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THE DYNAMICS OF POSTWAR INDUSTRIAL LOCATION

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THE location of industrial employment is a critical factor in virtually all models of urban spatial structure. However, most theoretical and empirical models of the urban economy say little about the determinants of industrial location. In the extreme, all employment is assumed to be centrally located (e.g., Muth, 1969, or Mills and Mackinnon, 1973), but, even when this assumption is relaxed as in transportation and land use studies (see Brown et al., 1972) or the recent vintage of urban simulation models (e.g., Ingram et al., 1972), employment location remains exogenously determined.[1] Theoretical analyses of industrial location have provided few specific insights into the underlying behavioral relationships, and existing empirical work has failed to identify much more than aggregate trends in employment dispersal. This paper develops a conceptual framework for analyzing the dynamic changes in industrial location and presents tests of several major hypotheses about the determinants of employment location. The empirical analysis models the spatial structure of employment for three selected industries in the Boston metropolitan area for the period 1947 through 1968.

I. Past Research[2]

Theoretical investigations of industrial location, dating back to Weber (1909), explain optimal location for profit maximizing firms. Spatial elements enter through variations in costs of inputs such as land, labor and transportation (cf. Isard, 1956, or Moses, 1958), or variations in the demand for goods arising from output transportation costs or "spatial monopoly" elements (e.g., Hotelling, 1929; Greenhut, 1952). These analyses conclude not surprisingly that firm location will be related to the impact of location on costs and revenues; this impact, however, depends upon the characteristics of the given firm or industry—that is, input elasticities of substitution, the demand for outputs, and the magnitude of cost differentials. Importantly, these theoretical analyses are all static equilibrium statements and say little about dynamic adjustments.

Empirical analyses of manufacturing employment location fall into two categories. Most have been descriptive—typically a presentation of aggregate data revealing the decentralization of employment over time (e.g., Haig, 1926; Kain, 1967). Employment location by sector or specific industry has generally been represented by relative employment in central city and suburban areas, although suburban location has sometimes been disaggregated into zones (e.g., Struyk and James, 1975); the components of employment changes—firm births, deaths, and relocations and firm growth—have also been analyzed (e.g., Leone, 1975; Schmenner, 1975; and Struyk and James, 1975). Observed changes are generally explained by casual observations about changes in costs, transportation, technology, or other factors that might have been related to the passage of time, but no explicit tests are made.

Studies in the second category, cross-sectional analyses of firm decisions, have been unable to disentangle technological changes, cost changes, and changes in other characteristics of the metropolitan area (such as the transportation surface) which motivate the studies and particular model specifications employed.[3] Further, these

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[1] The one exception to this is the endogenous determination of population serving employment, chiefly retail trade (e.g., Lowry, 1972). However, these are generally gravity models based upon residential location, and exogenously determined industrial location is still the driving force.

[2] See the more extensive review in Hanushek and Song (1977).

[3] Analyses using Dunn and Bradstreet firm location data (Leone, 1975; Struyk and James, 1975; and Schmenner, 1975) have data on firm decisions for 1967, 1969, and 1971, but there is no information about changes in exogenous factors over the period, and these data are either aggregated over time or used as separate cross-sections.

studies have used rather crude proxies of locational advantages and have proved quite inconclusive (e.g., Moses and Williamson, 1967; Kemper, 1974; Schmenner, 1975).

II. Conceptual Model

While past modelling efforts haven't been very successful, there does seem to be a consensus on the factors that are likely to be important and, to some extent, on how these have changed over time (e.g., Meyer and Quigley, 1977, chapter 1). An individual profit maximizing firm will base locational decisions on the way revenues and costs vary with the firm's potential locations. For industries serving a national market, product demand (gross of transportation costs) can be assumed invariant to location within a metropolitan area, and locational decisions become a function of operating costs at different locations. Operating costs of firms will be related to geographic concentration because of agglomerative economies—for example, the ready availability of business services, the closeness of freight terminals (mainly rail and ship), and, in some businesses, the ability to carry on face-to-face communications. Further, input costs such as land prices, property tax rates, and wage rates may differ within a metropolitan area. The effect of these differences on the optimal location of the firm depends upon the production technology of firms.

