Interdisziplinäres Institut für Raumordnung

Stadt- und Regionalentwicklung

Wirtschaftsuniversität Wien

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1989

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Research (Science) Parks as Public Investment

A Critical Assessment

IIR-Discussion 41 1989

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1 Introduction

In recent years, state and local governments in the United States, directly and through public universities, have invested millions of dollars in research parks[1], for land, buildings, specialized equipment, utilities, and other infrastructure. Sizable investments have been made, as well, by private universities, non-profit foundations, and private developers. These different types of investors have somewhat different objectives. But all share the belief that research parks will stimulate regional economic development by attracting and nurturing innovation-oriented businesses, and thereby alter the area's economic structure and long-term performance. This belief apparently is shared by developers, university administrators, and government officials in other countries, particularly in Europe, since science parks have sprouted there, as well.

This widespread belief has never been questioned seriously. Yet, for several reasons, research parks may not always live up to their promise. If that is the case, the proliferation of research parks in the 1980s is a public policy problem that deserves some attention[2].

In this paper we critically assess the use of public funds to develop research parks in the United States, using results from a two-year study funded by the Ford Foundation. We first provide a profile of the research parks that currently exist in the United States. We then describe briefly the types of investments made in research parks by state and local governments, universities, and other key actors, and the motivations for those investments. The next section of the paper explains the hypothetical basis for the widespread belief that research parks are sound investments. We then test these hypotheses using two types of evidence: from a case study of the Research Triangle Park, an early and well-known "success" located in North Carolina, and from an analysis of data from samples of counties with and without research parks, using quasi-experimental and econometric techniques. We conclude by summarizing our findings and drawing some lessons for public policy.

[1]These are referred to as research, science, and technology parks in different parts of the world. For convenience, we use the term "research parks" as a general reference.

[2]The number of research parks has multiplied threefold since 1982. Of the 110 or so parks that exist in 1989, approximately 70 percent are less than eight years old.

It is important to note that our conclusions do not necessarily apply to science parks outside the U.S., though we suspect there are numerous similarities. We are currently collecting data from those parks to conduct a cross-national comparison.

2 A Profile of U.S. Research Parks

Research parks are business parks in which the primary activity of the majority of resident establishments is basic or applied research, or new product or process development, rather than manufacturing, sales, headquarters, or other business functions. Typically, the proportion of a park's workforce who are scientists or engineers with graduate degrees is used as a proxy for research and development activity. Defined in this way, research parks are to be distinguished from spatial concentrations of technology-oriented activity that are not organized as a single legal entity, such as the route 128 corridor in Massachusetts. They are also to be distinguished from technology centers and incubators. The former, often university-based, are principally involved with the coordination of technological development and the management of technology transfer. Incubators are buildings that house small, start-up businesses. They may also include services that new businesses need, but often cannot afford by themselves. Technology centers and incubators sometimes exist within research parks.

We often envision research "parks" as broad expanses of greenspace interrupted by cleanly designed low-rise buildings along curving roads in a campus environment. Indeed, the most prominent U.S parks, including those at Stanford University, the Research Triangle in North Carolina, and the University of Utah, have those characteristics and may be responsible for the popular image. There are, however, a variety of physical park configurations, including relatively small, inner city developments that contain multi-story, converted factory or warehouse buildings (for example, the New Haven Science Park in Connecticut).

One-third of the U.S. parks contain incubator space for small, start-up organizations. This low percentage is in contrast to non-U.S. science parks which place a higher priority on new technology development and incubation (see, foe example, Allesch and Fiedler, 1985; Gibb, 1985; and Sternberg,

1988).

Regardless of their configuration, parks typically use planning controls to regulate the use of land or buildings. That practice distinguishes parks from other possible business location sites in the same region. The use of deed restrictions (in 81.5 percent of the parks surveyed) preserves the character of the park by outlawing certain types of activity – mostly heavy manufacturing, residential, and warehousing[3]. Ninety percent of the parks we surveyed also regulated the "footprint," or the ratio of the building's ground floor area to the lot size, and 56.6 percent imposed a minimum lot size requirement[4]. These limitations often make the total cost of locating in a park substantial. As a result, many businesses, particularly new start-ups, are priced out of research parks, unless they have access to venture capital or business incubators, as discussed above.

