



Are new technology-based firms located on science parks really more innovative? Evidence from Taiwan

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ABSTRACT

The establishment of science parks is employed as a vital strategy for developing high-tech industries in many countries. Whether new technology-based firms (NTBFs) located within science parks are, in comparison to their counterparts located outside of science parks, more efficient in terms of R&D investment remains less explored. The purpose of this paper is to compare the R&D productivity of NTBFs located within and outside of science parks by measuring the elasticity of R&D with respect to output. Using panel data for NTBFs located within and outside the Hsinchu Science Industrial Park (HSIP) in Taiwan, our empirical findings show that the elasticity of R&D with respect to outputs of NTBFs located within HSIP is significantly higher than that of other firms. These findings further reveal that NTBFs located in the science park invest more efficiently. Our results also indicate a slight advantage in R&D for firms in the science park, arising from the fact that the science park offers a clustering effect and establishes links among firms and research institutions.

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1. Introduction

New technology-based firms (NTBFs) purportedly play a predominant role in enhancing entrepreneurship and economic growth. Inspired by the successful development of NTBFs located in the vicinity of Stanford and MIT in the U.S., the establishment of science parks near universities and research institutions is employed as a vital strategy for developing high-tech industries in many countries, such as those in Western Europe and developing nations in Asia.

Whether the park policy is successful can be judged by the number of jobs created and innovation performance, among a number of other factors. From the standpoint of R&D policy, whether NTBFs located on parks show better performance in terms of innovation is a question of governmental concern. To assess whether on-park firms are more innovative, it is more appropriate to make a comparison based on R&D efficiency rather than on R&D output (Siegel et al., 2003). Although on-park innovation is usually stimulated by government incentives, the surrounding intellectually produc-

tive environments, and despite the pre-selection of firms based on aggressive technological abilities, it cannot be assumed that high R&D productivity is inevitable among on-park firms. Do they really perform better than off-park firms in terms of R&D productivity? Why or why not? If the park policy is successful, can the government transplant this success to other regions? Can other developing countries adopt this mode to develop high-tech industries?

Despite the growing interest in the science-park phenomenon, empirical attempts to identify whether NTBFs located within science parks are more innovative are limited and the results remain ambiguous. Felsenstein (1994) examined the role of science parks as “seedbeds” of innovation. By examining the interactive effects for on-park and off-park firms, Felsenstein suggested that science parks may be functioning as “enclaves” of innovation rather than “seedbeds”, because the seedbed hypothesis is supported only under certain conditions. Westhead (1997) compared differences of R&D “inputs” and “outputs” of NTBFs located within and outside of science parks in the U.K. By adopting several measures to create proxy for R&D inputs and outputs, Westhead (1997) found that on-park firms tend to be more R&D intensive than off-park firms, even though the difference is not statistically significant. He also found that science-park firms did not demonstrate a statistically significant difference from off-park firms for all dimensions of R&D output. Lindelöf and Löfsten (2003) assessed the performance of

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NTBFs located on and off of science parks in Sweden and found significant differences in the strategies between on-park and off-park firms. The authors argued that NTBFs located on science parks place significantly greater emphasis on innovative activities.

The limited studies show mixed results, suggesting that this controversy unambiguously requires more empirical studies, in order to clarify the effectiveness of science parks. More importantly, the potential importance of the science park as a mechanism for generating technological spillover is well recognized, but do firms located on a science park really enjoy higher R&D productivity than observationally equivalent off-park firms? That is, are science parks indeed effectively targeting failures in the innovation market and promoting the development of high-tech industries? Previous studies comparing innovation activities focused solely on a comparison of inputs and outputs. In fact, the advantages drawn from regional factors to firms are not only attributable to the hypothetical linear process from scientific research to outputs, but also to the clustering effect among firms that exhibit a positive network externality. This network externality effect emerges from the exchange of technological knowledge and technological spillover in the science parks, from the advanced knowledge of technological scholars and professionals, and from the exchange of information and knowledge among researchers. Not only does this network externality help the level of innovation achieved, but it also increases the efficiency of the inputs that drive the firms' R&D activities. As a result, it seems worthwhile to explore the significance of the efficiency of R&D activities. The essential goal of this research is therefore to determine how to measure the efficiency of R&D investment in order to compare the difference between on-park and off-park firms.

