Chapter 6

Impact of Agglomerations on the Economy

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Abstract

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Introduction

Regional and local policymakers increasingly look to targeting-based strategies to promote and encourage high agglomerations of activity in selected industrial sectors. Such policies are motivated by the recognition that industry agglomeration provides location-specific advantages that are external to individual businesses but are shared by establishments operating in the local industry (Porter 2000). These localization externalities, as discussed by Woodward and Guimarães in Chapter 5, include the availability of a skilled workforce and specialized machinery, and information spillovers concerning product markets and production technologies (Barkley and Henry 1997; Krugman 1991; Marshall 1890). Although many economic development researchers and practitioners believe they exist, location-specific advantages of industry agglomeration are difficult to capture and measure directly. For this reason, past studies have used a variety of indirect indicators related to business performance (e.g., firm location, employment growth, wages) and comparisons of the growth of industries across regions to measure the effects of industry agglomeration (Glaeser et al. 1992; Head, Ries and Swenson 1995; Gibbs and Bernat 1997).

This chapter presents empirical evidence on the location-specific advantages of industry clustering, as well as the effects of industry agglomeration on indicators of growth and development in Maine. First, the importance that businesses place on location-specific advantages associated with industry clusters is examined. These findings are based on surveys of Maine companies operating in the biotechnology industry, and the environmental and energy technology industry. Second, results from several recent empirical studies are used to investigate the extent to which firm location, employment growth and earnings are positively associated with industry agglomeration, and to identify the industries in which agglomeration seems to matter. This analysis is guided by the notion that these indicators of growth and development may capture different aspects of localization externalities. For example, new businesses may locate in an area with a high agglomeration of industry to tap into a skilled labor force or key natural resource. On the other hand, incumbent establishments may grow more rapidly in an area with a high agglomeration of industry than elsewhere because of knowledge spillovers transmitted through repeated dealings with similar firms.

Previous studies have examined the effects of industry agglomeration on firm location, employment growth and wages (Head, Ries and Swenson 1995; Gibbs and Bernat 1997). Some of these studies distinguish between "static" and "dynamic" localization externalities (Glaeser et al. 1992; Henderson, Kuncoro and Turner 1995; Sveikauskas 1975). Static localization externalities are the immediate benefits an establishment receives from its close proximity to other businesses in the same industry. These benefits, such as the availability of industry-specific inputs, explain the high geographical concentration of many U.S. industries and the

importance of industry agglomeration to firm location (Guimarães, Figueiredo and Woodward 2000; Head, Ries and Swenson 1995; Krugman 1991).

Dynamic localization externalities are the location-specific advantages an establishment accrues over time from repeated dealings with other local businesses in the same industry. These knowledge spillovers explain the high levels of employment growth, productivity and wages associated with industry agglomeration (Gibbs and Bernat 1997; Henderson 1997). O'hUallachain and Satterthwaite (1992) found a positive relationship between employment growth and industry size, and Henderson, Kuncoro and Turner (1995) uncovered a positive relationship between employment growth and an industry's share of total local employment. Although the effects of industry agglomeration on rural employment growth reported by Barkley, Henry and Kim (1999) are somewhat mixed, Henry and Drabenstott (1996) found that industry clusters are a "major source" of manufacturing employment growth in U.S. rural areas.

Maine provides a good case study for an empirical analysis of industry agglomeration in rural areas. Thirteen of Maine's sixteen counties are classified as "nonmetropolitan" based on USDA's rural-urban continuum, and five of the nonmetropolitan counties are "not adjacent" to a metropolitan area. Some of the most agglomerated industries in Maine are logging, ship and boat building and repairing, miscellaneous wood products, water transportation services, sawmills and planing mills, fuel dealers, hotels and motels, and camps and recreational vehicle parks (Gabe 2003). Maine's wood products industries, which rely heavily on the state's natural resources, are typical of the types of sectors that are concentrated in U.S. nonmetropolitan areas

(Kim, Barkley and Henry 2000). Gibbs and Bernat (1997) found lumber and wood products clusters in 183 rural areas, which cover 848 nonmetropolitan U.S. counties.

Empirical Evidence on Industry Cluster Advantages in Maine

As noted above, some of the commonly-cited location-specific advantages of industry agglomeration are a large pool of trained, specialized workers; access to specialized equipment and machinery; and enhanced opportunities for inter-firm networking and information sharing. Although these benefits are often difficult for policymakers to measure, business surveys can be used to assess their importance to firm profitability and growth. Allen and Gabe (2003) and Noblet and Gabe (2006) surveyed Maine businesses in the biotechnology industry, and the environmental and energy technology industry. These industries have been targeted by Maine policymakers as key clusters for growth and development assistance. Given that they are highly agglomerated in the southern part of the state, the industries are ideal candidates for an analysis of industry cluster advantages.