In three case studies conducted as part of our Ford Foundation-sponsored project (Research Triangle Park, University of Utah, and Stanford), we found average per acre land values inside the parks to be somewhat lower than for equivalent sites outside the parks. In at least two of the cases, we attribute this observation to a capitalization of the higher total development costs due to planning and land use controls into lower property values[5]. Of course, this negative capitalization is partially offset by a positive capitalization of prestige and the protected milieu referred to above.

The value of research park land, like the value of business sites in general, varies significantly from place to place. Five parks in our sample (in Maclean (VA), Philadelphia, Tampa, Dallas, and Princeton) commanded more than $250,000 per acre. At the other extreme, land in a park in upstate Michigan sold last year for approximately $10,000 per acre.

The large majority of parks (85 percent) are located in metropolitan regions. Forty-five percent of these metropolitan parks (or 38 percent of the

[3]Ninety-four percent of the parks in our sample of 66 parks prohibited heavy manufacturing, 85 percent prohibited residential uses, 77 percent outlawed warehousing, 59 percent forbade retail and consumer services, and 30 percent prohibited light manufacturing.

[4]The thirty parks with minimum lot size requirements were distributed as follows: less than 1.1 acre (9), 1.1 to 2.5 acres (9), 2.6 to 5 acres (10), more than 5 acres (2).

[5]In the Stanford case, the lower land values within the park are due mostly to an early practice of granting longterm belowmarket rate leases, as a locational inducement. In the early years of the Stanford Research Park, there were restrictive land use covenants but few other limitations.

total) are in regions with over 1,000,000 population (1985 Census estimates). Parks are located in all geographic regions of the country, although the South is somewhat over-represented and the West is somewhat under-represented. Parks that have been created since 1982 are more likely to be located in either the largest metropolitan centers or in non-metropolitan areas.

Nearly 25 percent of U.S. parks are units of public or private universities. Another 60 percent of research parks have a formal or informal affiliation with nearby research or doctoral-granting universities, even though they are not owned by them. Most of the remaining 15 percent of parks that do not have an institutional affiliation with a university have interactions between employees in their resident organizations and a nearby university's faculty members.

The 75 percent of parks that are not units of a university are divided among six organizational types. Twenty-three percent of parks are university-private sector joint ventures. Parks also are for-profit corporations (approximately 15 percent of the total), units of state government (8 percent of total), local government ventures (8 percent of total), and not-for-profit private organizations (23 percent)[6]. Over one-half of all parks have some government affiliation, either through a public university or as a unit of a state or municipality.

3 Reasons for Investing in Research Parks

Research park investments are made by different actors, for different reasons.

- *Private investors.* One type of investment in research parks is by private individuals who provide equity to a development company for the purchase of land, site improvements, marketing, and other expenses[7]. This includes venture capitalists[8]. These investors view research parks as a real estate venture with the potential to generate positive net cash flow and capital appreciation. This group of financiers typically is less

[6]Based on a sample of 66 research parks.

[7]We exclude from discussion here the role of institutions that provide debt finance.

[8]Approximately 10 percent of our sample of park developers used venture capital, and 34 percent of our sample of park occupants used venture capital to finance their startup operations.

interested in the research and technology orientation of park occupants, than they are with the economic viability of the park. Consequently, if the research park is not sufficiently profitable, many private investors lobby park management for a relaxation of park land use restrictions, so office, commercial, warehousing, and even manufacturing activity could locate there (Goldstein and Luger, 1989a).

- *Park management.* The park management itself invests in infrastructure, facilities, and services for its occupants, using private funds (if the park is a for-profit corporation), university or state-local government contributions, special assessments, and/or internally-generated funds, from current or projected land sales or rentals.

  First, park management makes investments that relate to the immediate physical environment and facilities of individual resident organizations, including the construction of multi-tenant buildings that provide space for service, office, and small R&D enterprises; the provision of sewer and water service (82.8 percent of parks); the construction and maintenance of roadways (78.1 percent of parks); gas hookups (71.9 percent of parks); ground maintenance and landscaping (70.3 percent of parks); signage (70.3 percent of parks); land use planning (62.5 percent of parks); and security services (45.3 percent of parks).