However, this static analysis completely neglects the dynamic changes in technologies and costs identified as perhaps dominating the locational calculations of firms over the postwar period. Increased use of the motor truck for moving raw materials and finished goods, more land intensive plant designs, and the ubiquity of autos (which reduce the costs of collecting a labor force) interact with changes in the transportation surface and in land and labor costs over time. Additionally, actual firm locations depend not only on the changing magnitude and importance of these cost factors but also on the inertia generated by fixed investments and on projected future demand—suggesting that locational decisions will differ by industry and time.

Translating these factors into a model of the locational advantage of a particular place i at time t for industry k yields

$$L_{itk} = f_{tk}(A_{it},T_{it},S_{it},C_{it}), \qquad (1)$$

where

L_{itk} = location advantage;
A_{it} = agglomerative economies;
T_{it} = transportation costs;
S_{it} = availability of space; and,
C_{it} = other cost factors.

This formulation highlights several aspects of the problem not well-treated in past analyses. The locational advantage of a site depends not only upon the relevant exogenous factors at any point in time but also upon the relative importance of these factors to firms in a given industry (as determined by production technologies, etc.). Further, the importance of each of these factors—the relative weights attached to the exogenous influences—is likely to change over time even for a firm in a given industry. Analyses of aggregate trends in employment location have not been able to disentangle any of these separate influences. Cross-sectional analyses, even when conducted on an industry basis, simply provide a snapshot of the locational influences and are unable to predict how changes in exogenous factors (even if known) might affect future locational decisions since the influence of changing technologies (or "relative weights") is not separately identified.

III. Empirical Analysis

The empirical analysis in this paper relies upon a unique data set that allows testing a dynamic model similar to equation (1) for Boston area industrial employment during the post-World War II period.[4] The first part of this section describes aggregate changes in employment location; the second presents the exact model specification; and the third presents estimates of the influence of changing exogenous factors on employment location.

[4] All employment data used hereafter come from the *Annual Census of Manufactures,* Department of Labor and Industry, Commonwealth of Massachusetts. The study area includes 119 cities and towns falling within a 25 mile radius of Boston. This area, roughly corresponding to the study area for the Boston Regional Planning Project, includes the Boston SMSA, parts of the Brockton, Lawrence, and Lowell SMSAs, and outlying areas closely tied to Boston. For a group of major industries, annual data have been collected by individual city and town on number of firms, employment, investment, payroll, and value of product. A detailed description of the study area plus more description of aggregate employment characteristics is found in Hanushek and Song (1977).

A. *Aggregate Changes, 1947–1968*

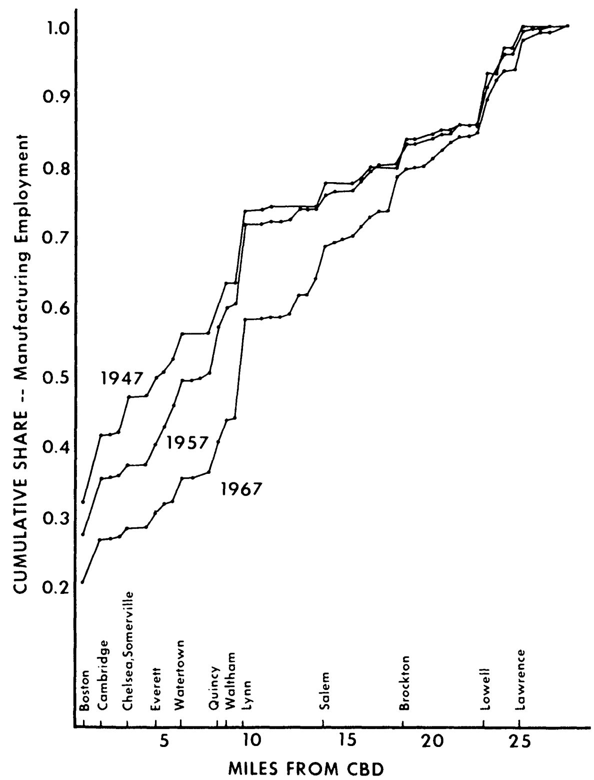
Between 1947 and 1968, the Boston area experienced both a steady decline in total manufacturing employment (amounting to 19%) and a decentralization of employment mirroring that observed in many other industrial cities (see Kain, 1967). While the City of Boston had 32% of area manufacturing employment in 1947, it had only 21% by 1967.

