labor variables were the most effective in explaining regional manufacturing growth, with other factors significant yet relatively weaker in explanatory power. Regarding food manufacturing, Duffy found the growth in employment to be positively related to distance from the Northeast manufacturing belt; the average wage for production workers in that industry; a binary variable designating "right-to-work" states; and a binary variable for Wyoming and Montana, which exhibited large residuals in the preliminary regressions.

Methodology and Data

Multiple linear regression analysis is the basic methodology used to evaluate the impact of various factors on food manufacturing growth across states. The regression model takes the following form:

$$Y = X\beta + \varepsilon$$

where Y is a vector of observations on the dependent variable; X is a matrix of independent variable observations; β is a vector of unknown parameter estimates; and ε is a vector of error terms. The characteristics of the classical normal linear regression model are assumed (Kmenta).

A model that assumes initial locational equilibrium would relate the *change* in the level of the dependent variable over the specified period to *changes* in the independent variables (Newman and Sullivan; Chalmers and Beckhelm). In comparison, a disequilibrium model relates the change in the dependent variable to the *start-of-period levels* of the independent variables. A fully specified model of food manufacturing growth that allows for both of the above situations would regress the dependent variables on changes in the independent variables, their levels at the beginning of the period, and the interaction between changes and levels (Plaut and Pluta). The number of variables in such a model could well be large enough to result in a serious loss of degrees of freedom, especially when the number of observations is limited, and could also give rise to a multicollinearity problem. The approach used here will initially assume that locational equilibrium exists at the start of the period under study. An equation will be estimated that relates the change in food manufacturing growth to changes in a group of independent variables. A second equation will then be estimated under the assumption that the industry is initially in disequilibrium and will include additional start-of-period variables.

Since the primary purpose of this study is to quantify the impact of state characteristics on food manufacturing growth, the data is based upon an individual state as the unit of observation. Alaska and Hawaii are excluded from the sample due to obvious transportation complications. All financial data in this study are indexed to 1992 using the GDP deflator. Furthermore, the time period used (1982-92) coincides with the Census of Manufactures, which is convenient for data collection and also represents a reasonably close approximation of the business cycle. Two common measures of growth--changes in output and employment--are utilized as dependent variables in separate regression equations. The difference in real value added between 1982 and

1992 represents the output change in the first set of regression equations. Value added is used, rather than sales, because it avoids the double counting inherent in sales and is a more appropriate measure of economic activity. The difference in employment levels between 1982 and 1992 is used as the dependent variable in the second set of equations because of its accepted importance as a measure of economic well-being.

It is a fairly simple task to identify broad categories that are presumed to affect growth in food manufacturing, such as markets and labor, and a variety of variables that fall into these categories. However, it is a more difficult matter to reduce the number of available explanatory variables to a manageable set that is suited for regression analysis. For this reason, industrial location theory and previous econometric and survey studies are used as a guide to identify potential explanatory variables. In sum, the variables hypothesized to affect food manufacturing growth across states fall into six broad categories: final markets, labor, education, non-labor inputs, policy, and agglomeration. The remainder of this section identifies the individual independent variables used in this analysis and associated hypotheses. Sources for the data are listed in the appendix.

Final markets

Variables that measure market potential have been successfully incorporated into regression models previously (Plaut and Pluta; Chalmers and Beckhelm). A goal of this study is to examine the type of relationship such market variables have with food manufacturing output and employment growth. For example, the demand-related variable, personal income potential (PIP), for state i measures the regional demand faced by state i, taking into account the final markets in all other states by use of a weighting scheme based on other states' proximity to state

i. In comparison, value added potential (VAP) is a measure of the concentration of food manufacturing activity and available supply faced by a given state. These variables are calculated as:

$$PIP_i = \sum_j \frac{PY_j}{d_{i,j}}$$

$$VAP_i = \sum_j \frac{VA_j}{d_{i,j}}$$

where PY_j is the total personal income for state j; VA_j is the value added from food manufacturing for state j; and $d_{i,j}$ is the distance between the primary population centers of states i and j. In other words, PIP is the sum of personal income of all states weighted by the inverse of the distance from state i to state j, while VAP is the sum of food manufacturing value added of all states weighted by the inverse of the distance from state i to state j. Chalmers and Beckhelm entered the measures of potential supply and demand separately into their regression equations, while Plaut and Pluta used the ratio of PIP to VAP. This study will examine both alternatives. It should be noted that Plaut and Pluta used the above formulation, while Chalmers and Beckhelm based their supply and demand measures on employment and population, respectively.

