Magrath, William B.

Working Paper

Factors Affecting the Location of the U.S. Biotechnology Industry

Staff Paper, No. SP 85-26

Provided in Cooperation with:
Charles H. Dyson School of Applied Economics and Management, Cornell University

Suggested Citation: Magrath, William B. (1985) : Factors Affecting the Location of the U.S. Biotechnology Industry, Staff Paper, No. SP 85-26, Cornell University, Charles H. Dyson School of Applied Economics and Management, Ithaca, NY, https://doi.org/10.22004/ag.econ.185895

This Version is available at:
https://hdl.handle.net/10419/276683

CORNELL AGRICULTURAL ECONOMICS STAFF PAPER

Factors Affecting the Location of the U.S. Biotechnology Industry

William B. Magrath

October 1985 A.E. Staff 85-26

Department of Agricultural Economics
Cornell University Agricultural Experiment Station
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University, Ithaca, New York, 14853

Factors Affecting the Location of the U.S. Biotechnology Industry

William B. Magrath*

*William B. Magrath is a Senior Research Support Specialist, Department of Ag. Econ., Cornell University.

An approach more frequently seen in the literature on location economics is to identify the site specific factors that most heavily contribute to profitability. This led to the development of the concepts of ubiquities, transfer orientation, and weight gaining/losing activities. For certain industries, the significance of particular raw materials, such as wood and water for pulp and paper production, can be readily seen. Less basic industries, utilizing a wider array of inputs, require more detailed study to identify the characteristics of desirable locations. Budgeting techniques have also been used for predictive and planning purposes but are only appropriate for mature industries with relatively uniform products and processes.3/

An approach that has received wider use is to survey managers with questions about the factors that were relevant to their location decisions. Examples of these studies are the classic study by Mueller, et al, and studies by Mandell, and Schmener. A survey of high technology electronics firms was also conducted by Premus for the Joint Economic Committee of Congress.

While subject to numerous weakness (sampling and respondent bias, poor design and administration, etc.) these surveys probably provide the best information available on the motivations behind firm location decisions. Generally, the findings of these studies are presented in terms of the relative importance of various factors (availability of low cost labor, access to raw materials). Authors typically go on to evaluate the suitability of a region(s) for particular industries or to suggest policies to improve the attractiveness of a region. While little can be found in the findings of these surveys to contradict the hypothesis that firm managers seek profit maximizing locations, they do indicate the importance of other factors. Most important, and most often neglected in other studies and in discussions of policy implications, is the observation that the location of most firms results from the personal circumstances of the founder. This is especially true of single location operations and relatively new firms. Specifically, firms tend to be located where they are because that is where the entrepreneur lived at the time the firm was started (Mueller, et al., pp. 4, 13-16).

It is difficult to compare the relative importance of other location factors as revealed by the different surveys reviewed for this paper. The surveys were conducted in slightly different ways and although similar questions were asked, wording may have differed slightly. The different time periods when the surveys were conducted is illustrated by the fact that in early work energy costs were not specifically considered. Nonetheless, review of this literature suggests that the estimated importance of key location factors is relatively consistent across surveys. High technology companies appear to possess slightly stronger preferences, although their relative ranking of different factors is quite similar to that of general manufacturing companies.

Other techniques to study location patterns involve the use of aggregate data and a variety of statistical procedures. Examples of these studies include a recent study of high technology industry by Glasmeier, Hall and Markosen (GHM). It provides an example of these approaches and of the difficulty of applying elaborate statistical techniques. Using an extensive database developed from U.S. Census sources, GHM developed measures to represent variables thought to be associated with plant location. For example,

they used county level wage rates, unionization rates and area unemployment rates to represent labor supply conditions. In all they used 20 measures to represent five sets of variables. Using stepwise linear regression they sought the set of measures that best explained the distribution of high technology employment. Despite the extensiveness of their data set, GHM were unable, as are most statistical location studies, to reach strong conclusions on the determinants of high technology activity.