Estimated employment density functions provide a convenient, although crude, summary of metropolitan employment patterns (cf. Mills, 1972). The rate of decay of employment density with respect to miles from the Boston Central Business District (CBD) fell from 0.28 in 1947 to 0.23 in 1957 to 0.17 in 1967.[5]

However, these summary data give a somewhat misleading view of employment decentralization, since the changes were not the result of a uniform flattening of the employment surface. A plot of cumulative employment shares against distance from the Boston CBD (figure 1) shows substantial, and nonuniform, changes in the shape of the employment surface. Relative growth in manufacturing employment took place in closer areas during the 1947–1957 period and in more distant areas during the 1957–1967 period.

Moreover, the aggregate statistics mask more fundamental changes in employment location. Employment changes have not occurred uniformly along rays emanating from Boston but instead have taken place through development of outlying employment nodes. Further, as suggested earlier, changes may be very different by industry. In fact, while mean employment distance from the Boston CBD for all manufacturing employment increased by 5.7% over the period, the corresponding increases for the three industries analyzed below were electrical manufacturing, 35.1%; leather, 14.4%; and woolens, 2.4%.

FIGURE 1.—CUMULATIVE DISTRIBUTION OF MANUFACTURING EMPLOYMENT BY DISTANCE FROM BOSTON CBD



B. *Model Specification and Data*

This section describes the specification and estimation of a locational choice model similar to equation (1) using annual employment data by industry for political jurisdictions in the Boston area (see note 4). The objective is to estimate the marginal impact of various structural factors on employment location for three selected industries: electrical manufacturing, leather, and woolens.[6]

Annual employment in an area is not itself a good measure of industrial location decisions for

[5] Following Mills (1972), if employment density, $D(u)$, at any distance u is $D(u) = De^{-\gamma u}$, integration yields $N(k) = N(1 + k)e^{-\gamma k}$ where $N(k)$ is total employment within k miles of the city center and N is total area employment. Using employment data by distance between the Boston CBD and the centroid of the 118 surrounding jurisdictions, γ is estimated through an iterative search that minimizes the sum of squared deviations between actual and predicted employment. The estimates of γ are very sensitive to definition of the area and estimation technique. The estimates for 1947, 1957, and 1967 based upon only the Boston SMSA are 0.51, 0.36, and 0.26, respectively. Mills' estimates for the Boston SMSA based upon aggregate Census data were 0.29 in 1948 and 0.25 in 1958. (The decentralized nature of the Boston economy can be seen by comparing these to the mean γ's for 19 SMSAs studied by Mills: 0.68 in 1948, 0.48 in 1958, and 0.42 in 1963.)

[6] These industries were chosen because (1) each was historically important to the region; (2) they were in different "stages of growth"; and (3) each served a national market, thus justifying concentration on costs.

Some preliminary analysis of capital investment by areas was also conducted but was rather unsuccessful. The investment data are of dubious quality, and the investment decision undoubtedly includes more factors than the simple locational differences measured here.

two reasons. First, exogenous changes in product demand will lead to employment fluctuations that do not reflect locational decisions. Such cyclic changes are eliminated by measuring local employment relative to the industry's total regional employment in each year.[7] Second, larger jurisdictions would, other things equal, have a larger employment share, but this would not reflect differences in costs.[8] Employment shares are normalized by land area to create share density, the measure of location attractiveness used throughout this study.

