Employment in China's hi-tech zones

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Abstract:

The purpose of this paper is to explore employment differences over time across China's hi-tech zones. Using data from China's Ministry of Science and Technology, we find that if a university science park is within a hi-tech zone, employment in that zone is higher, but that finding only holds for zones established in the pre-information communication technology period. After 2000, proximity to a university science park does not appear to be necessary for the exchange of tacit knowledge which we contend leverages the technology base of firms and organizations in the zone and thus their level of employment. We also find greater employment in hi-tech zones in which information technology is a dominant industry.

Keywords: employment | hi-tech zone | university science park | information technology | program management

Article:

Introduction

Investments in science and technology are the driver of a country's economic growth and development. Since the founding of the People's Republic of China in 1949, China's science and technology (S&T) policy has undergone four major phases (Campbell 2013; Su et al. 2016). In the first phase, China focused on developing heavy industry following the Soviet Union's path. The second phase began with the chaotic Cultural Revolution from 1960 to 1978. During this period, the country turned away from research and education and thus experienced almost 20 years of economic stagnation. The third phase began with a series of reforms initiated by Deng Xiaoping. Under his leadership, universities were reopened, academic scholars were encouraged to pursue research, and the country shifted towards a market economy. This period initiated China's industrial development; the government attracted international corporations and much of the responsibility for investing in research and development (R&D) shifted to the private sector.

China's technology-oriented policies have increasingly supported the growth of high-technology industries.[1] China's premier technology-based initiative during the fourth period was the initiation of the Torch Program, implemented in 1988 by the Ministry of Science and Technology (MOST). MOST drafts policies and administers all national R&D activities including the establishment of university science parks[2]; it also provides R&D assistance to private sector firms.

The Torch Program is "a national initiative to develop China's hi-tech industries by promoting the commercialization of S&T achievements, the industrialization of R&D results and the internationalization of hi-tech industries" (MOST 2011, p. 4). The program provides R&D assistance to several hi-tech industries including, but not limited to, information technology (IT), advanced material, biotechnology, sustainable energy, and automation.

National Hi-Tech Industrial Development Zones (hereafter hi-tech zones) are the most visible accomplishment of the Torch Program. Hi-tech zones are a form of technology infrastructure. Zones were created to assist firms develop and commercialize technology-based innovations in a designated hi-tech concentrated or clustered geographic area. In the early years of the program, hi-tech zones were established in major cities building on the existing intelligence and industrial base. Prior to 2000, 54 high-tech zones were built in major cities like Beijing, Shanghai, or in provincial capitals and other fast-developing urban areas (MOST 2011). The successful growth of these zones led to the establishment of more hi-tech zones across the country. By mid-2017, 156 hi-tech zones had been established. While MOST oversees the central administration of the hi-tech zones and provides overall administrative guidance, the provincial government remains in charge of supporting the industrial development of the zones (e.g., daily management) and initiating policies to attract new enterprises.

National hi-tech zones have become a leading economic driver in China. With an annual growth rate of sales of around 20% over recent decades (1991 to 2011), national hi-tech zones have contributed substantially to the economic development of China. In 2015, for example, hi-tech zones accounted for nearly 12% of national Gross Domestic Product (GDP) (MOST 2017).

With the goal of promoting technology innovation, many hi-tech zones have diversified in an effort to establish industrial strength in multiple sectors, although a zone is often recognized nationally for its primary industrial activity. The first (established in 1988), and the largest hi-tech zone, Zhongguancun in Beijing, enjoys a competitive position primarily in IT; Shanghai Zhangjiang (established in 1992) has a reputation in bio-medicine; and Wuhan's zone (established in 1991) specializes in optoelectronic communication.

Many national hi-tech zones were intentionally located in or near major cities with a developed knowledge industry and frequently with a university science park. For example, in 2010, the

[1] One example was China's development of a clean-technology industry (Campbell 2013). Due to concerns of dependence on foreign oil and heavy environmental pollution in China, the Chinese government has been investing in energy technology projects, especially renewable energy and energy storage technology. China is now a leading country in solar cell industry.

