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The University Research Park as a Microcluster: Mapping Its Development and Anatomy

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ABSTRACT. University research parks facilitate co-location of businesses within or in relative proximity to the main campus. They provide a favorable environment for interaction among tenant firms, as well as between firms and academia. Because of their physical size, employment base, support services, export driven activities and their overall role in the region's economy, university research parks can be regarded as microclusters. In this paper we dissect and map the anatomy of a university research park to demonstrate its dynamism and economic impact on the region's economy through a mixture of different yet related activities. First we identify core activities that include technology companies and incubator based technology companies. These core activities are supported by park management support organizations, park tenant support organizations, and community service support organizations. Individual firms and agencies assigned to each of these categories are identified and employment is classified as export driven or non-export driven. Only the export component is used to estimate the indirect and induced employment in the metropolitan region that is dependent on park activity. The methodology and results of this project will be particularly useful in conceptualization and operationalization of economic impacts of university research parks on their local and regional economies.

1. Introduction

Michael Porter's 1990 *Competitive Advantage of Nations* has been widely credited for the popularization of the concept of industry clusters, although the original observations on geographic clustering of specialized companies can be traced way back to Alfred Marshall's (1890) work on industrial districts. Porter enhanced the basic idea of an industry cluster as a geographical concentration of industries that increase their competitiveness through co-location and collaboration. Moreover, he argued that the competitiveness of a region is based on the competitiveness of the industries, which in turn depends upon four key determinants, known as the "Diamond of Advantage:" factor conditions; home demand conditions; related and supporting industries; and industry strategy, structure and competitiveness (Porter 1990, 1998).

The concept of industry clusters found its two main applications in academic and applied research: one, as a strategy for regional economic development, and two, as an analytical tool in identifying existing functional relationships between region's industries (DeVol 2000, Doeringer and Terkla 1995, Held 1996).

Empirical studies on successful clusters have demonstrated the importance of co-location and interaction between research universities, suppliers of venture capital, adequate infrastructure and support services as well as active social networks as key drivers of innovation in a particular region (Markusen 1996, Porter 2000, Saxenian 1994). Because many of these region's attributes can be influenced by economic policy, cluster approach to regional economic development became widely accepted strategy at state, regional and local levels. Consequently, countless high-tech corridors, technopoles, and science parks have sprung up to provide the environment believed to be conducive to the development of targeted industries.

Geographic scope of clusters can range from a single city, to region, or a state. More than single industries, clusters encompass an array of linked industries and other organizations, including suppliers of inputs, governmental and educational institutions, as well as trade associations and technical support (Porter 2000). By facilitating co-location of businesses within or in relative vicinity of host campus, university research parks provide a favorable environment for dense interaction among firms, and between firms and academia.

Conceptualizing university research park as an industry microcluster

A typical university research park resembles an industry cluster in terms of employment base, firm type, and the overall role in the region's economy. But, because university research parks are typically organized within geographically limited area (physical boundaries of a park), encompass a smaller number of firms, and are managed as a unit, they can be regarded as microclusters.

An obvious difference between a regional cluster and the university research park conceptualized as a microcluster is in the process of identification of geographical and functional scope. Identification of cluster "boundaries" – i.e., organizations that actually or potentially comprises a cluster – is primarily based on the understanding of the linkages and complementarities across industries and institutions that are most important to competition in a particular field. In case of university research parks, a microcluster is easily identified as the firms located within the park's boundaries.

One of the most interesting aspects of university research parks in economic development literature is their role as drivers in local/regional economy. While academic debate in support of "pro" and "con" arguments continues (Link & Scott, 2006 and 2007; Miyata, 2000), an increasing number of studies deal with measurement of economic impacts of university research parks in specific communities, e.g. economic impact study of the University City Science Center for greater Philadelphia (Economy League

of Greater Philadelphia. 2009), Purdue Research Foundation Economic Impact Study (Thomas P. Miller and Associates, 2011) and The University of Arizona Science and Tech Park Economic Impact Study (Lim, 2010).

Conceptualizing the university research park as a microcluster allows for identification of types of firms in terms of their primary role – as "core" and "supporting" firms. Furthermore, the firms can be identified in terms of export- and non-export employment, which is a crucial step in operationalization, measurement and understanding of economic impacts on local and regional economy that are associated with the university research park.