Directly measuring the explanatory variables in equation (1) is difficult, partly because the theoretical concepts are quite vague. Agglomerative forces are proxied by (1) the distance from Boston to each city (to reflect the influence of the centralized business facilities, etc., which are concentrated in Boston);[9] and (2) manufacturing activity in the locality.[10]

The effect of the transportation system on manufacturing location is a focal point in this study, and, absent travel cost data over time, is measured by local access to specific transportation modes. The availability of railroad service is measured by whether or not a primary railroad line goes through a given city or town; highway services are measured by the distance from a city's centroid to individual express highways in each year.[11]

Space availability, which would be most important for growing industries, is measured by vacant land in a jurisdiction.[12] Vacant land estimates for 1952 and 1963 are interpolated and extrapolated linearly for other years.

Data for other costs, such as differences in land values, property taxes, and wage rates, are unfortunately unavailable, and thus the factors are not explicitly included in the analysis.[13] However, some of their influence is undoubtedly included in the measure of distance from Boston CBD.

Dynamic aspects of locational decisions are included in two ways. First, separate models are estimated to describe the birth, death, and relocation process and the growth process. Second, the functional form of the model estimated allows for dynamic changes in the relationships.

Decisions that involve new firm operations (births, deaths, and relocations) may be different in character from changes in employment through growth. Several past authors (e.g., Leone, 1975; Struyk and James, 1975; or Moses and Williamson, 1967) have concentrated upon the former decisions, presumably because these provide more information about the effects of the current technologies and locational influences than the more "passive" decisions about employment growth for which inertia, fixed investments, and nonlocational factors such as industry demand might disguise locational influences. Even though actual firm changes are not directly observed, differences between these "active" and "passive" decisions are tested by estimating models that explain the existence of minimal amounts of employment in a given industry. Specifically, the dependent variable ($EXIST_{itk}$) equals one if the share density of industry k in the city i in time t is greater than 0.00035/square mile

[7] This normalization also eliminates secular trends in employment, which seems appropriate since the focus is relative location. The influence of secular trends is, however, indirectly included through the choice of industries with different growth patterns.

[8] Land areas for localities other than the City of Boston range from 1.9 to 33.2 square miles.

[9] Explaining location with proxies of Boston's characteristics implies that the model will not provide information about Boston itself. Explaining Boston's employment requires regional models such as Burrows and Metcalf (1971). The estimation excludes the City of Boston; its share can be calculated as the residual since the shares for a given year must sum to 1.

[10] Local concentrations were also calculated as shares of the total manufacturing employment in the region except that own city manufacturing share was calculated excluding employment in the industry being modelled.

[11] Three separate highway variables were analyzed. These were distance to Route 128 (the major circumferential highway), distance to the Massachusetts Turnpike (the major highway going west from Boston), and the distance to the closest expressway (either Route 128, the Mass. Turnpike, or Routes 2, 3, 24, 25, 93, 495). These distances are not constant for a given city because they are also a function of when different highway segments were completed.

[12] Vacant land is calculated as acreage that is either classified as Vacant Land, Forest or Agriculture. See Boston Regional Planning Project, *Comprehensive Land Use Inventory* (Commonwealth of Massachusetts, 1966), appendices C and G.

[13] Land values are difficult to collect at a single point in time, let alone over time as would be required, because of the considerable variation in prices even within a limited geographical area. Similarly, because of assessment variations, property taxes are difficult to obtain (see Hamer, 1973). Simple theoretical models (e.g., Muth, 1969) predict that wage rates will fall with distance from the CBD. However, this prediction is based upon assumptions of centralized employment, and the predictions are less clear for decentralized employment such as in Boston. Empirical studies find little evidence of wage gradients, and Wachter (1972) finds some slight evidence of *higher* wages in suburban Boston areas.

and zero otherwise. (This cut-off corresponds, for the mean city size, to about 0.5% of the total area's employment in the particular industry.) Models explaining the existence of a given industry are estimated using all "industrial" cities, i.e., all cities with share density for total manufacturing employment greater than 0.00035/square mile for any year in the period 1947–1968. Second, conditional upon having industry specific employment densities greater than the cut-off, models explaining employment share density itself are estimated.[14]