If one assumes that food manufacturing firms expand production near areas of relatively high demand and avoid areas of concentrated activity where competition is the greatest, it implies that DPIP (the change in PIP from 1982 to 1992) is positively related to manufacturing activity and DVAP is inversely related to manufacturing growth.[2] Yet the opposite might be true if food

[2]Change variables are denoted by beginning with the letter "D."

manufacturing firms are tied to areas that supply raw farm products for processing, or if agglomeration economies cause firms to cluster together. Therefore, the sign attached to the estimated coefficients of these variables in the regression equations will lend insight as to whether food manufacturers hold a locational orientation towards demand areas, farm production areas, or other food manufacturers.

On the other hand, it may be that food manufacturers simply follow population trends. This proposition is tested using a straightforward measure of population change. DPOP is the change in the population of a given state for the period 1982-92. Population change is the primary driver of the overall demand for food, and a positive relationship is expected for both output and employment.

Labor market characteristics

Given the interest of policymakers in attracting or supporting various kinds of industry to provide jobs and spur economic growth, it is important to determine whether characteristics of the labor market in a given state are important to employment and output decisions. For example, which is more important to expansion decisions--productivity or wage rates? Might not a high level of unionization repel food manufacturers, or are they insulated from concerns regarding this factor?

The change in the average annual wage per employee (DWAGE) paid by food manufacturers in a given state is used to examine the impact of wages. The annual wage per employee is calculated by dividing the total payroll for food manufacturers by total employment. Since wages are a strong component of the total costs of manufacturers, it is expected that states with relatively high wage increases will experience slower output and employment growth.

DPROD is a simple measure of productivity change, defined as the change in the ratio of food manufacturing value added to payroll. It is anticipated that states with relatively greater productivity gains will also experience larger gains in output. Productivity gains may be inversely related to employment changes, however.

The ratio of the civilian labor force to the civilian noninstitutional population is used as a measure of labor supply. A larger ratio implies tighter labor markets, which could constrain both employment and output growth. This would affect labor-intensive firms in particular, as well as firms considering new plant construction. The difference between the 1982 and 1992 values, DL_POP, is used in the model and its coefficient is expected to carry a negative sign. However, it seems unlikely this ratio would have much impact unless the differences across states were quite large.

To examine the impact of unionization in a state, DUNION is entered into the regression model. This is the change in the ratio of union membership of a given state to total employment in that state. It is expected that manufacturers are less inclined to expand in states where unions are relatively more active or are expanding their membership. A negative sign is anticipated for both output and employment.

Education

Even blue-collar firms report that the skills required for new jobs is on the rise (Testa, et al). A well-educated labor force is more likely to possess the skills desired by firms and be amenable to further training, while the existence and quality of local educational facilities is an important factor in the desirability of an area in which to live. DCOL is the change in the percent of population (25 years or older) that has completed four or more years of college. A positive sign is expected for the parameter estimates.

Inputs

Since the energy shocks of the 1970s, energy availability and cost has grown more important in industrial location analysis (Blair and Premus). To examine the impact on food manufacturing, a proxy for energy cost is used in the model. DE_PR is the change in the cost per 100 kilowatt hours of electricity for all manufacturers in a given state from 1981 to 1992. It is expected that relative increases in these costs would limit output expansion. However, the relationship of energy costs to employment would depend on whether the two inputs are substitutes or complements.

Many rural communites have considered whether an attempt should be made to attract food manufacturing to enhance local economic growth. But if farm output is directly linked to food manufacturing growth in a given area, then an appropriate strategy might be to support one or more segments of production agriculture. To establish whether this linkage exists, a variable representing the change in cash receipts from farm marketings (DFARM) is used in the model to provide a measure of the relative growth of farm output across states. Normally, a positive relationship would be expected between this variable and food manufacturing activity. However, a key assumption here is that a state is a good geographic representation of the input market faced by food manufacturing plants. If firms draw inputs from a multi-state region, it would weaken the relationship between the change in manufacturing activity and farm output in a given state.