This paper aims to explore the relationship between innovative environments and innovative productivity. We attempt to investigate whether on-park firms exhibit better performance in terms of R&D productivity than other firms. Employing the elasticity of R&D with respect to output as a measure of R&D productivity and using panel data for NTBFs located on and off the Hsinchu Science Industrial Park (HSIP) in Taiwan, our empirical findings show that the elasticity of R&D with respect to outputs for NTBFs located in the science park is significantly higher than that of other firms. Our findings further reveal that NTBFs located in the science park invest more efficiently in innovation. These results also point to a slight advantage in R&D for on-park firms, arising from the clustering effect offered by science parks and the establishment of links among firms and research institutions.

The remainder of this paper is organized as follows: Section 2 briefly presents the history of science parks in Taiwan. Section 3 discusses the theoretical and conceptual foundation underlying the question of why on-park firms might display higher R&D productivity. In Section 4 we describe our data sources and present simple statistical tests of innovative activities for both on-park and off-park firms. The empirical analyses comparing R&D productivity are presented in Section 5. Concluding remarks and policy implications are offered in the final section.

2. A brief history of science parks in Taiwan

The post-war economic miracle of Taiwan is always an attractive research topic due to the country's tremendous and consistent high growth rate of real per capita GDP, over 8% on average during the 1950–2000 period. In the 1950s, agriculture predominated in Taiwan's economy, but by adopting an import substitution policy followed by an export promotion strategy, the Taiwanese economy began to take off in the late 1960s. Before the 1980s, Taiwan's successful export-oriented economic policy relied heavily on labor-intensive manufacturing exports. Benefiting from the

rapid economic growth in the 1960s and 1970s, national income and savings grew and the situation surrounding shortages of both capital and foreign exchange improved. The development strategy then evolved to emphasize the promotion of technology-intensive as well as capital-intensive industries.

Enormous changes in Taiwan's industrial environment occurred from the 1980s onward. Not long after, environmental protection, increasing land and labor costs, and violent fluctuation in Taiwan's local currency emerged as major issues. In order to upgrade its economy toward technology-intensive and capital-intensive industries, inspired by the success of California's Silicon Valley, the Statute for the Establishment and Administration of a Science-Based Industrial Park of Taiwan was enacted in July of 1979. The park was established in December of 1980 in Hsinchu City – and also came to be known as the Hsinchu Science-Based Industrial Park (HSIP) – in order to attract high-technology companies focusing both on research and manufacturing.

The essentials of the HSIP strategy are to create a favorable environment and a suitable location with appropriate incentives, and to systematically attract advanced foreign technologies and human resources. The resultant development of NTBFs was anticipated to integrate and strengthen the industrial structure of the economy.

2.1. Residential qualification

The Statute indicated that the HSIP was to review carefully the industries to be accepted in the science park. Specifically, at least one of the following criteria must be met:

- (1) The industry possesses various design capabilities in product development and manufacturing, and has a comprehensive plan for product development.
- (2) The industry produces products with potential for development and innovation.
- (3) The industry is R&D-intensive, or helps introduce and/or cultivate advanced scientists and technicians during the manufacturing process.
- (4) The industry should be represented by an established research institute focusing on advanced innovative research and development.

Given the criteria above, the HSIP mainly accommodates six industrial sectors: Biotechnology, Computers and Peripherals, Optoelectronics, Precision Machinery, Semiconductors, and Telecommunications. Qualified firms can submit an application form to the HSIP Administration; the application for admission is then forwarded for approval to the supervising committee of an administration body established under the National Science Council (NSC) of the Executive Yuan.

2.2. Location

Location choice and community design are particularly applicable to the environment of Silicon Valley, which boasts a cultural, educational, and research-oriented labor force as well as access to a sound industrial base.

HSIP, located in Hsinchu City, is approximately 80 km from two of Taiwan's industrial centers: Taipei in the north, and central Taichung. The geographic location would appear perfect, due to several advantages: first, at 40 min from Taiwan's international airport, the park is easily accessible. Second, the park is very close to three highly reputable national universities: National Tsing-Hua University, National Chiao-Tung University, and National Central University, each of which has strong curricula in the fields of science and engineering. Third, the park is also near the largest

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