Mapping Microcluster Anatomy

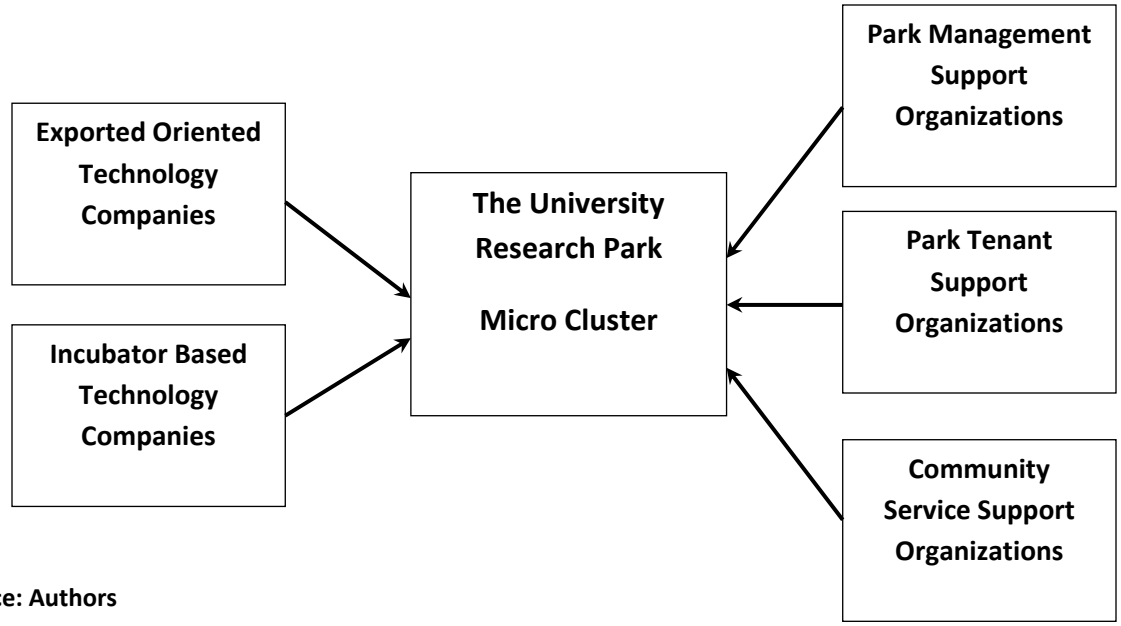
Literature has examined "anatomy" of clusters from different perspectives. Common approaches include identifying product-market relationships such as the buyer-seller linkages and input of supporting services. These and other dimensions of clusters, such as industry collaboration and information flow, require a combination of quantitative and qualitative methods, from input-output models to surveys and interviews of key industry representatives. In practice, clusters are often identified by local economic development leaders in collaboration with industry representatives and business consultants. An example of a localized cluster that has seen its reputation bloom is optical sciences in Southern Arizona. The University of Arizona has been proud of its optical science capabilities for decades. But the economic development implications of optical sciences were not widely recognized until Business Week magazine called the region "Optics Valley" in 1992 because of the large concentration of optics firms and organizations. In the years since the elements of the optics cluster, and its importance have been identified and analyzed by the Arizona Optics Industry Association, the

Arizona Department of Commerce, Tucson Regional Economic Opportunities, Inc (TREO) and, of course, the University of Arizona and its Office of Economic and Policy Analysis).

In case of the university research park, the geographic scope of the microcluster is determined by its physical site, while the list of tenants determines a finite number of firms in the microcluster. The focus of the analysis is on the microcluster's anatomy: identification of firms in terms of their function within the microcluster and consequently, the nature of their impacts on the local/regional economy. Figure 1 shows a general composition of a typical university research park. On the left side are shown (a) Export-oriented technology companies and (b) Incubator-based technology companies; on the right side are (c) Park management support organizations, (d) Park tenant support organizations, and (e) Community services support organizations. The Export-oriented technology companies and the Incubator-based technology companies are primary park tenants whereas the three groups of support organizations deliver essential supporting services that make the park an effective microcluster.