Explanations of employment change based upon changing technologies and transportation costs imply that simple linear models are inappropriate since the relative weights attached to the various locational factors will change over time. An estimation form of equation (1) which allows for these dynamic factors, albeit in a crude manner, is

$$L_{itk} = \beta_0{}^k + \beta_{1t}{}^k A_{it} + \beta_{2t}{}^k T_{it} + \beta_{3t}{}^k S_{it} + \epsilon_{it} \quad (2)$$

where the coefficients are assumed to change linearly over time, as in,

$$\beta_{jt}{}^k = \delta_{j0}{}^k + \delta_{j1}{}^k \, TIME, \; j = 1,2,3. \quad (3)$$

This model can be consistently estimated by least squares procedures.

The sample combines time series and cross-sectional observations about employment, and, assuming that some cities and towns have continuing locational advantages or disadvantages that are not captured by the included exogenous variables, the error structure is specified as

$$\epsilon_{it} = \mu_i + \nu_{it} \quad (4)$$

where μ_i is a city specific error term and ν_{it} is white noise (both assumed independent of the exogenous variables). All models are estimated using this error components structure (cf. Balestra and Nerlove, 1966).

C. *Estimation Results*

During the postwar period, electrical employment has become considerably less concentrated while leather employment has declined somewhat in terms of the number of cities and towns where it is located, and woolens employment has become much more concentrated. The models explaining the existence of minimal activity (table A1) include changes in the pull of the City of Boston, the effects of local industrial concentration in each given place, the effects of the changing highway system, and the specific impact of Route 128 (the major circumferential highway). Table 1 presents the marginal probabilities of industrial location for differences in the exogenous variables (holding other factors constant), evaluated in different years.

The qualitative effects of the exogenous factors are remarkably similar, but interesting quantitative differences emerge. The pull of Boston has lessened over time for the electrical and leather industries and has remained rather constant for the woolens industry, with the effect on the leather industry being strongest.[15] Being one mile farther from Boston increased the probability of leather industry employment by 0.001 in 1947 but by 0.026 in 1967, holding constant other factors. Local employment has become more important for each industry with the largest change in the leather industry and the least in the electrical industry.[16] Highway access, measured by distance to closest expressway, has a declining impact throughout the period. While employment was found close to existing highways in

[14] This formulation allows for different behavioral relationships in probability of minimal activity and share density—a finding subsequently confirmed. If one thought these two relationships were the same and that the observations were generated by the same error structure, share density models could be estimated for the entire sample of cities, but least squares would be inappropriate because of the truncation of the observed share densities at zero (Tobin, 1958). Some statistical problems may still be present in the linear dichotomous dependent variable models (see Hanushek and Jackson, 1977, chapter 7), but modification of the estimation model is not feasible because of the large samples and further structuring of the errors below. Estimation of the separate models seemed to use the information more fully than estimation of just one or the other and does allow for differences in the structure of the two decisions. This problem and the estimation solution are similar to that in Burrows and Metcalf (1971) for county employment.

[15] Distance to Boston is meant to measure agglomerative forces that could decline because of changes in services in Boston, changes in technology, or reductions in communication costs. However, this variable could also be measuring decreases in transportation costs or changes in land price gradients. This variable is insignificant for the woolens industry.

[16] Changes over time for the electrical industry, while positive, are small and statistically insignificant by standard tests.