Before looking at some of the survey questions related to industry clustering, a brief description of the two highlighted industries is provided. The Maine biotechnology industry consists of approximately 80 businesses. These companies are engaged in research and development, as well as the manufacturing and provision of a wide variety of products and services. The businesses cover a broad spectrum of the biotechnology industry, from human diagnostics to marine biotechnology to genomics and proteomics. Biotechnology firms are highly concentrated in southern Maine around the city of Portland, but they also operate in ten of the state's sixteen counties. An industry study conducted in 2002 found that these firms generated a combined

$432 million in annual sales and directly employed 3,690 workers, which is equivalent to 0.76 percent of total state employment (Allen and Gabe 2003). Including multiplier effects, the biotechnology industry contributed $685 million in output to the Maine economy in 2002, and supported 7,135 Maine jobs.

Maine's environmental and energy technology industry consists of about 688 businesses and organizations. It is quite diverse, made up of firms and organizations engaged in activities ranging from environmental consulting services to the development of non-traditional energy sources. Like the biotechnology industry, the environmental and energy technology industry in Maine is highly concentrated in the southern, more urbanized, part of the state. Two southern Maine counties are home to a combined 45 percent of industry establishments. Noblet and Gabe (2006) found that Maine's environmental and energy technology industry directly generated an estimated $574.1 million in sales, supported 5,269 full- and part-time jobs, and provided $222.8 million in employee earnings in 2006. Direct employment in the industry is equivalent to 1.1 percent of total state employment. Counting multiplier effects, the industry contributed $882.7 million in sales to the Maine economy, and supported 9,650 jobs that provided $330.9 million in earnings.

The business surveys included several questions that can be used to examine the location-specific advantages of industry clusters. A question relevant to labor market pooling asked firms to indicate "important sources" of workers. As reported in Table 1, almost 40 percent of the biotechnology survey respondents viewed other biotechnology businesses located within the state as an important source of new employees. By comparison, only one-third and one-quarter

of the businesses felt that four-year universities located in Maine and out-of-state businesses, respectively, are key sources of biotechnology employees. Likewise, in the environmental and energy technology industry, a higher proportion of firms (32 percent) felt that other Maine establishments are an important source of workers, compared to out-of-state businesses (24 percent) and four-year universities located in Maine (24 percent).

The importance that firm's place on the availability of specialized equipment was assessed with a question that asked if this "location issue" affects the establishment's profitability or growth potential. Sixty-nine percent of the biotechnology firms surveyed felt that the availability of specialized equipment impacted their profitability or growth potential. In terms of the proportion of biotechnology firms that felt it was important, the availability of specialized machinery ranked below business climate factors such as health care costs (92 percent), Maine's quality of life (85 percent) and labor costs (82 percent); and above factors such as access to in-state venture capital (39 percent), the quality of local K-12 schools (58 percent), and distribution and transportation costs (65 percent).

Compared to the biotechnology industry, a much smaller percentage (30 percent) of survey respondents in the environmental and energy technology industry believed that the availability of specialized equipment impacted their profitability or growth potential. In terms of the proportion of environmental and energy technology companies that felt it was important, the availability of specialized machinery ranked well below factors such as Maine's quality of life (81 percent), health care costs (79 percent) and state sales and income taxes (74 percent) and only slightly above financing issues such as access to in-state venture capital (16 percent), access to in-state

debt financing (23 percent), and availability of state government funding for research and development (29 percent).

With respect to the location-specific cluster advantage of knowledge spillovers, the surveys asked whether the business has ever engaged in joint research and development activities or shared technical information with other businesses or organizations (e.g., universities, non-profits). Results from the biotechnology survey, summarized in Table 2, show that 58 percent of the respondents have conducted joint research and development activities, and 56 percent have shared technical information with other businesses or organizations. However, surprisingly, the survey found that Maine biotechnology companies were more likely to partner with non-Maine businesses than with other Maine businesses for both types of activities (it is possible that these out-of-state business may be located across the border in New Hampshire).