  Second, park management often provides business services for the convenience of the resident organizations. These include conference and meeting facilities (39.1 percent of parks surveyed); an on-site hotel (26.6 percent of parks); management consulting (25 percent of parks); and restaurant, recreation, and child care facilities (32.8 percent of parks).

  Third, park management often acts as a liaison on behalf of the occupants, with other institutions in the area, including universities (84.4 percent of the parks) and state and local governments (66 percent).

  Park managers make these investments because other actors have not taken the responsibility (especially in the case of infrastructure); because resident businesses could not undertake them themselves, at least as efficiently[9]; and/or with the expectation that the investments will

[9]In the case of small, new firms, often in higher density, urban areas, parks provide services and facilities at lower cost to the individual business because the concentration

make the park more attractive to organizations, and hence, increase the site rent they can charge[10].

- *State and local government.* State and local governments provide direct and indirect subsidies to businesses and park developers with the justification that the parks will serve to stimulate regional employment growth and well-paying jobs for local university graduates[11]. This motivation recently has been strongest in stagnant and declining areas of the country.

  The most prevalent (and costly) form of government investment is the provision of infrastructure to or within parks: access roads, new highway interchanges, and water and sewer lines, for example. In some cases, state or local governments also abate property taxes for businesses within the park (in approximately 26 percent of the parks surveyed), dedicate public lands for park use (21 percent of parks surveyed)[12], lease or purchase properties within the parks for government use (20 percent of respondents), and construct facilities within the parks (15 percent of respondents). These government-constructed facilities often serve as "anchors," or symbols of stability for prospective tenants[13].

- *Universities.* Universities invest in research parks for two reasons. In several cases, universities act as a real estate developer and manager on land they already have in their portfolio. The best known example of this is the Stanford Research Park. Leland Stanford had bequeathed considerable amounts of land as part of his endowment of Stanford University, with the stipulation that it never be sold. Following World War II, the trustees decided to lease the land to local industries as a

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of businesses with similar needs creates economies of scale. This is the concept behind incubators. It also illustrates what we refer to below as "localization economies."

[10]In some cases, parks are governed by occupants who decide how to spend at least a portion of the park corporation's funds.

[11]Based on interviews with state and local officials in the three case study areas.

[12]The parks to which this applies are state or municipallyowned or part of a public university.

[13]Another important state activity is the creation of special park districts, protecting the parks from municipal annexation. Park occupants then pay no city taxes. They either purchase services from nearby municipalities or have them provided by the park manager. This legislation has been passed for approximately 10 percent of the parks.

way to generate revenues for the university. They employed planners to recommend land use controls that would protect the university from negative side-effects from this development[14].

In other cases, universities have bought land to develop as a research park, or have kept land bequeathed to them, rather than sell it. (The development of the Forrestal Campus by Princeton University is one of several recent examples.) Universities have developed research parks for at least three reasons: with the prospect of earning a positive rate of return, to ensure a supply of space for current and future university expansion, and to have a nearby site for the location of technology-oriented private businesses that could help faculty develop and commercialize inventions[15]. This last motivation reflects a growing awareness within the university that there are important opportunities for private sector-university cooperation in applied research and technology development (see, for example, Lynton and Elman, 1987; National Science Board, 1983; Gibson, 1988; Steinnes, 1987; Fairweather, 1989; and Feller, 1988).

- *Park Occupants.* The last group of investments is by the organizations that locate within the parks. These investments are in infrastructure and buildings. The infrastructure that is provided includes water, sewer and gas hookups, telecommunications facilities (e.g., microwave transmitters), and access roads, when they are not provided by others. Organizations that conduct R&D or light manufacturing with processes that use or produce hazardous materials also often construct their own containment facilities. Most organizations in research parks also construct their own buildings, either on land they own, or on land they have leased long-term. Organizations that lease space in buildings, either from the park or a management company, may retrofit the building to their own specifications. Alternatively, that retrofitting is done by the lessor.

[14]From an interview with Alf Branden, former VicePresident for Business and Finance, and one of the architects of Stanford Research Park. Palo Alto, California, July 1988.

[15]From interviews with officials at universities affiliated with the three case study research parks.

4 Expected Regional Development Outcomes

We stated earlier that the large investments made in research parks that are summarized in the preceding section have been motivated by the belief that research parks induce technology-based regional economic growth. This perception is based mostly on casual observations (particularly of a few well-known older parks) and anecdotal reports in the popular press. (For example, Alexander, 1977; Binyon, 1977; and Fairbanks, 1981.)