TABLE 1.—MARGINAL CHANGES IN PROBABILITIES OF INDUSTRY LOCATION AND IN SHARE OF EMPLOYMENT: 1947, 1957 AND 1967

	Marginal Change in Probability[a]			Marginal Change in Employment Share[a]		
Variable/Industry	1947	1957	1967	1947	1957	1967
Distance to Boston (per mile farther)						
Electrical	.0011	.0112	.0224	−.0001	−.0009	−.0017
Leather	.0013	.0130	.0260	−.0022	−.0222	−.0445
Woolens	.0000	.0003	.0006	.0015	.0153	.0305
Local Density (per 10% increase from sample mean)						
Electrical	.0020	.0024	.0028	−.0120	.0281	.0727
Leather	.0012	.0108	.0216	−.0048	.0058	.0176
Woolens	.0012	.0048	.0088	.0048	−.0018	−.0090
Distance to closest expressway (per mile farther)						
Electrical	−.1411	.0650	.2940	−.0387	−.0324	−.0254
Leather	−.0250	−.0250	−.0250	−.0301	.0013	.0362
Woolens	−.0195	.0480	.1230	.0276	−.0615	−.1606
Route 128						
Electrical	.2606	.2606	.2606	.0085	.0085	.0085
Leather	.2674	.2674	.2674	−.1940	−.1940	−.1940
Woolens	.0954	.0954	.0954	−.0173	−.0173	−.0173

[a] Difference in probability of minimal industry employment.
[b] Difference in employment share evaluated at mean city size.

the early period, it spread out as the highway system became more extensive.[17] For jurisdictions on Route 128, the probability of employment (after highway completion) is increased by 0.26 for the electrical industry, by 0.27 for the leather industry, and by 0.095 for the woolens industry.[18]

The similarity across industries is striking since the electrical industry is rapidly expanding over the period while both the leather and woolens industries are contracting.[19] In other words, "births" and "deaths" appear to be influenced similarly by locational factors.

[17] At the beginning of the period, when only the Mass. Turnpike existed, the average jurisdiction was 16 miles from the highway; by 1968, the average was under 3 miles. Trended access is insignificant for the leather industry.

[18] Alternative models (here and for share densities below) which tested one and two year lags in the introduction of highway segment, the impact of specific highways (the Mass. Turnpike and distance to Route 128), and the importance of primary railroad line showed no improvement in results. Further, differences in vacant land, somewhat surprisingly for the growing electrical industry, have no effect on employment location. This may arise from general availability of minimal amounts of space outside of Boston; alternatively, with a well functioning land market, prices (which are a function of variables already in the model) may adjust to eliminate space availability differentials.

[19] Electrical industry employment is found in 28 cities in 1947 and expands steadily to 80 cities in 1968; in contrast, leather employment declined from 12 cities to 8 and woolens employment from 17 to 11.

The models explain between 42% and 50% of the variation in location probabilities. Additionally, the city specific error component represents 55% to 66% of the total residual variation; i.e., a large proportion of the unexplained locational probabilities is explained by unmeasured locational factors that remain constant for a city over the entire period.

The models explaining relative employment location (table A1) are estimated conditional on the industry being located in the city and town. The estimated marginal effects of the exogenous variables on the share of employment (for a city of average area) are also included in table 1. Unlike the probability of employment, patterns of employment growth exhibit considerable inter-industry variation in both direction and magnitude of impact of exogenous factors.

Electrical and leather industry employment shares follow quite similar patterns. In contrast to employment probabilities, shares of closer-in locations increased over time, other things constant. For leather employment, being one mile farther from Boston implies a 0.002 smaller share in 1947 and a 0.045 smaller share in 1967. For both, local employment concentrations have become increasingly important; by the end of the period a 10% increase in local employment implies an increase of over 7% of the region's electrical employment. The impact of expressway access has decreased over time, although electrical industry employment growth continues to occur at locations near expressways throughout the period. The major difference between electrical and leather industry employment patterns is the effect of Route 128: electrical employment has grown relatively in places on Route 128 while leather employment has not.

The woolens industry, which has declined relative to the leather industry and the growing electrical industry, exhibits very different locational patterns. Woolens employment has become increasingly less dependent upon proximity to Boston, is little affected by other local industries, but has become increasingly concentrated near expressways.

The share density models explain 25%–30% of employment variation over the period; additionally, 52% to 87% of the residual variation arises from unmeasured city specific locational advantages.[20]

IV. Summary and Conclusions

Past research on industrial location has explained employment decentralization by technological change, which implies increased space demands and smaller agglomeration economies, and by increased demands for highway access, but these have not been adequately tested. This analysis explicitly tests these hypotheses by estimating employment location models for three selected industries in the Boston area over the post-World War II period.