Anatomy of the University Research Park

Whereas every science and technology park has distinctive attributes, most will follow the pattern established by the University of Arizona's Research Park (UA Tech Park). Export oriented technology companies and a variety of support organizations are identified (Figure 1). The UA Tech Park is anchored by a dozen mostly established export oriented technology companies and 6 mostly embryonic incubator-based export oriented technology companies. Additionally there are three community serving support organizations--a high school, a community college, and a branch of the University of Arizona. The Research Park per se is supported by 10 tenants including fire and police protection, facilities and plant maintenance, food services, real estate services.



Source: Authors

Figure 1. The University Research Parks as a Microcluster: Mapping Its Anatomy

Finally there are 5 tenants that are university-based and devoted to the promotion of university driven economic development through improved access to an appropriate research park or through improved access to information about innovation and technology or employee access to housing through improved mortgage access.

Indirect Primary Employment

The indirect primary concept is relatively obscure but it is useful for recognizing that not all export employment is easily identified. The concept was described in Blumenfeld's 1955 paper and subsequently discussed and utilized by others including Gibson and Glenn (2000). There are numerous examples many of which are tied to the concept of out-sourcing. A straight-forward example might be an electric generating plant which exports all of its electricity out of the region. Assume that this firm elects not to have in-house workers to service it's plant but instead out sources plant maintenance to a

specialist firm which co-locates to provide the service. According to the indirect primary concept, these maintenance workers should be treated just like the electricity generating workers--as export employees.

At the UA Tech Park the task of identifying export and indirect and induced employment is usually straight forward. Export oriented technology companies and incubator companies are export driven whereas the employees in community service support organizations are indirect or induced. On the surface, firms and organizations providing park management services, park maintenance functions such as landscape maintenance and other common area maintenance activities, and other park supporting activities such as fire protection, janitorial services and cafeteria and dinning services would have employees counted in the indirect and induced categories. But a careful look at the facts suggests that these activities are in fact export activities. The export firms in the park out source these activities to local firms and organizations; the cost of these activities is directly supported by the export firms through their rent. These indirect primary employees may appear to be indirect or induced employees but in fact they are export workers.

2. Results

The grand totals are impressive. The UA Tech Park supports 16,334 total employees in 36 tenant firms and elsewhere in the Metropolitan Tucson Region (Table 1). Only 3 of the 36 tenants have no indirect/induced impact. Put another way most of the firms in the Micro Cluster and almost all of their employees have a multiplier impact that eventually adds indirect and induced employment and, of course, direct employment to the Tucson Region.

Table 1. Employment of UA TechPark Tenants and Impacts (Summary)

Company & Organization by Activities	Total Employment	Direct Employment	Indirect Primary Employment	Indirect/ Induced Employment	Total Employment Share (in %)
Export Oriented Technology Companies	15,987	6,248	0	9,739	97.88%
Export Oriented Incubator Based Technology Companies	39	18	0	21	0.24%
Export Oriented Companies Total	**16,026**	**6,266**	**0**	**9,760**	**98.11%**
Community Servicing Support Organization	55	55	0	0	0.34%
Park Management/Support Organizations	237	0	164	73	1.45%
Park Tenant Support Organizations	16	0	9	7	0.10%
Non-Export Oriented Organizations Total	**308**	**55**	**173**	**80**	**1.89%**
Grand Total	**16,334**	**6,321**	**173**	**9,840**	**100.00%**
Total Number of Tenants (n)	**36**	**21**	**15**	**33***	**N/A**

Source: UA TechPark Annual Tenant Survey, September 2010

* Among total of 36 tenants, only 3 tenants do not have indirect/induced impact.

There are a dozen mature export oriented technology companies which account for almost 16,000 employees - 6,248 export employees and another 9,739 indirect and induced employees through the multiplier process (Table 2). Of this total almost all export employees are in the 6 largest firms and the same is true of the induced and indirect employment generated through the multiplier process. Among the better known tenants are Canon USA, Citi Group, IBM, NP Photonics, IBM System Storage Executive Briefing Center, and Raytheon. Sectors which lead in generation of total employment include Aerospace and Defense Related Research and Development, Electronic Component Development, Surveying and Mapping Services, Credit Card Banks Services, and Data Processing Services. These are also the bulk of the sectors yielding export employment.