By comparison, although environmental and energy technology firms appear less likely than biotechnology companies to share technical information or conduct joint research and development with any type of partner, Table 3 shows that they are more apt to engage in these types of activities with other Maine businesses than with firms from outside the state. A possible explanation for the differences in the in-state versus out-of-state orientation of information-based partnerships of the two highlighted industries is that they rely on different types of knowledge. Howells (2002, p. 877) suggests that scientific industries, such as biotechnology, "depend more on codification and the transmission of information via codified 'knowledge,'" which generate spillovers that are "less localized in nature." On the other hand, for industries dominated by engineers – like Maine's environmental and energy technology industry – "learning-by-doing

and tacit knowledge are more important," which are displayed through "more localized spillover effects."

These survey results reveal the importance, or in some cases indifference, that businesses place on the location-specific advantages often associated with industry clusters. Maine firms in the two highlighted technology-based industries, which are highly agglomerated within the state, tend to believe that other Maine businesses (at least more so than other sources of employees) are a good place to find workers. This provides modest evidence – although the numbers are not overwhelming – that businesses tap into a locally-available skilled workforce. The evidence is mixed on the benefits that businesses derive from the local availability of specialized equipment and machinery. Over two-thirds of the biotechnology firms believe that this business climate factor impacts their profitability or growth potential, but only 30 percent of companies in the environmental and energy technology industry feel it is relevant. Finally, survey results related to knowledge spillovers suggest that businesses in both industries seem to interact with others, especially in research and development activities and the sharing of technical information. However, in the biotechnology industry, these types of interaction are more likely to occur with a non-Maine business than with an in-state partner.

Empirical Evidence on Industry Clusters and Local Business Vitality

The second part of the chapter summarizes recent studies on the effects of industry agglomeration on business location, employment growth and wages. This section explores the extent to which clusters stimulate economic vitality, and provides insights into the industries that gain a boost from agglomeration. Empirical results are discussed after a general overview is

provided of the firm location and establishment growth models used in the analysis. Detailed descriptions of these models are presented elsewhere (Gabe and Bell 2004; Gabe, 2003, 2004).

As outlined by Deller in Chapter 4, business location models typically relate the expected profits ($\pi_{i,j}$) earned by establishment i in municipality j to a set of location-specific attributes,

[1] $\pi_{i,j} = \beta' X_{i,j} + e_{i,j}$

where, β is a vector of parameters, $X_{i,j}$ is a vector of location-specific attributes, and $e_{i,j}$ is a random error term (Carlton 1983; Friedman, Gerlowski and Silberman 1992; Guimarães, Figueiredo and Woodward 2000). Profit-maximizing behavior suggests that establishment i will locate in municipality k if the expected profits in municipality k exceed the expected profits the business could earn elsewhere (e.g., $\pi_{i,k} > \pi_{i,j}, \ \forall j \in J$).

McFadden's (1974) conditional logit model is commonly applied to this type of discrete-choice location problem (Carlton 1983; Coughlin, Terza and Arromdee 1991; Head, Ries and Swenson 1995; Leatherman and Kastens Chapter 7; Cader, Leatherman and Crespi Chapter ???). However, Guimarães, Figueiredo and Woodward (2003) propose the use of a Poisson regression framework, instead of the conditional logit model, to analyze business location decisions (see also Ruem and Harris, Chapter 8). The number of businesses that began operations in each municipality is estimated using a Poisson regression model in which the likelihood of observing n_j new businesses is:

[2] $f(n_j) = (e^{-\lambda j} \lambda_j^{nj})/n_j!$ and $\ln \lambda_j = \beta' X_j$,

where, β is a vector of parameters and $X_{i,j}$ is a vector of location-specific attributes (Coughlin and Segev 2000; Greene 2000). Along with the industry agglomeration variable (i.e., location

quotient), described by XXX in Chapter X, the vector $X_{i,j}$ contains the municipality's distance to the nearest interstate highway, population size, local labor costs, and several local government spending variables. The government spending variables were included in the empirical model to examine the effects of local fiscal policy on business location, which was the focus of the original paper (Gabe and Bell 2004). Analysis presented in this chapter extends the original research with a new emphasis on the importance of industry agglomeration as a location factor. The population size variable accounts for the effect of urbanization economies on location, while the distance to an interstate highway measures accessibility to markets.