Policy variables

Two variables under the direct control of state lawmakers are corporate tax rates and right-to-work laws. It would be useful to policymakers, especially in states where agriculture or related manufacturing is relatively important, to have evidence on how these factors affect food manufacturing output and employment. DTAX is simply the change in the corporate tax rate, and a negative relationship is anticipated between this variable and both output and employment. In addition, a binary variable is used to account for states with right-to-work laws, which make it illegal to require union membership as a condition of employment (Wheat). RTW is equal to 1 if a state has right-to-work laws, equal to zero otherwise. A positive sign is expected.

Agglomeration

It has been suggested that food manufacturers are inclined to locate where other manufacturers locate. Henderson and McNamara found evidence of this in a study of food manufacturing plant location. DMFGSH measures the change in manufacturing's share of all employment. A positive relationship is expected with both output and employment.

Disequilibrium variables

The level values of five independent variables are used to account for potential disequilibrium in the food industry at the start of the period under study. These are the 1982 values for population, wages, productivity, energy prices (the 1981 value is used), and manufacturing share of state employment. Population flows are constantly occurring and the decade preceding the period under study was marked by a turnaround in the rural-to-urban migration that was in existence for most of this century. Though this is not necessarily a state phenomenon, it may have affected those states that are primarily rural or urban in nature. This would have an impact on final demand as well as conditions in the labor market. In addition, the early 1980s were a time of significant restructuring for the manufacturing industry in general, which had an impact on wages, productivity, and employment. Finally, energy prices rose sharply in the 1970s before peaking in the early-to-mid 1980s (Testa, et al). An attempt was made to limit the number of additional variables entering the model because preliminary work suggested a potential multicollinearity problem.

Results and Analysis

The results from the output regressions are shown in Table 3. Equations 1 and 2 regress changes in food manufacturing value added on changes in the independent variables. Equation 1 incorporates DPIP and DVAP separately, while equation 2 uses the change in the ratio PIP/VAP (DPV). Equation 3 adds start-of-period level variables that act as controls for potential disequilibrium. There is little difference in the summary statistics between the first two equations. Equation 2 was chosen to use as the base for adding disequilibrium controls (equation 3), primarily due to the relatively high variance inflation factors associated with DPIP and DVAP, indicating a potential multicollinearity problem. Equation 3 was first estimated with the five additional level variables, and those not significant were dropped and the equation re-estimated. In addition, DMFGSH was dropped from the final version of equation 3 due to a multicollinearity problem. Three of the five level variables were retained in the output model--population, productivity, and manufacturing share of employment.

A similar procedure was followed for the employment regressions, shown in Table 4. DPV was somewhat more successful in explaining the variation in employment changes among states than DPIP and DVAP and was retained in the final regression equation 6. DMFGSH was again dropped. In addition, four of the five level variables that controlled for disequilibrium were retained in equation 6--population, annual wage per employee, electricity price, and the manufacturing share of employment. The F value of each equation was such that it indicated significance at the 0.05 level or better. The remaining discussion focuses primarily on the results of equations 3 and 6, which include the start-of-period level variables.

Final markets

The coefficient of DPV was significant and negative in both the output and employment equation. Furthermore, the sign of DPIP was negative and the sign of DVAP was positive in both of the initial change equations estimated (equations 1 and 4). This suggests that food manufacturing, in general, is dominated by firms that are tied to locations near agricultural production or near other food manufacturers. But what is true for the industry in general may not be true for specific sub-industries. More insight could be gained by subdividing the sample into demand-oriented, supply-oriented, and footloose industries, or by examining industry groupings at the four-digit standard industrial classification level.

The coefficient for population change was positive and significant in both output and employment equations, suggesting that states with larger population growth do tend to experience greater increases in overall food manufacturing activity and employment. Though the population level variable was significant in both equations, the coefficient was negative in the employment equation, suggesting that states with larger initial populations experienced a smaller increase (or perhaps even a decline) in food manufacturing employment, all other things equal. This may indicate that food manufacturers relocated labor-intensive production away from heavily populated areas, which is consistent with a trend that has been identified for all manufacturing (Testa, et al).

Labor market characteristics

Neither the initial wage nor the change in wages were important to output growth.

However, both were significant and negatively associated with employment change. In fact, these were the only significant labor-related variables in the employment equation. The coefficient of the labor force/participation rate variable was not significantly different from zero in either model. Nor was the change in productivity. However, the initial productivity level was positive and significant in the output equation, which indicates that food manufacturing firms chose to make subsequent output expansion decisions that favored high-productivity areas, even if subsequent productivity gains did not influence their decisions.