In this section we provide a theoretical basis for the current interest in research parks. The planners and policy officials who advocate research park development generally are not aware of these theoretical arguments – at least not formally. However, elements of theory appear informally in planning and policy documents and in discussions of public objectives and purposes.

Two different, but complementary, streams of regional development theory provide hypotheses about the impacts of research park investments on regional economic development. Growth (or development) pole theory stresses the diffusion of growth and innovative activity from a center, or seedbed (the research park). Entrepreneurship theory often focuses on the attributes of a region that enhance its creativity and dynamism. (Goldstein and Luger, 1989b, provide a more complete and critical discussion of these theories.)

We discuss the full range of regional development impacts elsewhere (Ibid.). Here, we focus on employment generation and job quality. From growth and development pole theory we expect indirect employment generation through the mechanisms of backward linkages, forward linkages, intracorporate organizational linkages, and through the creation of localization economies. The theory predicts that backward linkages lead suppliers of equipment, materials, and business services to locate in proximity to the research park. Forward linkages should lead establishments that purchase R&D outputs to locate in proximity to the research park. A special forward linkage occurs when a corporation locates a manufacturing plant in proximity to its own R&D facility in order to increase the interaction of engineers with production managers. Other types of regional employment generation based on intracorporate linkages might be the decision to move a headquarters function to the area of its principal R&D facility. Localization economies created by a research park lead to the growth of other R&D facilities in the region to take advantage of a specialized labor pool, and accessibility to other

research-based institutions already in the region (e.g. universities), technical and market information through proximity to R&D facilities of competing firms, and a social and cultural milieu created by the concentration of a highly educated work force.

Entrepreneurship theory also stresses a type of localization economies. According to that theory, research park enterprises employ a highly creative work force that increases the overall innovativeness of the region. That creativity and innovativeness presumably attract venture capital and other entrepreneurs to the region. The culture of innovation then should build upon itself "synergistically," leading to business spinoff activity, new business formations, and increased risk-taking. An infrastructure conducive to spawning and nurturing innovative activity should develop and help sustain the region's dynamism and adaptiveness into the future.

5 The Impact of Research Parks on Regional Employment: Evidence

Over 40 years ago, Howard Odum, a sociologist and regionalist at the University of North Carolina at Chapel Hill, was one of the first to hypothesize that research activity can stimulate the economic development of a region (Wilson, 1967). Odum had the South, and specifically North Carolina, in mind, and his ideas were heavily influential in the series of decisions that eventually led to the creation of the Research Triangle Park.

Over time, economic development officials from all over the United States and from other parts of the world have come to treat Odum's hypothesis as an assumption. After visiting Research Triangle Park, Stanford, the University of Utah, and a small number of other established research parks, many of those officials returned home to set up their own parks; hence, the dramatic growth in the research park population. Unfortunately, park developers too often fail to account for unique local conditions, or even to assess whether any park can be justified in a benefit-cost sense.

The principal question that we now need to address is whether, and under what conditions, Odum's hypothesis can be sustained. Specifically, can we expect research parks to achieve their intended regional development outcomes?

We first note that of the 110 research parks that now exist in the United States, twenty-four have no establishments and no employment; they exist only on paper. Franco (1985) has estimated that over 50 percent of all parks that are announced never become viable and go out of business. This nearly happened to the Research Triangle Park. Of those parks that manage to stay in business, as many as 50 percent cease to operate primarily as *research* parks because they could not attract a sufficient number of R&D laboratories. Instead, to maintain the park's viability as a real estate project, managers of these parks typically relax restrictions and allow general business, office, and/or manufacturing uses. This indicates that research parks are relatively risky investments. One out of every two that start up fail altogether. And approximately half of the remaining parks maintain viability only by changing their original mission. Hence, only around 25 percent of park start-ups continue in existence as planned.

Even if a research park remains organizationally viable, it may not stimulate regional economic development beyond its direct contribution. That is the particular issue we investigate in this section. We proceed by summarizing two types of evidence about the indirect or induced employment effects of research park development: results from a case study of the Research Triangle Park, and results of quasi-experimental and econometric analyses of data from counties throughout the U.S. with and without research parks. Both of these confirm that the growth transmission process is more complex and less regular than growth/development or entrepreneurship theory predicts.