[2] In China, science parks are linked with one or more universities, and they are usually located in or close to a university. The hi-tech zones discussed in this paper are different from university science parks. Hi-tech zones are larger than university science parks and might include one or more university parks in the zone.

national hi-tech zones included 339 colleges and universities, 772 research institutes, 473 post-doctoral workstations, 252 national research centers, and 2792 enterprise technology centers (MOST 2011).

The purpose of this paper is to explore employment levels across China's hi-tech zones.[3] To the best of our knowledge, this paper is the first to examine longitudinally and statistically any economic dimension of hi-tech zones. In fact, Hobbs et al. (2017a) recently reviewed 87 academic and policy papers on science and technology parks and concluded that more papers were focused on China ($n = 16$) than on any other country, and those papers were case studies.

In the second section, we posit an analytical model to investigate inter-zone differences in the level of employment in 2015, and we discuss the data used to estimate this model. We used Hu's (2007) scholarly paper as a starting point for our paper. He analyzed empirically labor productivity across the 53 Chinese science parks/hi-tech zones established as part of the Torch Program (see our discussion of Fig. 1 below). Our model of employment across hi-tech zones is parsimonious due to limited data, but our findings are robust across various specifications of the model.

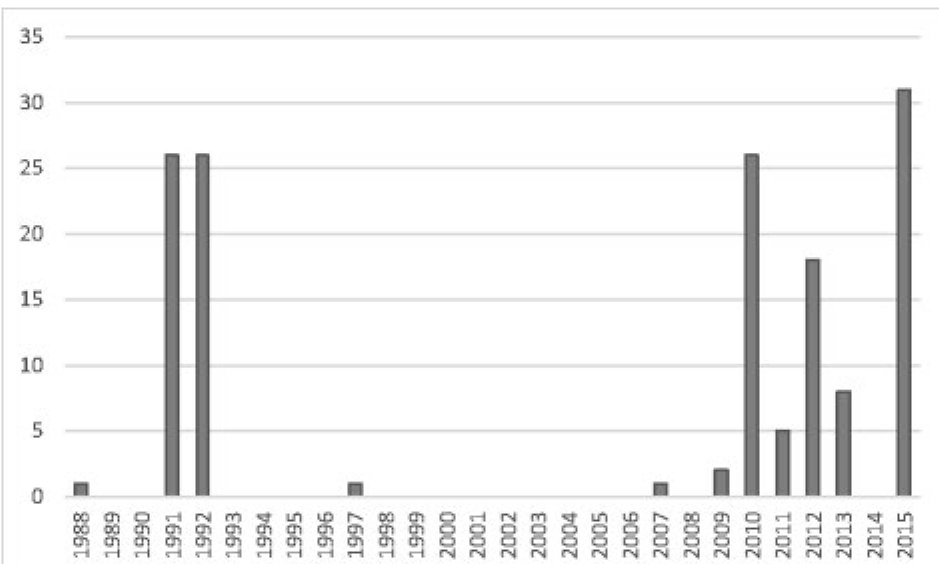

Fig. 1. Distribution of China's Hi-Tech Zones, by Year of Establishment, ($n = 145$). Source: China Statistical Yearbook (2016)

The paper concludes in the third section with summary remarks and a possible research agenda for future studies on China's hi-tech zones and its university science parks.

Analytical model and data

Our analytical model is represented as:

[3] An earlier version of this paper was presented at the Technology Transfer Society annual conference at George Mason University. We thank Cristiano Antonelli and Nick Vonortas for their helpful comments and suggestions.

$$Employ = \mathrm{f}(Age, UnivPark, ICT, Industry) \quad (1)$$

where *Employ* measures total 2015 employment in each hi-tech zone, *Age* is the age of the hi-tech zone measured as the difference between 2016 and the year the zone was established,[4] *UnivPark* accounts for whether there is a university science park in the hi-tech zone or not. *ICT* accounts for hi-tech zones established after the start of the so-called information communication technology (ICT) revolution in 2000. And, *Industry* represents fix effects for the industrial focus of the park.