In sum, there is no entirely satisfactory methodology for the analysis of location decisions. The choice of research technique needs to be made in the context of the problem being studied and the information that is sought. For example, budgeting procedures are probably the best approach to specific location decisions for individual firms, while statistical procedures are applicable to testing hypothesis about well-defined industries. Given the explanatory nature of this research, it was most appropriate to use the survey technique to develop a general understanding of the factors relevant to biotechnology decisions.

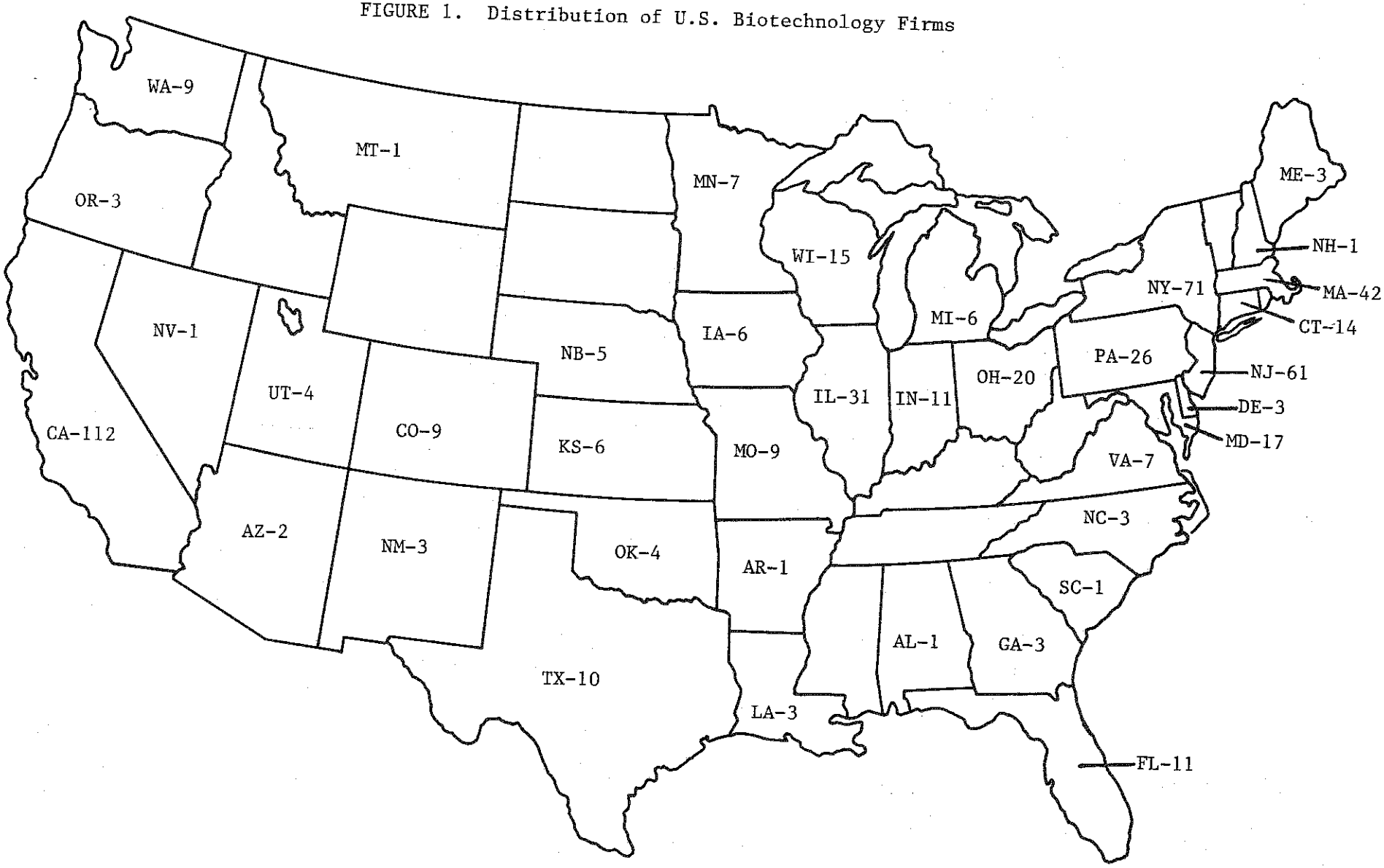
Survey Methodology and Results

In carrying out the objective of this research, the first issue that needed to be considered was the selection of firms to survey. There is no generally accepted statistical definition of the biotechnology industry. The Standard Industrial Classification (SIC) system groups into several distinct categories (Basic Chemicals, Drugs, Food and Kindred products) firms that would be generally considered as being involved with biotechnology. Unfortunately, these categories also include firms that would not be considered as biotechnology firms. The reason for this is that the defining characteristic of the biotechnology industry is the use of living organisms, biological agents or novel biological systems in industrial production. The SIC and other widely used classification systems, on the other hand, are based on a firm's primary output.

In order to obtain a listing of firms that are actively involved in commercial use or development of modern biotechnologies I examined a number of sources. Ultimately, the most satisfactory listing was thought to be the International Biotechnology Directory, 1984 (Coombs, 1984) which provides names, addresses and short descriptions of 731 companies. We combined this list with one published by the Office of Technology Assessment (1984). We initially surveyed the resulting list of companies to obtain publicly available financial information. Despite its being the best available listing of biotechnology firms, several firms indicated no involvement in biotechnology and 52 firms could not be contacted by mail. After removing those firms from consideration a final list of 696 firms remained in the present sample.

The firms surveyed included a wide variety of biotechnology involvements. Major corporations with interests in brewing, food processing and pharmaceuticals were included as well as small companies working with developing technologies and others manufacturing equipment and provding consulting services. Although it is impossible to know, it is likely that the firms surveyed represent a substantial portion of the U.S. biotechnology industry. The geographic distribution of firms sent surveys is shown in Figure 1. Consistent with what is widely believed about the biotechnology there is a concentration of firms in California and around Boston, Massachusetts. Somewhat surprising is the