5.1 The Case of the Research Triangle Park

This case study is divided into a brief history of the Research Triangle Park and a discussion of the park's impact on the regional economy. (Sellars, 1989, provides an extensive history of the Research Triangle Park.)

5.1.1 History

In the mid-1950s, North Carolina had the second lowest per capita income of any state, and its employment base was concentrated in three low-wage, declining industries: tobacco, textiles, and furniture. There was little or no

R&D activity in the region except for that in the area's three research universities – the University of North Carolina at Chapel Hill, North Carolina State University, and Duke University. The combination of high quality public universities and the lack of job opportunities for highly skilled scientists and engineers had led to a brain drain from the state of serious proportion.

In 1955, Governor Luther Hodges formed a committee of the state's business leaders and prominent university officials to investigate how the strengths of the area's universities could be used to help restructure the state's economy. One year later, the committee produced a report that proposed that the three research universities could attract a concentration of industrial research labs to the region to take advantage of the faculty expertise, that in turn would attract technology-based production facilities to surrounding parts of the state. It is noteworthy that this report did not envision a research park. Because only a few relatively new research parks existed at the time, the concept was not yet well-known.

After two years, a retired industrialist from New York was recruited to invest in the concept proposed by the committee. He proposed to build a private research park on 4,000 wholly undeveloped acres near the center of the triangle formed by Chapel Hill, Raleigh, and Durham. However, he could not attract additional investors, in part, because of public skepticism about the general research park concept, and in part, because questions of propriety were being raised about the promotion of a private research park by public universities and other state government agencies.

After a period of stagnation, a group of private citizens and civic-minded corporations bought out the stock of the (empty) private research park and formed the non-profit Research Triangle Foundation to govern the renamed Research Triangle Park. A $500,000 grant and gift of 180 acres in the middle of the park were used to create a non-profit contract research organization (the Research Triangle Institute) as the park's first occupant (Little, 1988).

The park was slow in attracting additional organizations until 1965 when IBM bought a site for a major facility. Luther Hodges, who had gone from the governorship to Washington as John F. Kennedy's Secretary of Commerce, and Terry Sanford, who was then Governor, were instrumental in getting the National Institutes of Health to locate its National Institute of Environmental Health Sciences in the park as well. These occupants served as anchors; they amplified the attractiveness of the region, due to its concen-

tration of research universities, to a string of R&D branch plants of major national and international corporations, and other federal government labs. The park grew slowly, but steadily over the next twenty-two years. By 1989, there were forty-one R&D enterprises in the park with an aggregate work force of over 30,000. A large majority of the enterprises are R&D branch plants of major corporations (rather than indigenous, home-grown businesses) occupying large, expensive, and widely separated sites with stringent restrictions on their use.

5.1.2 Impact

To assess the regional development outcomes of the Research Triangle Park we collected information from the population of park enterprises and from a stratified random sample of enterprises outside the park but within the triangle region. The sample was drawn from enterprises, in selected industrial sectors, that had first located in the region after the park was created in 1958[16]. We asked the CEOs of the sample enterprises their perceptions of the park's influence on their organization's location decision, as well as on the economic development of the region, in general.

First, one-third of the 36 respondents from organizations *inside the park* indicated that it was "unlikely" or "very unlikely" that they would have located in the region if the park itself had not existed. On the other hand, 44.4 percent said that it was "likely" or "very likely" they would have located in the region even if the park had not existed. (The remainder answered "maybe".) "Proximity to the area's research universities" was given most often as the respondents' main reason for locating in the region. Other possible responses, including "the location of other corporate branches in the region," "a concentration of firms in the same or related industry sector" and "accessibility to input materials" were not mentioned as frequently as location determinants.

To the question: *"What, if anything, is important about the area universities to your organization?"* the most frequent responses were "access to graduating students for recruiting" and "access to faculty expertise." "Adjunct faculty appointments for staff scientists and engineers" and "access to

[16]We used inputoutput tables to select the industrial sectors with the most active trading relationships with the types of organizations most commonly found within research parks.

university facilities and laboratories" were mentioned less often.