The union variable was significant and negative for the output model. It is not surprising that firms would avoid states with increasing union strength or limit expansion in those areas. However, unions did not have a significant impact on employment change. This agrees with Duffy, who did not find unionization to be significant in an equation describing employment growth in food manufacturing. In contrast, Plaut and Pluta and Wheat found unions an important determinant of employment change for all manufacturing. It may be that unions have a lesser impact on food manufacturing employment than on other types of manufacturing employment. However, the time period used in this study coincided with a general restructuring in manufacturing and a decline in union power, while the Plaut and Pluta and Wheat studies dealt with earlier time periods when unions were considered to be stronger. Nevertheless, it would likely be more profitable for firms to expand output in non-unionized areas, ceteris paribus.

Education

The results for the education variable support the hypothesis that food manufacturers prefer to hire a well-educated labor force. The coefficient for DCOL was significant and positive for the employment equation, indicating that food manufacturing employment grows more quickly in states where the educational level of the general population (and thus the labor pool) is increasing more rapidly. However, DCOL was not significant in the output equation. This may reflect a realignment of industry subgroups in a manner that corresponds more closely with their workforce needs, yet has little impact on overall output.

Inputs

The coefficient for the change in energy price in the employment equation was significant and positive. In short, food manufacturers in states with higher energy prices used relatively more labor than in states with smaller increases in energy prices. This indicates that labor is a substitute for, rather than complement of energy, and probably more accurately represents the relationship between labor and capital. However, the coefficient for the initial energy price was negative and significant, which shows that relatively high energy costs at the start of the period acted as a drag on subsequent employment growth.

For the output model, the change in energy price was significant, but the initial energy price was not retained in the final regression since its coefficient was not significant. However, the sign of the coefficient on the change variable was positive, the opposite of what was expected. This indicates that relatively greater output growth occurs in states with relatively greater increases in energy prices. Plaut and Pluta also found a positive relationship between output and energy prices. This result is not readily explainable. It may be that the price of electricity is simply a poor proxy for overall energy costs. For example, electricity prices in the Midwest were much less variable and increased relatively less during the 1970s and 1980s than did prices for other forms of energy such as natural gas, distillate fuel, coal, and motor gasoline (Testa, et al).

The coefficient on farm output was positive in both the employment and output equations, yet was not significantly different from zero. This indicates there is not a strong link between a change in a state's farm output and changes in food manufacturing activity. It may be that processing plants draw inputs from a multi-state area, rather than from a state-wide area. For example, Iowa processors have been importing hogs from out of state while the state's own hog numbers stagnated. This would naturally weaken the link between hog production and pork processing in Iowa as well as in surrounding states.

Policy

The coefficient on the change in corporate tax rates was negative, as expected, but not significantly different from zero in the output equation. Nor was the tax coefficient significant in the employment equation. To account for the possibility that the industry was in a tax-related disequilibrium at the outset, equations 3 and 6 were re-estimated with initial 1982 tax rates, but the coefficients were insignificant with little impact on the change variable coefficients. In sum, employment and output decisions are apparently made with little regard to changes in state corporate tax rates.

The RTW coefficient was not significant for the output equation, but was positive and significant for the employment equation. This indicates that the existence of RTW laws are associated with relatively higher employment growth. The fact that RTW laws support employment growth but not output growth may indicate a higher labor-capital ratio is a characteristic of food manufacturing in these states.

Agglomeration

The results for the agglomeration variable indicate that while the initial distribution of manufacturing's share of state employment had an impact on subsequent growth, relative changes over the subject period were either not important or did not have a positive impact. The change variable, DMFGSH, was dropped from equations 3 and 6 due to collinearity problems. It had a variance inflation factor in excess of 10, which indicates a high level of correlation to a linear combination of the other explanatory variables. But the coefficient on DMFGSH was significant and negative in equation 2, indicating that food manufacturers are not likely to increase production in states where manufacturing in general is becoming more important to the local economy. Furthermore, the coefficient on the start-of-period variable MFGSH82 was significant and positive, which indicates that states where manufacturing was relatively more important in 1982 registered larger gains in output and employment growth.