FIGURE 1. Distribution of U.S. Biotechnology Firms



relatively large number of firms (71) located in New York, making it the second ranking biotechnology state as measured by firm numbers. New Jersey with 61 firms ranks third in the presence of biotechnology activity. The addresses given by firms makes it difficult to know to what extent the distribution shown in Figure 1 represents "corporate headquarters" versus production facilities or research and development laboratories.

Based on the survey instruments used for other industries (see above) a questionnaire was prepared. In addition to probing for information on the relative importance of various location determinants, the questions were designed to elicit information to help understand specific issues related to the biotechnology industry. For example, a set of questions were related to the importance of universities as attributes of regions. The questionnaire is reproduced in appendix 1.

Of the 696 firms surveyed in Fall 1984, completed returns were received from 111. An additional 11 surveys were returned by the post office as undeliverable. There was no follow-up with non respondents. Of those receiving surveys, there was a total return rate of 16%. Response covered a range of geographic areas. The greatest number of responses were received from California, followed by New Jersey, Pennsylvania, Massachusetts, and New York. In all, responses were received from firms in 27 states. The geographic distribution of responding firms was generally consistent with the distribution shown in Figure 1.

Forty-four of the firms indicated that their major activity was research and development. Twenty-nine and fifteen said that manufacturing and pharmaceuticals, respectively, were their major product lines. Eight firms listed agricultural products, only 4 firms indicated any activity in food processing. The three major enterprises of respondents are summarized in Table 1.

The majority (62%) of the responses were from privately held companies. Fifty percent were privately held corporations, twelve percent were sole proprietorships or partnerships, the rest (38%) were publicly held corporations. The average company had been in business for 23 years, however, 51

Table 1. Survey Respondents by Product Line

	Total	1st	2nd	3rd
			(% of firms)*	
R & D	68	44	21	3
Pharmacueticals	29	15	10	4
Food Processing	4	3	0	1
Veterinary	15	0	5	10
Agricultural Products	19	8	7	4
Manufacturing	58	29	22	7
Other	19	11	3	5

*Percentages do not add to 100 because some firms did not indicate second and third product lines.

percent had been started after 1970. The median number of employees was reported as 50 and median annual sales were $1 million. The presence of several large firms in the sample accounted for average sales and employees of $282 million and 1,803, respectively.