The most important reasons cited by respondents for locating in the park rather than on sites outside the park, but within the region, were "the prestige of the park" and "the suitability and quality of the building site." "Access to ideas and creative people working in other park establishments" was not as frequent a response. This reply is consistent with other responses that reveal that scientists and engineers in more than 60 percent of park businesses have only "occasional" or "little" professional interaction with counterparts in other park enterprises.

Of the sample of 148 enterprises located *outside Research Triangle Park*, 40.9 percent said that the presence of the park was of "high" or "moderate" importance in choosing the region. The other 59.1 percent of the sample respondents said the park was only of "minor" or "no" importance. When asked: *"Would you have located in the region if the park did not exist?"* 75 percent of respondents answered "very likely" or "likely". Eight businesses (5.7 percent of 140 responses) said it was "very unlikely" that they would have located in the region if the Research Triangle Park did not exist, and nine businesses (6.4 percent) said it was "unlikely." (12.9 percent answered "maybe".) Seventeen businesses answering "very unlikely" and "unlikely" seems like a small number. But, when it is projected to the entire triangle area business population it is not insignificant. Assuming the responses we received and the sample we drew are representative we can inflate the eight "very unlikely" answers by a factor of ten and the nine "unlikely" responses by a factor of five[17]. Then, the induced number of businesses is 125 and the induced number of jobs is approximately 1700. This number, of course, is conservative, because it does not account for further rounds of induced business formation and job creation, by enterprises that interact with the businesses we surveyed outside the park.

Finally, we asked the businesses outside Research Triangle Park if they would exist *anywhere* if the park had not been created, in order to ascertain the net gain in economic activity that could be attributed to the park.

[17]We drew a oneinthree sample from the population and received back 30 percent of the questionnaires that were mailed. Therefore, the response rate is approximately 10 percent of the population. We inflate the "unlikely" responses by half this amount using the assumption that those respondents had twice the probability of locating in the region if the park did not exist.

Over 88 percent of the respondents said that it was either "very likely" or "likely." Again, three "very unlikely" and five "unlikely" responses are not large numbers, but when projected to the population, they inflate to 55 businesses. These are enterprises, moreover, that most likely were created specifically to interact with park businesses.

One can infer from these results that the Research Triangle Park has been responsible for inducing a considerable amount of technology-related employment in the region. Yet, park-induced growth accounts for less than twenty-five percent of the overall employment growth in technology-related businesses. We would conclude that the primary engine of economic development in the region has not been the park itself, but the three research universities.

5.2 Quasi-Experimental and Econometric Analyses

We first addressed the counterfactual question: *"Have research parks induced more growth in their regions than would have occurred without them?"* by asking park managers how several outcomes would have differed if a research park had not been created in their region. Of the 57 managers who responded, 49.1 percent said that their area's employment growth rate would have been "somewhat lower" and 12.3 percent said it would have been "much lower." Similarly, 31.6 percent said business start-ups would have been "somewhat lower" while 14 percent said "much lower."

While these responses are suggestive, their subjective basis raises some questions about validity; park managers are not disinterested observers. For that reason, we also employed a more objective quasi-experimental research design to answer the counterfactual question about park-induced employment growth. Specifically, we compared employment growth rates in counties *with* research parks to average employment growth rates in counties *without* research parks, but with the same metropolitan status and population size, and within the same Census region. We use the employment growth rate as a proxy for the rate of economic development.

We defined "economic development success/failure" in two ways: as a continuous measure equal to the difference between research park and control group counties' growth rates, and as a dichotomous measure which labels as a "success" any park in a county with a four year-average employment

	Areas with parks	Areas with no parks
Metropolitan Area Population		
60,000 or less	2.29%	1.66%
60,001-499,999	3.24%	3.34%
500,000-999,999	3.47%	2.90%
1,000,000 or more	2.87%	2.90%
Presence of Research University		
No research university	3.29%	2.83%
Type I research university	1.88%	2.77%
Type II research university	2.82%	3.01%

Type I and Type II are classifications given to research universities by the Carnegie Foundation, based on the volume of funded research and number of Ph.D.s awarded. Type I is a higher research classification than Type II.

Table 1: Comparison of Employment Growth Rates in Areas With and Without Parks, 1983-87

growth rate equal to 120 percent or more of the four year-average employment growth rate in the control group of counties[18]. (We used two measures of success/failure as a form of sensitivity analysis.)