The business growth model that underlies our empirical analysis is

[3] $S_{t'} = [G(S_t, A_t)]d(S_t)e_t$

[4] $(\ln S_{t'} - \ln S_t) / d = \ln G(S_t, A_t) + u_t$

where S and A are establishment size and age, G(.) is a firm growth function, the subscript t indicates time where $t' > t$ and $d = t' - t$, e is a lognormally distributed error term, and u is normally distributed with mean zero and independent of S and A (Evans 1987). This type of model has been used to examine the relationship between firm (employment) growth rates and internal conditions such as business size and age (Simon and Bonini 1958; Hymer and Pashigian 1962; Singh and Whittington 1975; Hall 1987). Previous studies have investigated Gibrat's law, which suggests that firm growth is independent of firm size (Hart and Prais 1956). Jovanovic's (1982) passive firm learning hypothesis, which implies a negative relationship between growth and firm age, has also been tested in many empirical studies (Evans 1987; Dunne, Roberts and Samuelson 1989; Variyam and Kraybill 1992, 1994).

Equation 4 can be expanded to include industry agglomeration and other regional characteristics that may affect establishment growth,

$$[5] \quad (\ln S_{t'} - \ln S_t) = \beta_0 + \beta_1 \ln S_t + \beta_2 \ln A_t + \beta_3 (\ln S_t)^2 + \beta_4 (\ln A_t)^2 + \beta_5 (\ln S_t) \times (\ln A_t) + \beta_6 \ln LQ + \beta_7 \ln COMP + \beta_8 \ln POP + \beta_9 \ln DIVER + \beta_{10} INDGRO + \beta_{11} \ln CITY\ WAGE + e$$

where, LQ (location quotient) is a measure of industry agglomeration, COMP represents the competitiveness of the local industry, POP is municipality population size, DIVER is a measure of local economic diversification, INDGRO is the logarithmic growth rate of U.S. employment in the establishment's industry, and CITY WAGE is the local wage rate. As in the business location model, population size is included as a measure of urbanization economies, expected to enhance business growth. The economic diversification variable, defined as the percentage of local employment made up by the five largest industries, is used to test the idea that local industrial variety stimulates growth (Jacobs 1969; Glaeser et al. 1992). Following Glaeser et al. 1992, the competitiveness of the local industry is represented by the average size of establishments operating in the industry (relative to the national industry average). Porter (1990) suggests that competition occurring within a local industry encourages innovation and growth, while Romer (1986) believes that competition may limit growth because it erodes the market power necessary to capture rents from new innovations.

The dependent variable used in the establishment wages model is the natural logarithm of quarterly wages paid per establishment employee divided by the average quarterly wages earned per worker in the U.S. industry. This is interpreted as a rate by which establishments "over" or "under" pay their workers relative to the national industry average. The employee earnings

model uses the same set of explanatory variables as the employment growth model shown in equation 5, although the reasoning behind the inclusion of some of the control variables is slightly different. For instance, employment size is included in the wage model to test the hypothesis that large companies pay higher wages than small businesses (Brown and Medoff 1989; Doms, Dunne and Troske 1997).

The firm location, business growth and wages models described above are estimated using data on Maine establishments. The firm location analysis focuses on 3,763 new establishments that began operations in one of Maine's 129 most populated municipalities between 1993 and 1995. These businesses were identified using Covered Employment and Wages (ES-202) data. To be counted as a new business, the establishment must have an "initial liability date" between the first quarters of 1993 and 1995, and it must have remained in operation with one or more workers until at least 1996. The empirical analysis of employment growth and wages uses ES-202 data on a sample of 21,775 establishments that employed one or more workers during the first quarter of 1996. A three-year logarithmic growth rate of employment between 1996 and 1999 is examined, as well as wages paid during the first quarter of 1996.

Industry agglomeration is represented in all three of the empirical models by location quotients, a measure of local (i.e., municipality) industry specialization relative to the U.S. economy. As described by Woodward and Guimarães (Chapter 5) and Barkley and Henry (Chapter 9), location quotients are calculated as the percentage of a municipality's businesses in a 2-digit SIC industrial category divided by the percentage of U.S. businesses in the same category. Location quotients greater than one imply that the region has a specialization in the particular industry.

Table 4 summarizes empirical results on the effects of industry agglomeration on business location, establishment growth and wages. Separate business location models are estimated for 54 2-digit SIC industries, and establishment growth and wages models for 58 2-digit industries. As discussed above, a Poisson estimator is employed to analyze business location. To account for the censored nature of the dependent variable (i.e., establishments that closed have a "growth rate" of -1.0), a Tobit estimator is used to analyze establishment growth. Finally, the analysis of establishment wages uses an OLS estimator. In the table, a "+" sign means that the municipality-industry location quotient has a positive and statistically significant effect on the selected indicator, while a "-" sign means that the industry agglomeration variable has a negative and significant effect on the indicator. Cells are left blank in cases where the location quotient does not have a statistically significant effect on the indicator of business vitality.