Summary

The results indicate that the traditional market factors affecting manufacturing growth in general also hold sway for food manufacturing. Markets, population growth, labor force characteristics, and agglomeration all have an impact on the output and employment growth of food manufacturers. In addition, the successful incorporation of start-of-period variables suggests a disequilibrium approach is more appropriate to describe changes in food manufacturing output and employment over the subject period.

The results also indicate that food manufacturers in general do not focus on high-demand areas, but tend to locate production where other food manufacturers are. This might indicate an orientation towards locating near agricultural production, but the results also showed there was not a strong link between growth in agricultural production and food manufacturing activity. And since food manufacturing is not drawn to areas where manufacturing is a relatively more important part of a state's economy, it suggests that food firms face agglomeration economies that are specific to their type of activity.

The policy variables used in this study suggest that food manufacturers respond in a manner similar to nonfood manufacturers. State corporate tax rates do not have a significant impact on food manufacturing growth. This result agrees with Plaut and Pluta and Wheat in their more general studies of manufacturing. But care must be taken in these comparisons, as these other studies were conducted using earlier time periods. Yet state corporate taxes were not ranked highly as an impetus to expansion or contraction in the survey of food firms conducted by Vesecky and Lins. In contrast, the existence of right-to-work laws do have an important positive impact on employment in food manufacturing, a result also found in other studies. But one wonders whether the firms in these states are substituting labor for capital, which could lead to a competitive cost disadvantage over the longer term.

Further research along these lines using data that is more disaggregated is warranted. Breaking the sample into supply-oriented, demand-oriented, and footloose industries would add more insight. In addition, splitting the sample by states that experienced an increase in output or employment versus those that experienced a decline would enable a more thorough investigation on how different factors affect the direction in which an industry or firm is moving. Finally, focusing on rural vs. urban areas could provide important insights for rural policymakers interested in attracting food manufacturing firms to take advantage of local agricultural resources.

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Appendix: Data Sources

1. Food manufacturing value added: *Census of Manufactures*, U.S. Dept. of Commerce.

2. Food manufacturing employment: *Census of Manufactures*, U.S. Dept. of Commerce.

3. Personal income: *Regional Economic Information System*, U.S. Dept. of Commerce.

4. Distance between population centers: Rand McNally.

5. Population: *Regional Economic Information System*, U.S. Dept. of Commerce.

6. Food manufacturing payroll: *Census of Manufactures*, U.S. Dept. of Commerce.

7. Labor force/participation: *Geographic Profile of Employment and Unemployment*, U.S. Dept. of Labor.

8. Unionization: *Statistical Abstract of the U.S.*

9. Percent population with four or more years of college: *Census of Population: General Social and Economic Characteristics*, U.S. Dept. of Commerce.

10. Electric price: *Census of Manufactures*, U.S. Dept. of Commerce.

11. Farm receipts: *Agricultural Statistics*, U.S. Dept. of Agriculture.

12. State corporate tax rates: *Facts and Figures on Government Finance*, Tax Foundation, Inc.

13. States with right-to-work laws: *Statistical Abstract of the U.S.*.

14. All manufacturing employment: *Regional Economic Information System*, U.S. Dept. of Commerce.

15. Total state employment: *Regional Economic Information System*, U.S. Dept. of Commerce.

Table 1. Top location/expansion factors from prior studies: food manufacturing*

Lopez and Henderson (location)	Vesecky and Lins (expansion)	Vesecky and Lins (contraction)
1. Availability of existing plant facility	1. Proximity to markets	1. Availability of transportation
2. Availability of raw agricultural supplies	2. Availability of transportation	2. Skill of labor pool
3. Already reside or do business in state	3. Proximity to supplies	3. Proximity to existing food processing facilities
4. Proximity to markets	4. Availability of plant facility	4. Availability / quality of water
5. Availability of labor	5. Proximity to distribution center	5. Image of state
6. Availability / quality of water	6. Proximity to existing food processing facilities	6. High demand in neighboring state
7. Proximity to distribution centers	7. Availability / quality of water	7. Transportation costs
8. Availability of waste treatment / disposal facilities	8. Possible new markets in state	8. Availability of waste treatment facilities
9. Attractive place to live	9. Attractive place to live	9. Shipping costs
10. Labor productivity / work ethic	10. High demand in neighboring state	10. Availability of existing plant facilities

*As ranked by authors

Table 2. Descriptive statistics.