The analysis finds that: (1) there are significant differences in the locational choice for different industries; (2) decentralization has not occurred through uniform dispersal of employment to outlying areas, but instead has occurred through development of outlying employment nodes; (3) dynamic changes in locational advantage are extremely important; (4) firm "births" and "deaths" (proxied by minimal amounts of industry employment in a jurisdiction) involve different behavioral relationships than employment growth; (5) the influence of locational factors on births and deaths is remarkably similar; (6) the pull of the central city has lessened over time in terms of the probability of finding some employment of a given industry, but not necessarily in terms of employment shares; (7) local employment concentrations (outside of the central city) have become increasingly important and can offset the disadvantage of being farther from the central city; (8) highway access is an important determinant of employment location, but the advantage of locations closer to expressways has lessened as expressways have become more ubiquitous; and, (9) a significant portion of employment growth cannot be explained by the measured locational factors (agglomeration economies, transportation access, and space availability), although unmeasured characteristics of locations that remain constant over time explain a majority of the residual variation.

[20] The variation explained by the measured locational factors is higher in the probability models than in the share models. However, the variation arising from both measured and unmeasured (city specific) factors is about the same in the two different models.

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APPENDIX

TABLE A-1.—ESTIMATED MODELS OF PROBABILITY AND SHARE DENSITY OF EMPLOYMENT BY INDUSTRY

	Dependent Variable: $EXIST_{itk}$ Industry			Dependent Variable: $SHARE_{itk}$ Industry		
Variable	Electrical	Leather	Woolens	Electrical	Leather	Woolens
DISBOS·TIME	0.00112	0.0013	0.00003	-0.068×10^{-4}	-0.086×10^{-3}	0.856×10^{-4}
	(3.5)	(6.0)	(−0.1)	(−3.4)	(−5.1)	(6.0)
LOCDEN	11.01	0.40	2.13	−0.977	−1.21	0.91
	(2.9)	(0.3)	(2.1)	(−5.0)	(−2.2)	(3.8)
LOCDEN·TIME	0.300	2.82	1.18	0.528	0.120	−0.124
	(0.2)	(6.6)	(4.3)	(8.0)	(1.6)	(−3.2)
*R*128	0.2506	0.2674	0.0954	0.00067	−0.015	−0.00097
	(7.5)	(10.7)	(4.5)	(2.1)	(−7.0)	(−0.9)
DISCLOSE	−0.164	−0.025	−0.027	−0.0031	−0.0026	0.0021
	(−10.6)	(−2.2)	(−2.8)	(−4.2)	(−3.8)	(7.0)
DISCLOSE·TIME	0.0229	−0.0000	0.0075	0.055	0.270×10^{-3}	-0.555×10^{-3}
	(7.9)	(−0.2)	(3.8)	(4.1)	(1.8)	(−7.3)
CONSTANT	0.250	0.073	−0.00006	0.00097	0.025	0.333×10^{-5}
	(9.1)	(4.0)	(−0.0)	(3.3)	(11.8)	(0.0003)
R^2	0.46	0.50	0.42	0.26	0.26	0.30
Intraclass Correlation	0.66	0.55	0.59	0.71	0.87	0.52

Note: Estimated by Balestra-Nerlove (1966) procedures. *t*-statistics are in parentheses.

Variable Definitions
(for place *i* in year *t* and industry *k*)

Variable		Definition
$SHARE_{itk}$	=	employment share density
$EXIST_{itk}$	=	1 if share density is greater than 0.00035/square mile
	=	0 otherwise
$DISBOS_i$	=	distance in miles from Boston CBD (Central Business District) to centroid of place *i*
$LOCDEN_{itk}$	=	local share density of total manufacturing employment not in industry *k*
$R128_{it}$	=	1 if Route 128 passes through place *i* during any time *t* after construction
	=	0 otherwise
$DISCLOSE_{it}$	=	distance in miles from centroid of place *i* to closest express highway
$TIME_t$	=	1 in 1947; = 2 in 1948, etc.