Table 1 contains the 1983-87 employment growth rate averages for counties with and without research parks, by metropolitan area population and type of nearby university. We discuss each in turn.

- *Metropolitan area population.* Two groups of park counties appear to have grown faster than the control group – those with less than 60,001 people and those with a population between 500,000 and 1,000,000. The first of these results is not surprising. In small metro areas, parks

[18]We measured the employment growth rates between years t+1 and t+4, where t is the year the research park was established.

can serve the same function as a central business district: they can be a source of agglomeration economies that small places otherwise would lack.

It also is not surprising to see an increase in average growth rates among areas with parks as population increases, at least for the first three size groups. Larger metro areas are more likely than smaller areas to have locational characteristics that park occupants find attractive, including good airports, cultural amenities, and large and diversified pools of available labor. The slower growth rate in the 1,000,000 or more category may indicate the onset of congestion.

- *Presence of research university.* Areas that have research parks and universities grew more slowly than areas with research universities and no parks. And areas with parks and no universities grew faster than areas with neither a park nor a university. These results suggest that research parks play the same economic stimulus role as research universities, where universities do not exist.

Table 2 uses the dichotomous measure of success/failure. The second column therefore reports the number of cases in which the employment growth rate for counties with parks exceeded 120 percent of the employment growth rate for counties without parks. The third column reports the number of cases in which the opposite is true.

In most instances, there is an even split between successes and failures. We see, again, that the number of successes is considerably greater for larger metropolitan areas than for smaller ones. For reasons we cannot explain, there are many more failures than successes in the 60,001 to 499,999 population range.

The difficulty we have interpreting some of the results in Tables 1 and 2 could be due to the fact that we examine one source of variation at a time, without controlling for other effects. The standard way to avoid that problem is to employ multiple regression analysis. We did that, using both the continuous and dichotomous measures of success as dependent variables, and the following explanatory variables[19]: county type (core?), deed restriction used?

[19]These were not all used in the same regression models. Ten different models were run, some as ordinary least squares and some as logit.

	No. of successes	No. of failures
Metropolitan Area Population		
60,000 or less	4	3
60,001-499,999	3	11
500,000-999,999	4	3
1,000,000 or more	11	6
Presence of Research University		
No research university	9	8
Type I research university	3	4
Type II research university	10	11
Vintage		
1970s	8	8
1980 and 1981	4	2
1982	7	5
1983	6	8

Table 2: Research Park "Successes" and "Failures"

government assistance used? non-metropolitan area? metropolitan area population, manufacturing limited? park collects garbage? research university near? affiliated with research university? Type I research university near? age of park, percent floor space in incubators, and percent of space leased. Variables followed by a question mark were entered as yes/no dummies. The explanatory variables are either attributes of the region in which the park is located or attributes of the parks themselves.

Five of the variables listed above were statistically significant in most of the models that were estimated[20]: the age, or vintage of the park; the presence of a research university; the use of limitations on manufacturing activity; the use of deed restrictions; and the provision of garbage collection services.

[20]Complete regression results can be obtained from the authors.

- *Park vintage.* The older the park, the more likely that it has been successful. One reason is that the farther back in time we go, the fewer parks we find competing for a given number of private and government R&D labs. But perhaps more important is that the handful of parks that succeeded early were able to establish themselves as "meccas" of high technology. These areas pose formidable competition for areas with new research parks trying to establish themselves.

- *Presence of a research university.* Having a leading (Type I) research university within the same metropolitan area or non-metropolitan county of a research park had a negative effect on the relative employment growth rate differential. This surprising result may be interpreted as a local labor market phenomenon: leading research universities raise the local wage and salary levels so that manufacturing and other non-R&D activity may be repelled. If this interpretation is true it has important implications for the type and quality of economic development that is stimulated by R&D activity. Changes in the occupational distribution, mean income levels, and level of income inequality, for instance, are more likely economic development outcomes than increases in the region's employment growth rate.

  If we assume that parks adjacent to research universities are more likely than other parks to have R&D businesses, as opposed to light manufacturing and other permitted uses, we could interpret this result to mean that strictly research-oriented activities lead to relatively small employment growth in the short-run. This interpretation is substantiated by the results for the next variable.