Variables	Label	Units	Mean	Std. Dev.
dva	change in food mfg. value added	$000	641,496	813,958
demp	change in food mfg. employment	$000	195	4,766
dpip	change in personal income potential	$000	4,001,891	2,307,456
dvap	change in value added potential	$000	105,804	38,562
dpv	change in pip/vap ratio	percent	2.667	2.319
dpop	change in population	000	481	1,004
dwage	change in annual wage per employee	$000	-0.243	2.563
dl_pop	change in labor force /population	percent	2.435	1.950
dunion	change in unionization	percent	-8.081	4.009
dprod4	change in productivity	value added / payroll	0.682	0.686
dcol	change in pct. pop. w/ 4 years college	percent	3.681	1.384
de pr	change in electricity price	cost per 100 kwh	0.968	0.701
dfarm	change in farm receipts	$million	-926	1,137
dtax	change in corp. tax rates	percent.	0.348	1.610
rtw***	existence of right to work laws	0 or 1	0.416	0.498
dmfgsh	change in mfg. share of employment	percent	-2.758	2.493
pop82	1982 population	000	4,783	4,897
rwage82	1982 food mfg. annual wage	$000	23.955	3.316
e_pr81	1981 electricity price	cost per 100 kwh	3.944	1.268
mfgsh82	1982 mfg. share of state employment	percent	15.958	6.160

Table 3. Regression results for value added model.

Change variables	Label	Regression Coefficients Equation 1	Equation 2	Equation 3
intercept	intercept	-839,822*	17,876	-1,539,929*
dpip	change in personal income potential	-0.254*		
dvap	change in value added potential	15.897*		
dpv	change in pip/vap ratio		-229,882*	-252,628*
dpop	change in population	497.433*	468.487*	324.264*
dwage	change in annual wage per employee	-22,511	-28,625	-15,328
dl_pop	change in labor force /population	-16,748	6,351.333	19,903
dunion	change in unionization	-23,667	-29,103	-33,239**
dprod4	change in productivity	320,219*	211,633**	152,765
dcol	change in pct. pop. w/ 4 years college	-73,286	-7,053	70,439
de pr	change in energy price	286,386*	112,639	281,134*
dfarm	change in farm receipts	-58.272	-107.613	12.028
dtax	change in corp. tax rates	-37,666	-30,310	-4,935
rtw***	existence of right to work laws	5,044	-46,844	-89,939
dmfgsh	change in mfg. share of employment	-56,203	-165,460*	
Level variables				
pop82	1982 population			50.809*
prod482	1982 productivity			291,663*
mfgsh82	1982 mfg. share of employment			36,832*
F value		13.558*	15.083*	18.548*
R^2		0.838	0.838	0.887
adj. R^2		0.776	0.782	0.839

*Significant at 0.05 level
**Significant at 0.10 level
***Binary variable

Table 4. Regression results for employment model.

Change variables	Label	Regression Coefficients Equation 4	Equation 5	Equation 6
intercept	intercept	-5,688	-2,232	5,562
dpip	change in personal income potential	-0.002*		
dvap	change in value added potential	0.086**		
dpv	change in pip/vap ratio		-2,285.242*	-1,184.707*
dpop	change in population	-0.068	0.216	1.999*
dwage	change in annual wage per employee	-419.887	-459.432	-817.742*
dl_pop	change in labor force /population	374.290	684.826*	-87.347
dunion	change in unionization	-95.270	-145.955	-251.757
dprod4	change in productivity	-2,221.493**	-3,577.152*	-1,520.660
dcol	change in pct. pop. w/ 4 years college	1,105.746	1,501.385**	1,663.553*
de pr	change in electricity price	1,506.909	1,461.432	1561.542**
dfarm	change in farm receipts	1.586**	1.827*	0.767
dtax	change in corp. tax rates	564.962	629.947	450.750
rtw***	existence of right to work laws	2,913.751**	2,588.831**	2,345.453*
dmfgsh	change in mfg. share of employment	163.176	-491.086	
Level variables				
pop82	1982 population			-0.494*
rwage82	1982 food mfg. annual wage			-467.675*
e_pr81	1981 electricity price			-1,057.475**
mfgsh82	1982 mfg. share of state employment			346.393*
F value		2.117*	3.345*	6.706*
R^2		0.447	0.534	0.758
adj. R^2		0.236	0.374	0.645

*Significant at 0.05 level
**Significant at 0.10 level
***Binary variable