It has been shown that there are considerable economics of scale in the production of at least some biotechnology products (Kalter et al.). Combined with the generally light weight of biotechnology products this argues for relatively few plants serving dispersed markets. To examine this we asked respondents to describe their firms primary market area. Results are shown in Table 2 for current sales and for 1989. As can be seen almost three quarters of the firms currently serve international markets with most of the remainder serving national markets. No firms described their markets as focusing at the state or local level.

Table 2. Current and Forecasted Sales Area
(% of Responding Firms)

	Current	Forecast (1989)
Local	0	0
State	0	0
Regional	3	1
Nationwide	26	26
International	71	73

We also asked respondents to indicate the importance of a variety of factors that are often proposed as affecting location. These responses are shown in Table 3. By far the most important factors are the availability of professional employees and technicians which were described as critical by 34 and 26 percent of firms respectively. These were followed in importance by business climate, state and local taxes, cost of living and cultural amenities. Factors frequently described as unimportant were proximity to markets (57%), proximity to raw materials (56%), access to venture capital (46%) and academic institutions (60%). These results seem plausible in light of the human capital intensive nature of the biotechnology industry, and national and international markets for products, inputs and capital. The low importance attracted to universities suggests that managers perceive that new scientific results related to their companies move easily and are readily available regardless of location.

Table 4 compares the results of this survey with surveys of the location preferences of firms in other industries. The comparison indicates that, in general, the ranking of factors is similar, but that there are several important differences. Labor availability and cost, tax climate, and access to raw materials appear to have similar weight across industries. Biotechnology firms appear considerably more sensitive to Business climate and access to venture capital than firms in other industries (despite the fact that access to venture capital was generally unimportant to biotechnology firms). Local

Table 3. Importance of Various Location Factors for Biotechnology Firms (% of Responding Firms) a/

	Critical	Important	C & I	Unimportant	Undesirable
Proximity to Raw Materials	5	26	31	56	10
Proximity to Markets	4	32	36	57	5
Business Climate	14	61	75	18	2
Access to Venture Capital	5	36	41	46	12
Cost of Living	2	57	59	32	5
Availability of Professionally Trained Employees	34	45	79	17	2
Availability of Technicians	26	53	79	17	2
Labor Costs	6	72	78	16	4
Unions	1	19	20	34	41
State and Local Taxes	5	60	65	28	5
Academic Institutions	5	21	26	60	16
Transportation Facilities	6	21	27	53	18
Cultural Amenities	3	54	57	35	6
Climate	3	32	35	59	5
Proximity of Competition	0	8	8	76	14

a/ Non respondents mean rows may not total to 100%.

academic institutions are more highly valued by biotechnology firms than general manufacturing firms, but less than by the high technology electronic firms surveyed by the Joint Economic Committee.

Sixty percent of the firms surveyed indicated that state and local government incentives had significant impact on location decisions (Table 5). There was little consensus, however, on the effectiveness of various types of location incentive programs. Receiving most interest were low interest loans, investment tax credits, and property tax abatement (Table 6).

Table 4. Comparison of Survey Research on Importance of Location Factors (% of respondents indicating important or very important)

Factor	a/	Manufacturing b/ D	A	C	High Tech c/	This Survey d/
Labor Availability	56				89.3	
skilled		41	49	49		79
unskilled		22	39	35		--
Labor Cost	65	61	22	54	72.2	78
Tax Climate	52	59	37	38	67.2	65
Business Climate	53	36	59	38		75
Academic Institutions		3	--	3	58.7	26
Cost of Living					58.5	59
Transportation		55	81	65	58.4	27
Access to Markets	62	50	36	35	58.1	36
Regional Regulatory Environment	4	12	5	8	49.0	
Energy Costs/ Availability					41.4	
Cultural Annuities	14				36.8	57
Climate					35.8	35
Access to Raw Materials	50	20	17	32	27.6	31
Water	41	24	18	13		
Unions	23					20
Access to Venture Capital	3	2	2	3		41

a/ Mueller, Wilken, and Wood, p. 12. Percent of employment represented by firms mentioning factor as important.