- *Limiting manufacturing and using deed restrictions.* Of the attributes of the parks themselves, both the use of deed restrictions and limitations on manufacturing activity within the park have negative effects on the dependent variable. Again, R&D and other types of economic activity, particularly manufacturing, are not necessarily compatible in the same local labor market. And the "purer" the research park, the less economic activity – besides other R&D – the park is likely to attract.

- *Park-provided services.* Finally, the provision of garbage collection by park management has a statistically significant positive effect on the

dependent variable. We interpret this to be a proxy for the perceived level of service provided by park management in general. Not surprisingly, the higher the level of service, the more businesses will want to locate in the park, and the more indirect job creation there will be.

5.3 Summing Up the Evidence

In this section we have presented several pieces of evidence about the "success" of research parks, measured in terms of their ability to induce employment growth. We noted, first, that approximately half of all park start-ups fail as real estate ventures, and half of those that remain are converted from research to more general business parks. This latter group of parks may be successful as real estate ventures, but not as policy undertakings, since their original objective (i.e., to attract a critical mass of R&D activity) was not achieved. We showed, finally, that of the extant parks, only about half can be judged "successful" in terms of their ability to create jobs that otherwise would not have existed in the region.

The case study of the Research Triangle Park indicates the magnitude of employment growth that is directly dependent on research park development. We estimated that at least 1700 jobs would not have been created outside the park if the park did not exist. Roughly half that number are in businesses that were established specifically to serve Research Triangle Park organizations. More generally, the businesses we surveyed in the triangle region, outside the park, cited proximity to the university – specifically its faculty and graduates – as the most important feature of their location. Intra-corporate and forward linkages with park organizations were of secondary importance.

Our quasi-experimental and econometric approaches indicate some of the critical factors necessary for parks to generate employment within their region. These factors can be summarized as: vintage, orientation, and amenities. Vintage refers to the date the park was established. Our results suggest that "the early bird gets the worm" since the probability of success is higher for earlier parks than for later ones. The results also indicate that the research, versus manufacturing, orientation of a park affects the magnitude of employment generation. The more research-oriented a park is, as evidenced by the use of land use restrictions and the type of university affiliation, the fewer jobs it will create in the region. Finally, our results suggest that

amenities matter. All else equal, businesses favor research parks that provide essential services. The more popular parks are as location sites, the greater employment creation there is, both within and outside the park.

6 Conclusions

The evidence presented above has implications for both theory and policy. The conclusion we draw for theory is that research parks do not behave as a classic growth/development pole in larger regions that contain research universities, since backward, forward, and lateral linkages do not play a major role in the generation of employment in those areas. The universities themselves are the growth poles, and localization economies, rather than linkages based on material inputs and outputs, provide most of the growth stimulus.

In regions without research universities and in smaller metropolitan areas that otherwise lack the basis for agglomeration economies, research parks can serve as a growth/development pole. But the strength of the pole in those instances depends on the critical factors mentioned above – vintage, orientation, and amenities – as well as on intangibles, including good fortune and wise and effective leadership.

The policy lesson we draw from this analysis is that research parks will not be wise investments in many regions. The "success" rate among all parks that are announced is relatively low. And, to the extent that vintage matters, it is too late for regions contemplating parks to "get in on the ground floor."

Research parks will be most successful in helping to stimulate economic development in regions that already are richly endowed with the resources that attract highly educated scientists and engineers. That is not to say that regions with less rich endowments can not have a high-technology future, but more basic and long-term investments in improving public and higher education, environmental quality, and residential environments will be needed first.

Finally, we need to remember that research parks, when successful, will attract additional R&D activity to a region, primarily. The number of new job opportunities will tend to be highly skewed to the professional and managerial end of the occupational distribution, while many of those who will get the new jobs may be recruited from outside the region. The surroun-

ding regions, rather than being the recipients of new manufacturing activity drawn to these areas because of the research park, ironically may suffer its own brain-drain, assuming they have a supply of qualified labor.

In light of this conclusion, state or local government officials considering a new research park should conduct a careful and sober feasibility assessment based upon a clear and specific set of objectives. There is no single formula for success, although there are factors that make the chances of success higher. If a decision to create a research park is made, government leaders should be prepared to invest liberally, and all other stakeholders should be prepared to wait a number of years before the investment is returned.

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