Other results from the analysis of business location, discussed in more detail by Gabe and Bell (2004), suggest that local spending on educational instruction and operations – but not educational administration – encourages business location. In addition, businesses are attracted to areas with a large population, while fewer establishments begin operations in areas located far away from an interstate highway. As discussed in the original firm growth paper (Gabe 2004), several of the control variables unrelated to local industry agglomeration have a significant effect on establishment employment growth and wages. Establishment size and age were found to have a negative effect on employment growth, which is consistent with other studies on the topic (Evans 1987; Dunne, Roberts and Samuelson 1989; Variyam and Kraybill 1992, 1994). Also

found in other studies, establishment size has a positive effect on the wages paid by a business (Brown and Medoff 1989; Doms, Dunne and Troske 1997).

The empirical results suggest that all three indicators are, to some degree, positively associated with industry agglomeration. Agglomeration clearly appears to matter, according to at least one indicator of growth or development, in 35 of the 58 2-digit SIC industries. Industry agglomeration encourages business location in 17 of 54 industries, it promotes establishment growth in 17 of 58 industries, and agglomeration increases establishment wages in 9 of 58 industries. On the other hand, industry agglomeration has a negative effect on employment growth in one industry, and it decreases wages in two industries.

The municipality-industry location quotient has a positive effect on all three indicators of growth and development in just one industry, "real estate." Industry agglomeration has a positive effect on two of the three indicators in the "printing and publishing," "trucking and warehousing," "communication," "wholesale trade – nondurable goods," "apparel and accessory stores," "hotels and other lodging places," "personal services," and "business services" industries. Finally, the location quotient has a positive effect on one of the three indicators in 24 of the 58 2-digit SIC industries.

These results demonstrate how the indicators of growth and development used in the study capture different aspects of localization externalities. Recall that static localization externalities, most likely to affect establishment location, are the benefits received immediately upon beginning operations near other similar businesses. The "lumber and wood products" industry,

mentioned earlier in the chapter to exhibit clustering in U.S. nonmetropolitan areas, provides a good example of an industry characterized by static localization externalities. Wood product businesses flock to an area with a high agglomeration of industry to immediately take advantage of a key natural resource (i.e., Maine's forests). However, for establishments already in operation, there are no signs of dynamic localization externalities resulting in enhanced growth or wages. Beyond this example, it is interesting to note in Table 4 that agglomeration affects employment growth or wages in only six of the seventeen industries in which agglomeration encourages location. This suggests that static localization externalities rarely lead to lasting agglomeration benefits after an establishment begins operations.

Results also imply that the way in which agglomeration impacts growth and development may vary systematically by industry. Although a full comparison based on multiple industry characteristics is beyond the scope of the current analysis, the average size of U.S. industry establishments serves to illustrate this point. In the 17 industries in which industry agglomeration affects location, the average U.S. establishment employed 31.1 workers. This compares with an average of 23.7 workers per establishment in the 37 industries in which agglomeration does not exert a significant effect on location. On the other hand, the average U.S. establishment employed 23.5 workers in those industries in which agglomeration enhances growth, compared to 30.4 workers in the industries in which agglomeration does not have a significant effect on growth. This suggests that agglomeration affects the location of new businesses in industries with a large average employment size, while agglomeration encourages employment growth of incumbent businesses in industries characterized by small establishments. Whereas Kim, Barkley and Henry (2000) found that average establishment size increases an

industry's tendency to agglomerate, these results provide some evidence that average establishment size may also influence the ways in which agglomeration impacts location and employment growth.

Once again, the concepts of static versus dynamic localization externalities may shed light on to these results. It appears that dynamic localization externalities are relevant to industries characterized by small businesses, which is consistent with the idea of "Marshallian" clusters of small businesses engaging in cooperation and coordination over time (Markusen 1996; Barkley and Henry 1997). On the other hand, static localization externalities are important in industries characterized by large businesses. This suggests that businesses more apt to benefit from internal economies of scale (i.e., large employment size) locate in areas to take advantage of industry-specific inputs, but they do not tend to interact much with other local businesses.

Conclusions

The empirical evidence presented in this chapter illustrates some of the challenges in implementing a cluster-based economic development strategy. As discussed by Woodward and Guimarães in Chapter 5, Henry and Barkley in Chapter 9, and XXXXX in Chapter X, important questions arise in picking which industry to target, creating supportive institutions, and in helping "latecomers" catch up with established clusters (Barkley and Henry 1997). Results presented in this chapter expand the list of issues that policymakers must consider when planning a targeted industrial development strategy.