We expect that *Age* will be positively related to *Employ*. Simply, older hi-tech zones have had longer to attract firms and organizations, and a longer time period for them to grow.

We also expect that *UnivPark* will be positively related to *Employ*. Hobbs et al. (2017b) and Link and Scott (2006) have shown that university research and science parks in the United States that are geographically closer to a university realize greater employment growth because of their immediate access to the tacit knowledge that is embodied in university faculty.[5] Building on that logic, we expect that hi-tech zones will realize greater employment when there is a university science park in the hi-tech zone. The university science park represents a source of tacit knowledge that leverages the technology base of the firms and organizations in the established zone.

Hobbs et al. (2017b) also showed for U.S. university research and science parks that the importance of proximity to a university decreased during the ICT revolution because of Internet access to faculty.[6] Reflecting on that finding, we predict that the effect on employment of there being a university science park in the hi-tech zone will be diminished if the zone was established during the ICT.

A priori, we do not predict the direction of different industries on *Employ*.

The data used to estimate Eq. (1) come from the 2016 China Statistical Yearbook published by National Bureau of Statistics of the People's Republic of China. Our sample of 145 zones is distributed by year of being established in Fig. 1. Clearly, the distribution of establishment dates in our sample of zones is bimodal. Fifty-two zones were established in 1991 and 1992, and 88 zones were established between 2010 and 2015.

Descriptive statistics on the relevant variables in Eq. (1) are in Table 1. The variable *UnivPark* equals 1 if there is a university science park within a zone, and 0 otherwise. Over one-third of the zones in our sample contain a university science park. The variable *ICT* equals 1 for zones established after 2000, and 0 otherwise. About 63% of the zones in our sample were established after 2000. The industry focus of each zone is represented based

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[4] Any park founded in 2015 is thus coded as having an age of 1 year.
[5] Link and Yang (2017) investigated a distance variable in their analysis of the employment growth among Korean technoparks, but they found no statistical relationship between distance and employment using a model similar to that in equation (1) above.
[6] Hobbs et al. (2017b, p. 503) wrote: "… the ICT revolution mitigated aspects of the need for scientists to have face-to-face interactions with university scientists and [it] increased park productivity more generally …"

on information on the zone's website. If the IT industry was listed, then *IT* = 1, and 0 otherwise; if the energy sector was listed, then *Energy* = 1, and 0 otherwise; and if the manufacturing sector was listed, then *Manuf* = 1, and 0 otherwise. As shown in Table 1, about 48% of the zones include firms in the IT industry, about 25% of the zones include firms in the energy sector, and about 10% of the parks include firms in the manufacturing sector.

Table 1. Descriptive statistics on variables in Eq. (1), (n = 145)

Variable	Mean	Standard deviation	Range
Employ (in thousands)	118.14	214.50	0.573–2308.23
Age (in years)	11.39	10.27	1–28
UnivPark	0.366	0.483	0/1
ICT	0.628	0.485	0/1
IT	0.476	0.501	0/1
Energy	0.248	0.44	0/1
Manuf	0.097	0.296	0/1

An interaction term between *UnivPark* and *ICT* (*UnivPark*ICT*) is included in alternative specifications of Eq. (1) to account for the possible impact of the ICT revolution on the employment impact of a university science park being in a hi-tech zone.

The regression results from the alternative specifications of Eq. (1) are in Table 2.