b/ Mandell, p. 22. Percent of employers citing factor as among the 5 most important. D, A, C, refer to results of surveys in Detroit, Atlanta, and Chicago, respectively.

c/ Premus, p. 23. Percent of firms indicating factors as significant or very significant.

d/ Percent identifying factor as critical or important.

Table 5. Impact of Local and State Incentives (% of Responding Firms)

Very significant	59
Significant	24
Some Significance	13
Insignificant	11

Table 6. Biotechnology Managers Impression of Effectiveness of Location Incentives (%)

	Highly Effective	Effective	Ineffective
Loan Guarantees	27	41	32
Low Interest Loans	46	41	12
Industrial Development Bonds	32	38	30
Property Tax Abatement	32	51	17
Education and Training Programs	14	40	47
Research Subsidies	20	47	32
Investment Tax Credits	46	51	3

Because of the emphasis that is often placed on Universities and research facilities as being promotors of high tech industry, respondents were also asked to indicate the ways in which universities are important attributes of regions. The two most often cited as very important were as sources of future employees and for library resources. Teaching opportunities for employees, access to laboratories and cultural activities were generally considered unimportant (see Table 7). Another indication of the way in which universities are related to the location of biotechnology firms is the finding that one third of the founders of responding firms had previously been associated with a local university.

Of the 111 firms that responded, 58 continue to operate in the same city in which operation first started, and 91 were located in the original state. In addition, 35 were founded in and continue to operate in the city in which the founder lived prior to starting the company. Sixty-seven of the firms were still located in the home state of the founder. Further, as firms grow, most (76%) plan to expand their current facilities (Table 8).

Table 7. Significance of Universities to Biotechnology Firms (% of Responding Firms)

	Very Important	Important	Unimportant
Training for Current Employees	24	53	23
Sources of Future Employees	49	49	3
Teaching Opportunities for Employees	6	30	64
Faculty Research	17	54	29
Opportunities for Collaborative Research	32	45	23
Access to Faculty Consulting	29	48	23
Access to Laboratories	19	36	45
Access to Libraries	45	45	10
Cultural Activities	6	47	48

Table 8. Future Plans of Survey Respondents (% of Responding Firms)

Additional Production Facilities	21
Relocation of Current Facilities	8
Expansion of Current Facilities	76

The fact that biotechnology firms generally remain in the area in which they were founded is consistant with findings from other industries. This, together with the indicated importance of business climate and the fact that firms tend to be initially located near their founders home, indicates the highly individual and personal nature of location decisions. In general, the factors that affect biotechnology location are not different from those that affect location by manufacturing firms in general.

Summary and Policy Implications

This research suggests a number of important considerations for those interested in the local economic development potential of biotechnology. In general, unlike firms heavily dependent on site specific resources, biotechnology firms seem to be successfully located in a wide variety of places. Similar to other industries biotechnology firms are attracted to

regions by conducive business and social climates. This suggests that any individual region is unlikely to have a natural predisposition to be a major center for biotechnology. Agglomerations that do occur will almost certainly be due to a regions capacity to successfully foster (formally or informally) an entrepreneurial climate. Further, the growing competition among states and localities to attract these firms reduces the chance of any one region becoming dominant in biotechnology.

The theory that no individual region is likely to capture a large share of the benefits of high tech development also has implications for the financial support of research. Because research results have the character of public goods, it will be difficult to prevent technology developed in, say, New York from being commerialized in other states. To some extent this can be managed by the development of policies for the acquisition of patents and their use to further regional development objectives. More generally it is another justification for federal support of high technology research and for state and local pressure to that end.