First, the presence of an agglomerated industry does not always lead to the location-specific advantages commonly associated with clusters. Although researchers and economic development practitioners often talk about the benefits of a pooled labor force, shared equipment and specialized machinery, and knowledge spillovers among businesses, there is no guarantee that these benefits will in fact materialize. Survey results for two agglomerated industries in Maine provide modest support for the benefits of a pooled labor force: that is, establishments feel that other businesses in the state are an important source of workers. The evidence related to the benefit received from the availability of specialized machinery is mixed: nearly 70 percent of biotechnology businesses felt that this affected their profitability or growth potential, while only 30 percent of companies in the environmental and energy technology industry perceived this to be a benefit. Finally, the survey results show that businesses in both industries are likely to share technical information and conduct joint research and development activities with others, but these activities are not necessarily confined to a small geographical area defined by political boundaries.

Another challenge facing policymakers revealed in the second part of the chapter is that the effects of clusters on local economic vitality differ widely across industries. This suggests that multiple indicators should be used to measure the success of agglomeration-based strategies. The results show that agglomeration encourages location in some industries, especially those made up of large businesses. These static localization externalities arise from industry-specific inputs present in the cluster as well as increased information about business opportunities, which Porter (2000) suggests lowers "entry barriers" to business location. On the other hand, agglomeration tends to stimulate the growth of incumbent establishments in industries

characterized by small businesses. This paints a picture of cooperation and coordination among small businesses operating in "Marshallian" clusters.

These results do not imply that local industries made up of large companies will outperform small business industry clusters in terms of supporting new business activity. Using a similar dataset on business location in Maine, Gabe (2003) shows that more new business activity occurs in industry clusters comprised of small establishments than in clusters made up of large companies. This finding, considered along with the analysis presented in this chapter, suggests that – while agglomeration is an important location factor in industries characterized by large businesses – small business clusters are generally more conducive to new business activity. The results do not show, however, whether or not large businesses (attracted by industry agglomeration) tend to seek out clusters made up of small establishments.

Gabe's (2003) study also found that, along with average employment size, the average age of establishments in an industry cluster has a negative effect on business location. Likewise, previous analysis found that industry cluster "age" has a negative effect on business employment growth and wages (Gabe 2004). These results show that newly formed clusters are more likely than mature clusters to generate static and dynamic localization externalities. Thus, when implementing and evaluating a targeted economic development strategy, policymakers should consider attributes of the targeted industry (e.g., average business size) as well as characteristics of the local cluster itself (e.g., age and business size). This multidimensional approach will better illuminate the impact of agglomerations on the local economy.

References

Allen, T. and Gabe, T. (2003) 'The Business Climate for Biotechnology in Maine', Maine Agricultural and Forest Experiment Station, University of Maine, Miscellaneous Report 432.

Barkley, D. and Henry, M. (1997) 'Rural Industrial Development: To Cluster or Not to Cluster?', *Review of Agricultural Economics*, 19:308-25.

Barkley, D., Henry, M. and Kim Y. (1999) 'Industry Agglomerations and Employment Change in Non-Metropolitan Areas', *Review of Urban and Regional Development Studies*, 11:168-86.

Brown, C. and Medoff, J. (1989) 'The Employer Size-Wage Effect', *Journal of Political Economy*, 97:1027-59.

Carlton, D. (1983) 'The Location and Employment Choices of New Firms: An Econometric Model with Discrete and Continuous Endogenous Variables', *Review of Economics and Statistics*, 65:440-9.

Coughlin, C., Terza, J. and Arromdee, V. (1991) 'State Characteristics and the Location of Foreign Direct Investment within the United States', *Review of Economics and Statistics*, 73:675-83.

Coughlin, C. and Segev, E. (2000) 'Location Determinants of New Foreign-Owned Manufacturing Plants', *Journal of Regional Science*, 40:323-51.

Doms, M., Dunne, T. and Troske, K. (1997) 'Workers, Wages, and Technology', *Quarterly Journal of Economics*, 112:253-90.

Dunne, T., Roberts, M. and Samuelson, L. (1989) 'The Growth and Failure of U.S. Manufacturing Plants', *Quarterly Journal of Economics*, 104:671-98.

Evans, D. (1987) 'Tests of Alternative Theories of Firm Growth', *Journal of Political Economy*, 95:657-74.

Friedman, J., Gerlowski, D. and Silberman, J. (1992) 'What Attracts Foreign Multinational Corporations? Evidence from Branch Plant Location in the United States', *Journal of Regional Science*, 32:403-18.