Table 2. Employment Impact of Export Oriented Technology Companies by Activities

Company by Activities	Total Employment	Direct (Export) Employment	Indirect Primary Employment	Indirect/ Induced Employment	Total Employment Share (in %)
Security and Other Technical Consulting Service	7	4	0	3	0.04%
IT Marketing Service	10	6	0	4	0.06%
Credit Card Banks Services	9,528	2,520	0	7,008	59.60%
Surveying and Mapping Services	55	28	0	27	0.34%
Electronic Component Development	69	37	0	32	0.43%
Scientific Research & Technology Development	26	12	0	14	0.16%
Data Processing Services	3,097	1,532	0	1,565	19.37%
Aerospace & Defense Related R&D	3,195	2,109	0	1,086	19.98%
Total	**15,987**	**6,248**	**0**	**9,739**	**100.00%**
Number of Tenants (*n*)	**12**	**12**	**0**	**12**	**N/A**
Multiplier	**2.56**				

Source: UA TechPark Annual Tenant Survey, September 2010

One common difference between an industrial park with high-tech tenants and a university based tech park is that the university park will more often than not have an incubator dedicated to "bringing along" developing technology companies (Table 3). These will sometimes be smaller companies with speculative products, untested production models, and business models which are "underdevelopment." From time to time an incubator based firm will actually have export-type employment and, perhaps, a small number of indirect and inducted employees supported by the export employment.

The UA Tech Park Incubator accommodates 6 tenants and 39 export, indirect and induced employees. Whereas these numbers are modest they have the potential to grow two ways in the future. Ideally one or more of these tenants will blossom and move from the Incubator into the research park per se. Alternatively, more developing companies coming from the Tucson Community, the University of Arizona, or elsewhere will emerge to call the UA Tech Park home. The 6 firms currently in the Park represent Bio, agricultural, and information technology development which seems appropriate inasmuch as we are talking about a university based research park.

Table 3. Employment Impact of Export Oriented Incubator Based Technology Companies by Activities

Company by Activities	Total Employment	Direct (Export) Employment	Indirect Primary Employment	Indirect/ Induced Employment	Total Employment Share (in %)
Bio Research & Technology Development	33	15	0	18	84.62%
Ag. Research & Technology Development	2	1	0	1	5.13%
IT Research & Technology Development	4	2	0	2	10.26%
Total	**39**	**18**	**0**	**21**	**100.00%**
Number of Tenants (*n*)	**6**	**6**	**0**	**6**	**N/A**
Multiplier	**2.17**				

Source: UA TechPark Annual Tenant Survey, September 2010

It is not uncommon for university-based research parks to have non-core tenants. The UA Tech Park has three community servicing support organizations with a total employment of 55 and has discussed hosting other such tenants (Table 4). Tenants of these sorts might provide services for the larger community or for Park tenants.

The three current tenants are the Vail Academy and High School, Pima Community College, and The University of Arizona South. The three tenants are accommodated inasmuch as the park has, or had, excess capacity but there are other considerations too including the fact that the Park wishes to be a good neighbor. This is certainly the case of the Vail Academy when the Research Park ownership was transferred from IBM to the State of Arizona the local (Vail) school district lost revenue from property taxes. By providing space for the Academy and High School it proved temporary relief for the school district. By providing space for the Community College and the University of Arizona South the Research Park is providing educational access to residents of Southern Arizona and the Tucson Metropolitan area and potential access to training and education programs to park tenants too.

Other non- core tenants that have been considered by the University of Arizona and have been located in other Research Parks elsewhere include hotel and conference facilities, a health club, and a golf course.

Table 4. Community Servicing Support Organization* by Activities

Organization by Activities	Total Employment	Direct (non-Export) Employment	Indirect Primary Employment	Indirect/ Induced Employment	Total Employment Share (in %)
High School	**23**	**23**	**0**	**0**	**41.82%**
Academies, College or University	**32**	**32**	**0**	**0**	**58.18%**
Total	**55**	**55**	**0**	**0**	**100.00%**
Number of Tenants (n)	**3**	**3**	**0**	**0**	**N/A**
Multiplier	**N/A**				

Source: UA TechPark Annual Tenant Survey, September 2010

* Other types of Community Servicing Support Organization include Hotel & Conference Facilities, Health Club, Golf Course and etc.