Before significant public resources are devoted to attracting new high technology firms, it is, however, important to realize that there is no strong evidence that the presence of these industries contributes significantly or uniquely to the achievement of regional development objectives. The Office of Technology Assessment has found that established traditional industries are likely to continue to be the source of the greatest absolute growth in employment opportunities (U.S. Congress, July 1984). The regions most likely to benefit from rapid technological change will be those in which traditional industries utilize and adopt new methods to improve efficiency and promote growth.

According to survey respondents the most important characteristics of regions for biotechnology companies is the availability of skilled labor. Respondents also indicated that the role of universities in providing skilled labor is an important way in which universities contribute to the appeal of a region. Nonetheless, universities and other academic institutions are not identified by managers as being important attributes of regions per se. However, it is also true that the industry is, in fact, clustered in a number of states (California, New York, Massachusetts, Wisconsin) that are noted for quality research universities. Additionally, one-third of the founders of responding firms were associated with local universities.

Finally, this research suggests that there should be no conflict between policies promoting the development of a biotechnology industry and the development of traditional industry. The preferences of biotechnology managers are quite similar to those in other industries. Thus, policies and programs that broadly encourage business expansion and entrepreneurial activity should be the prime focus of local and regional developers.

Footnotes

1/ See Samuelson (1983) for a discussion of the theoretical analysis of von Thunen.

2/ For example, linear, quadratic and mixed integer programming models have been used for location decision making.

3/ See Hoover, chapters 2 and 3.

References

Carlino, Gerald and Edwin S. Mills. "Do Public Policies Affect County Growth?" Business Review, July-August, 1985, p. 3-16.

Carlton, Dennis W. "The Location and Employment Choices of New Firms: An Econometric Model with Discrete and Continuous Endogenous Variables." Review of Economics and Statics, Vol. 65, No. 3, August 1983.

Coombs, J. International Biotechnology Directory 1984, The Nature Press: London, 1983.

Edwards, Christopher G. "Solving Regional Development Problems with Biotech: Essential Issues." Bio/Technology, Vol. 12, No. 4, April 1984, p. 287.

Glaser, Vicki. "The Business of Biotechnology: Regional Activities Lures New Companies." Bio/Technology, Vol. 2, No. 12, December 1984, pp. 1065-78.

Glasmeier, Amy K., Peter Hall, Ann R. Markusen. "Recent Evidence on High-Technology Industries' Spatial Tendencies: A Preliminary Investigation." Institute of Urban and Regional Development, Working Paper 417, University of California, Berkeley, October 1983.

Gruenstein, John M.L. "Targeting High Tech in the Delaware Valley." Business Review, May-June, 1984, pp. 3-14.

Hoover, Edgar M. An Introduction to Regional Service. Alfred A. Knopf, New York, 1975.

Mandell, Lewis. Industrial Location Decisions, Detroit Compared with Atlanta and Chicago. Praeger, New York, 1975.

Mueller, Eva, Arnold Wilken and Margaret Wood. Location Decisions and Industrial Mobility in Michigan 1961. Institute for Social Research, Survey Research Series No. 22, The University of Michigan, Ann Arbor, Michigan, 1961.

Samuelson, Paul A. "Thunen at Two Hundred." Journal of Economic Literature, Vol. 21, December 1983, pp. 1468-88.

Schmenner, Roger W. Making Business Location Decisions. Prentice-Hall, Englewood Cliffs, New Jersey, 1982.

Thunen, Johann H. von. Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie, Third edition, Ed.: Heinrich Waentig, Jena: Gustav Fisher, 1930.

United States Congress, Joint Economic Committee. Location of High Technology Firms and Regional Economic Development. U.S. Government Printing Office, Washington, D.C., June 1982.

United States Congress, Office of Technology Assessment. Commercial Biotechnolgy: An International Assessment. (OTA-BA-218) U.S. Government Printing Office, Washington, D.C., 1984.

_____. Technology, Innovation, and Regional Economic Development Background Paper Census of State Government Initiatives for High-Technology Industrial Development. (OTA-BP-ST1-21) U.S. Government Printing Office, Washington, D.C., May 1983.