Gabe, T. (2003) 'Local Industry Agglomeration and New Business Activity', *Growth and Change*, 34:17-39.

Gabe, T. (2004) 'Establishment Growth in Small Cities and Towns', *International Regional Science Review*, 27:164-86.

Gabe, T. and Bell, K. (2004) 'Tradeoffs Between Local Taxes and Government Spending as Determinants of Business Location', *Journal of Regional Science*, 44:21-41.

Gibbs, R. and Bernat, G. (1997) 'Rural Industry Clusters Raise Local Earnings', *Rural Development Perspectives*, 12:18-25.

Glaeser, E., Kallal, H., Scheinkman, J. and Shleifer, A. (1992) 'Growth in Cities', *Journal of Political Economy*, 100:1126-52.

Greene, W. (2000) *Econometric Analysis*: Fourth Edition, Upper Saddle River, NJ: Prentice Hall.

Guimarães, P., Figueiredo, O. and Woodward, D. (2000) 'Agglomeration and the Location of Foreign Direct Investment in Portugal', *Journal of Urban Economics*, 47:115-35.

Guimarães, P., Figueiredo, O. and Woodward, D. (2003) 'A Tractable Approach to the Firm Location Decision Problem', *Review of Economics and Statistics*, 85:201-4.

Hall, B. (1987) 'The Relationship Between Firm Size and Firm Growth in the US Manufacturing Sector', *Journal of Industrial Economics*, 35:583-606

Hart, P. and Prais, S. (1956) 'The Analysis of Business Concentration: A Statistical Approach', *Journal of the Royal Statistical Society*, 119:150-81.

Head, K., Ries, J. and Swenson, D. (1995) 'Agglomeration Benefits and Location Choice: Evidence from Japanese Manufacturing Investments in the United States', *Journal of International Economics*, 38:223-47.

Henderson, V. (1997) 'Externalities and Industrial Development', *Journal of Urban Economics*, 42:449-70.

Henderson, V., Kuncoro, A. and Turner, M. (1995) 'Industrial Development in Cities', *Journal of Political Economy*, 103:1067-90.

Henry, M. and Drabenstott, M. (1996) 'A New Micro View of the U.S. Rural Economy', *Economic Review*, 81:53-70.

Howells, J. (2002) 'Tacit Knowledge, Innovation and Economic Growth', *Urban Studies*, 39:871-84.

Hymer, S. and Pashigian, P. (1962) 'Firm Size and Rate of Growth', *Journal of Political Economy*, 70:556-69.

Jacobs, J. (1969) *The Economy of Cities*. New York: Vintage.

Jovanovic, B. (1982) 'Selection and the Evolution of Industry', *Econometrica*, 50:649-70.

Kim, Y., Barkley, D. and Henry, M. (2000) 'Industry Characteristics Linked to Establishment Concentrations in Nonmetropolitan Areas', *Journal of Regional Science*, 40:231-59.

Krugman, P. (1991) *Geography and Trade*, Cambridge, MA: The MIT Press.

McFadden, D. (1974) 'Conditional Logit Analysis of Qualitative Choice Behavior', in P. Zarembka (ed.) *Frontiers in Econometrics*, New York: Academic Press.

Marshall, A. (1890) *Principles of Economics*, London: Macmillan.

Noblet, C. and Gabe, T. (2006) 'Business Climate for Maine's Environmental and Energy Technology Sector', Department of Resource Economics and Policy, University of Maine, Staff Paper 565.

O'hUallachain, B. and Satterthwaite, M. (1992) 'Sectoral Growth Patterns at the Metropolitan Level: An Evaluation of Economic Development Incentives', *Journal of Urban Economics*, 31:25-58.

Porter, M. (1990) *The Competitive Advantage of Nations*. New York: Free Press.

Porter, M. (2000) 'Location, Competition, and Economic Development: Local Clusters in a Global Economy', *Economic Development Quarterly*, 14:15-34.

Romer, P. (1986) 'Increasing Returns and Long-Run Growth', *Journal of Political Economy*, 94:1002-37.

Simon, H. and Bonini, C. (1958) 'The Size Distribution of Business Firms', *American Economic Review*, 48:607-17.

Singh, A. and Whittington, G. (1975) 'The Size and Growth of Firms', *Review of Economic Studies*, 42:15-26.

Sveikauskas, L. (1975) 'The Productivity of Cities', *Quarterly Journal of Economics*, 89:393-413.