Table 5 describes the 10 tenants that provide park management, park maintenance including landscape maintenance and maintenance of common areas, and park supporting organizations including those providing fire protection, janitorial services, and cafeteria/dinning services. These tenants have a total of 164 indirect primary employees which are all directly supported by monthly rent payments. These tenants support an additional 73 indirect and induced employees through the multiplier process in other Tucson area firms.

Table 5. Park Management/Support Organizations

Organization by Activities	Total Employment	Direct (non-Export) Employment	Indirect Primary Employment	Indirect/ Induced Employment	Total Employment Share (in %)
Park Management Organization	96	0	61	35	40.51%
Park Maintenance Organization	74	0	55	19	31.22%
Park Supporting Organization	67	0	48	19	28.27%
Total	237	0	164	73	100.00%
Number of Tenants (n)	10	0	10	10	N/A
Multiplier	1.45				

Source: UA TechPark Annual Tenant Survey, September 2010

The 4 tenant support organizations described in Table 6 have 9 indirect primary employees and another 7 indirect and induced employees which are supported through the multiplier process. Organizations included here are the UA Office of University Research Parks, the Arizona Center for Innovation, the Arizona Technology Council, and Meriwest Mortgage.

Table 6. Park Tenant Support Organizations

Organization by Activities	Total Employment	Direct (non-Export) Employment	Indirect Primary Employment	Indirect/ Induced Employment	Total Employment Share (in %)
Research Park Tenant Supporting Services	16	0	9	7	100.00%
Total	16	0	9	7	100.00%
Number of Tenants (n)	4	0	4	4	N/A
Multiplier	1.78				

Source: UA TechPark Annual Tenant Survey, September 2010

The multiplier for the entire micro cluster is 2.6 (Table 7). Export oriented technology companies are the largest contributors to this total but incubator based technology companies, park management/support organizations and park tenant support organizations make a modest contribution too. Park management support/organizations and park tenant support organizations make their contribution as indirect primary employers. Community servicing support organizations do not contribute to either export or multiplier employment but these organizations do contribute to the grand total employment of 16,334.

Table 7. Multiplier by Activities

Company & Organization by Activities	Total Employment	Direct Employment	Indirect Primary Employment	Indirect/ Induced Employment	Multiplier
Export Oriented Technology Companies	15,987	6,248	0	9,739	2.56
Export Oriented Incubator Based Technology Companies	39	18	0	21	2.17
Export Oriented Companies Total	**16,026**	**6,266**	**0**	**9,760**	**2.56**
Community Servicing Support Organization	55	55	0	0	N/A*
Park Management/Support Organizations	237	0	164	73	1.45**
Park Tenant Support Organizations	16	0	9	7	1.78**
Non-Export Oriented Organizations Total	**308**	**55**	**173**	**80**	**1.46****
Grand Total	**16,334**	**6,321**	**173**	**9,840**	**2.60*****
Total Number of Tenants (n)	**36**	**21**	**15**	**33***	**N/A**

Source: UA TechPark Annual Tenant Survey, September 2010

* Multiplier for 'Community Servicing Support Organization' is not applicable since these organizations would have existed even without the presence of UA Tech Park, i.e. there is no measurable indirect/induced employment of 'Community Servicing Support Organization'. This is purposely designed to avoid the double counting issue.

** Multipliers for 'Park Management/Support Organizations' and for 'Park Tenant Support Organizations' are calculated as the ratio of 'Total Employment' to 'Indirect Primary Employment' since these activities' direct employment is labeled as "Indirect Primary Employment" due to the non-export oriented characteristics of employment. The employment for these organizations would have not existed without the presence of UA Tech Park.

*** Total Multiplier is calculated by excluding the number of employment in 'Community Servicing Support Organization' from both direct and total employment.

3. Conclusions

University Research Parks are complex entities. Using the UA Tech Park as an example we find that this Micro Cluster has five distinct elements, 36 tenants, and 16,334 mostly export driven employees. The bulk of the employees (15,987) are found in just a few large export-oriented technology companies. But smaller firms and organizations come into play, too. We employ the indirect primary concept to identify employees that might initially appear to be indirect or induced but in fact are important export oriented workers who contribute additional indirect and direct workers through the multiplier process.

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