Table 2. Least-squares regression results from alternative specifications of Eq. (1), (standard errors in parentheses)

Variable	(1) *Employ*	(2) *lnEmploy*	(3) *Employ*	(4) *lnEmploy*	(5) *Employ*	(6) *lnEmploy*
Age	8.097	–	6.304	–	6.836	–
	(1.612)****		(1.993)****		(3.755)**	
lnAge	–	0.507	–	0.471	–	0.485
		(0.055)****		(0.034)****		(0.082)****
UnivPark	51.235	0.142	118.170	0.328	251.140	0.638
	(33.467)*	(0.135)	(55.294)***	(0.215)*	(98.031)***	(0.246)***
*UnivPark*ICT*	–	–	−105.606	−0.292	−252.891	−0.634
			(69.630)*	(0.263)	(132.536)**	(0.323)***
IT	58.888	0.444	60.389	0.445	–	–
	(32.959)**	(0.132)****	(32.822)**	(0.132)****		
Energy	15.521	0.279	8.901	0.260	–	–
	(37.368)	(0.150)**	(37.451)	(0.151)**		
constant	−24.72	2.933	−3.066	3.005	34.007	3.442
	(30.912)	(0.139)****	(33.920)	(0.154)****	(65.360)	(0.201)****
R^2	0.205	0.463	0.217	0.467	0.235	0.531
F-level	9.00****	30.11****	7.72****	24.38****	6.65****	24.51****
n	145	145	145	145	69	69

The variable *Manuf* was not statistically significant in any specification and thus was deleted. Those results are available on request from the authors

Key: **** significant at .01-level, *** significant at .05-level, ** significant at .10-level, * significant at .15-level

In Table 2, specifications (1), (3), and (5) treat *Employ* and *Age* as linear variables, and specifications (2), (4), and (6) treat those variables as natural logs. In general, the natural log specifications fit the data better. In all specifications, the *Age* and the *lnAge* variables are positive and significant, as predicted. Employment, holding constant the age of the hi-tech zone, is greater when there is a university science park in the zone, although the estimated coefficient on *UnivPark* is positive and significant at only the 0.15-level in the specification in column (1), and positive and not significant in the natural log specification in column (2).

The results in columns (3) and (4) support our argument that the positive impact of a university science park on employment is greater during the pre-ICT period. In column (3), the estimated coefficient on *UnivPark*ICT* is negative and significant at the 0.15-level thus mitigating the impact of *UnivPark* as evidenced by the estimated coefficient on *UnivPark* being positive and greater than the negative estimated coefficient on *UnivPark*ICT*.

In the specifications in columns (1)–(4), the estimate coefficient on *IT* is positive and significant. The estimate coefficient on *Energy* is positive and significant in only the natural log specifications. The variable (discussed above) *Manuf*, was included in these four models, and its estimated coefficient was positive but never significant at a conventional level; it was thus deleted from the specifications reported in Table 2.[7]

The specifications in columns (5) and (6) use information on those hi-tech zones where IT is a dominant industry (i.e., *IT* = 1). Sample size is thus reduced from 145 to 69. Both the linear and natural log specifications are stronger in terms of the significance of the independent variables. The estimated coefficients on *UnivPark*ICT* is approximately equal to the estimated coefficients on *UnivPark*; thus, zones established after 2000 appear to receive no employment benefit from including a university science park.

Conclusions

Our analysis of employment differences across China's hi-tech zones is based on limited available information about the growth characteristics of these zones and on the nature of the university science parks within selected zones. Thus, any generalizations from our findings should be made with that caveat in mind. However, our findings are robust about the statistical and economic importance of there being a university science park within a hi-tech zone. Prior to the ICT revolution in 2000, our findings are clear that those zones with a park had greater levels of employment after controlling for the age of the zone. However, after 2000, the impact of a university science park on employment is diminished.

As technology zones, technology clusters, and even science and technology parks continue to be established in both developed countries and developing countries, our findings suggest that leveraging the employment growth of those infrastructures through their proximity to university resources may have limitations. In an era of rapid information communication, the tacit knowledge that resides in universities has become more easily accessible from a distance, and thus proximity to university resources is no longer requisite for employment growth, or possibly

[7] These results are available from the authors on request.

even for other aspects of economic growth. What is requisite for such growth remains an area of research that needs to be explored (Link and Link 2003; Link and Scott 2003, 2007, 2015).

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