Variyam, J. and Kraybill, D. (1992) 'Empirical Evidence on Determinants of Firm Growth', *Economics Letters*, 38:31-6.

Variyam, J. and Kraybill, D. (1994) 'Managerial Inputs and the Growth of Rural Small Firms', *American Journal of Agricultural Economics*, 76:568-75.

TABLE 1. Important Sources of Workers for Firms in the Maine biotechnology, and environmental and energy technology industries.

Source:	In Maine	Out-of-State
Biotechnology		
Other businesses	39.4%	25.7%
4-year universities	33.1%	30.1%
2-year universities	8.8%	2.9%
Environmental & Energy Technology		
Other businesses	31.9%	23.7%
4-year universities	23.7%	17.0%
2-year universities	14.3%	6.6%

TABLE 2. Partnerships of Maine Biotechnology Firms.

Cooperative Activity	Other Maine Business	Non-Maine Business	Maine Non-Profit Organization	Maine University Researcher	Total*
Conducted joint R&D	22%	39%	11%	20%	58%
Submitted joint research proposal	14%	18%	14%	10%	31%
Coordinated marketing effort	6%	20%	0%	0%	21%
Shared equipment or personnel	18%	2%	8%	14%	32%
Coordinated purchase of supplies	6%	9%	5%	0%	19%
Shared technical information	27%	35%	18%	21%	56%
Shared facilities and space	18%	13%	9%	16%	41%

* A summation of cell entries may exceed row totals because some businesses are involved in multiple partnerships and cooperative activities.

TABLE 3. Partnerships of Maine Environmental and Energy Technology Firms.

Cooperative Activity	Other Maine Business	Non-Maine Business	Maine Non-Profit Organization	Maine University Researcher	Total*
Conducted joint R&D	13%	8%	4%	3%	17%
Submitted joint research proposal	10%	7%	4%	4%	19%
Coordinated marketing effort	21%	13%	2%	0%	27%
Shared equipment or personnel	24%	9	4	1%	31%
Coordinated purchase of supplies	6%	1%	1%	0%	8%
Shared technical information	38%	23%	10%	7%	46%
Shared facilities and space	12%	1%	1%	1%	19%

* A summation of cell entries may exceed row totals because some businesses are involved in multiple partnerships and cooperative activities.

TABLE 4. Effects of Industry Agglomeration on Location, Growth and Wages.

Industry	Location	Growth	Wages
General contractors and operative builders			+
Heavy construction, except building			
Special trade contractors		+	
Food and kindred products			
Textile mill products	+		
Apparel and other textile products			
Lumber and wood products	+		
Furniture and fixtures		+	-
Paper and allied products	NA		
Printing and publishing		+	+
Chemicals and allied products	+		
Rubber and miscellaneous plastics products			
Leather and leather products		-	
Stone, clay, and glass products			+
Fabricated metal products			
Industrial machinery and equipment	+		
Electronic and other electronic equipment			
Transportation equipment	+		
Instruments and related products	NA	+	
Miscellaneous manufacturing industries	+		
Local and interurban passenger transit			
Trucking and warehousing	+	+	
Water transportation			
Transportation by air	NA		
Transportation services			
Communication	+	+	
Electric, gas, and sanitary services		+	
Wholesale trade - durable goods			
Wholesale trade - nondurable goods	+		+
Building materials and garden supplies			
General merchandise stores		+	
Food stores		+	
Automotive dealers and service stations		+	

Table is continued on the following page.

TABLE 4. Continued.

Industry	Location	Growth	Wages
Apparel and accessory stores	+	+	
Furniture and homefurnishings stores	+		
Eating and drinking places		+	
Miscellaneous retail	+		
Depository institutions			
Nondepository institutions			+
Security and commodity brokers			
Insurance carriers			-
Insurance agents, brokers, and service		+	
Real estate	+	+	+
Holding and other investment offices			
Hotels and other lodging places	+		+
Personal services	+	+	
Business services		+	+
Auto repair, services, and parking			
Miscellaneous repair services			
Motion pictures			
Amusement and recreation services			
Health services	+		
Legal services			
Educational services			
Social services		+	
Museums, botanical, zoological gardens	NA		
Membership organizations			+
Engineering and management services	+		

Notes: A "+" means that the municipality-industry location quotient has a positive and significant effect on the indicator. A "-" means that the municipality-industry location quotient has a negative and significant effect on the indicator. Cells are left blank in cases where the location quotient does not have a statistically significant effect on the indicator of growth or development. NA indicates that results are not available for the sector.