_____. Technology, Innovation and Regional Economic Development. (OTA-ST1-238) U.S. Government Printing Office, Washington, D.C., July 1984.

APPENDIX

Cornell University
Biotechnology Industry Location Questionnaire

1. Name of Company: _____

   Address: _____
   _____

2. Principal Product Line(s) or Service(s): Research and Development _____

   -number in order of importance

   Pharmaceuticals _____

   Food Processing _____

   Veterinarian, Animal Health _____

   Agricultural Products _____

   Manufacturing _____

   Other (please specify) _____
   _____

3. This company is: privately held (partnership or sole proprietor) _____,
   a privately held corporation _____,
   a publicly held corporation _____

4. Location(s) of other facilities (list only those involved in biotechnology applications)

   a) _____
   _____
   _____

   b) _____
   _____
   _____

5. When was this company founded? _____

6. Where was it initially located? _____

7. The sales of this company are primarily:

   Local _____
   Within this state _____
   Regional _____
   Nationwide _____
   International _____

8. As you currently forecast, in five years the sales of this company will primarily be:

Local	_____
Within this state	_____
Regional	_____
Nationwide	_____
International	_____

9. For each of the following location factors indicate its importance to companies such as this one.

	Critical	Important	Unimportant	Undesirable or Irrelevant
Proximity to raw materials	_____	_____	_____	_____
Proximity to markets	_____	_____	_____	_____
Business Climate	_____	_____	_____	_____
Access to Venture Capital	_____	_____	_____	_____
Cost of Living	_____	_____	_____	_____
Availability of Professionally Trained Employes (Ph.D M.S.)	_____	_____	_____	_____
Availability of Technicians (BA, BS, AA)	_____	_____	_____	_____
Labor Costs	_____	_____	_____	_____
Unions	_____	_____	_____	_____
State and Local Taxes	_____	_____	_____	_____
Academic Institutions	_____	_____	_____	_____
Transportation Facilities	_____	_____	_____	_____
Cultural Amenities	_____	_____	_____	_____
Climate	_____	_____	_____	_____
Proximity of Competitors	_____	_____	_____	_____

10. What impact have state and local government incentives had on the business location plans of this company?

____ very significant ____ significant ____ some significance ___ insignificant

Please describe _____

_____

_____

11. What location decisions do you expect this company to make in the next five years?

a) additional production facilities _____
b) relocation of current production facilities _____
c) expansion of current facilities _____

12. Which of the incentive plans listed below would be effective in influencing firms like this one?

	Highly Effective	Effective	Ineffective
Loan Guarantees	_____	_____	_____
Low Interest Loans	_____	_____	_____
Industrial Development Bonds	_____	_____	_____
Property Tax Abatement	_____	_____	_____
Education and Training Programs	_____	_____	_____
Research Subsidies	_____	_____	_____
Expanded Public University Research	_____	_____	_____
Investment Tax Credits	_____	_____	_____
Other	_____	_____	_____

13. In what ways are universities important attributes of a region for companies such as this one?

	Very Important	Important	Unimportant
Training for Current Employees	_____	_____	_____
Sources of Future Employees	_____	_____	_____
Teaching Opportunities for Employees	_____	_____	_____
Faculty Research	_____	_____	_____
Opportunities for Collaborative Research	_____	_____	_____
Access to Faculty Consulting	_____	_____	_____
Access to Laboratories	_____	_____	_____
Access to Libraries	_____	_____	_____
Cultural Activities	_____	_____	_____

14. Were the founders of this company associated with a local university immediately prior to starting this company? Yes _____ No _____

If so, as Faculty? _____
Staff? _____
Student? _____

15. Where was the principal residence of the founder(s) of this company immediately prior to starting this company? _____

_____

16. Size of firm a) annual sales _____
b) number of employees _____

17. Name of person completing survey _____
Title _____

Please return to:

William B. Magrath
Dept. of Agricultural Economics
Warren Hall
Cornell University
Ithaca, NY 14853