TO ADMIT OR NOT TO ADMIT: THE QUESTION OF RESEARCH PARK SIZE

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"To Admit or Not to Admit: The Question of Research Park Size." *Economics of Innovation and New Technology*, 2008, 17(7/8): 691-699. Co-authored with Steven K. Layson and John Neufeld.

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Abstract:
A theoretical model is used to explore the determinants of the optimum size of a private research park and the effect of university affiliation on that optimum size. Parks are assumed to operate as cooperatives where costs are equally shared among the member firms, and optimality occurs when the firms' average net benefits are maximized. To achieve this, existing members of a park will limit the park's size, denying entry to firms who wish to join and are willing to share the costs. University affiliation may either increase or decrease the optimum size of a park.
Keywords: Research park; Research park size; University affiliation
JEL Classification: D29 – Production and organization, Other; L38 – Non profit organizations and public enterprise, Public policy; O32 – Technological change –- Research and development, Management of technological innovation and R&D

Article:
1 INTRODUCTION
Research parks can have a significant impact on commercial research and development activities and are an important component of a nation's innovation system.[1] By providing a venue for research firms and organizations to operate in close proximity, they enable easier communication among professionals in different organizations, enhancing the research productivity of all of them. They enable communities to leverage technology-based growth into economic development, and they facilitate advancement through the stages of technology-based economic activity by reducing relevant market transactions especially with respect to technical labor.[2] These benefits have made the development of research parks a goal of public policy in the United States and in other countries. On July 22, 2004, Senator Bingaman introduced a Bill, S. 2737, 'The Science Park Administration Act of 2004,' to facilitate the development of science parks. The premise on which the Bill was based is: 'It is in the best interests of the Nation to encourage the formation of science parks to promote the clustering of innovation through high technology activities.' Building on the premise of S. 2737, Senator Pryor introduced on May 11, 2007 a Bill, S. 1373, the 'Building a Stronger America Act.' S. 1373 provides grants and loan guarantees for the development and construction of science parks to promote the clustering of innovation through high technology activities. As of 2002, the United States had 81 parks operating with approximately 30 additional planned. University involvement in creating and managing research parks is widespread but not universal.[3]

Their importance highlights the needs for more knowledge about how science parks 'work,' who locates within a park and why, and the scope of leverage that parks provide tenants and the region where they are located. In the United States, at least, park formation is growing and gaining increased public policy attention. Leyden, Link and Siegel (2008) have provided an initial theoretical examination of why a firm locates in a university research park. This paper examines the issue of what determines the size of a research park and how that size is effected by the presence (or absence) of university involvement. Given the importance of research parks, the issue of their size and of the impact of university involvement on that size is relevant to issues of efficient allocation of economic resources.

2 THE MODEL

The model of the research park developed in this paper is based on the economic theory of clubs. See Sandler and Tschirhart (1980) for a survey of this literature. For members of a private research park, the value of belonging to the park is the opportunity it affords to engage in synergistic R&D activities that can increase the members' profits. There are also, of course, costs of establishing and operating a research park. We assume these costs are shared equally among the members. The objective of a private research park, we assume, is to maximize the average net benefit of the park members. Average net benefit (ANB) is defined to be total R&D benefits to members of the park divided by the number of member firms (AB) minus the average (per firm) cost of establishing and operating the research park (AC). Both the average benefit from joining the park and the average cost of running the park will depend on the number of firms who join the park, N.

For the range of park members around the optimal level, diminishing marginal returns would ensure that the average benefits curve from R&D is declining. Initially, the marginal benefit exceeds the average benefit, causing average benefit to increase with increasing park membership. Each new member's contribution to marginal benefit is lower than that of the previous member, and marginal benefit eventually falls below average benefit, causing the average benefit of adding new members to fall (Figs. 1 and 2). Average benefit may eventually become asymptotic to some value (possibly zero), but this will occur after average benefit is maximized. Average benefit from R&D collaboration is thus assumed to be a strictly quasiconcave function of N. AB reaches a peak value at $N = \hat{N}$ and then steadily diminishes thereafter:

$$\mathrm{AB}'(N) > 0 \quad \text{for } N < \hat{N} \tag{1}$$

$$\mathrm{AB}'(N) < 0 \quad \text{for } N > \hat{N} \tag{2}$$

The total costs of the research park are composed of a fixed component F, consisting of installation and maintenance of basic infrastructure, administrative overhead, etc., and a variable component VC consisting of the costs of park physical maintenance and joint park activities. Let the total variable cost for a park of a given land size be:

$$\mathrm{VC} = c_1 N + c_2 N^2 \; (c_1, c_2 > 0) \tag{3}$$

The average cost function for the park (Fig. 3) is:

$$\mathrm{AC}(N) = \frac{F}{N} + \frac{\mathrm{VC}}{N} = \frac{F}{N} + c_1 + c_2 N \tag{4}$$

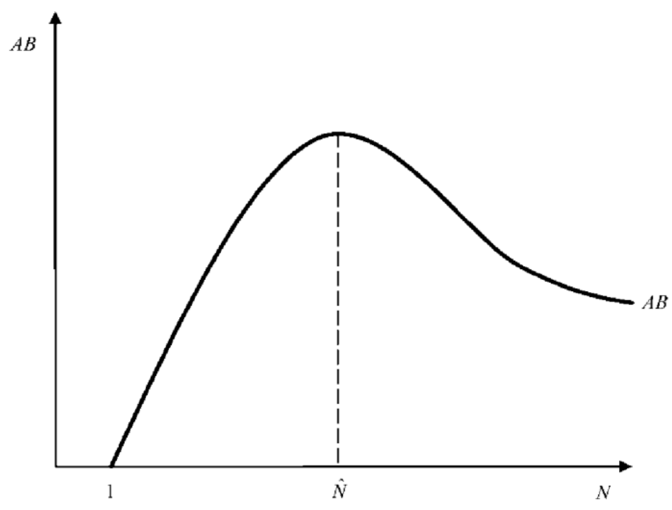

FIGURE 1 Average benefits from R&D collaboration and the number of park members.

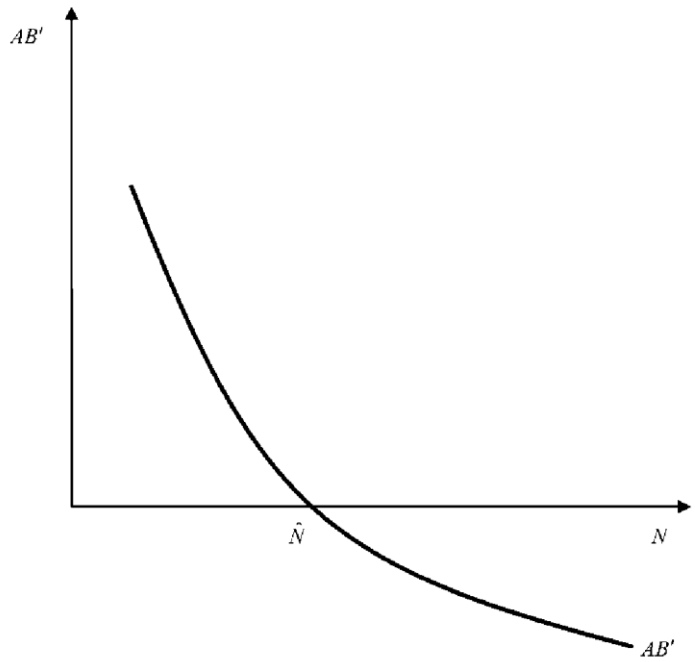

FIGURE 2 Marginal effect on average benefit of admitting a new firm to the park.

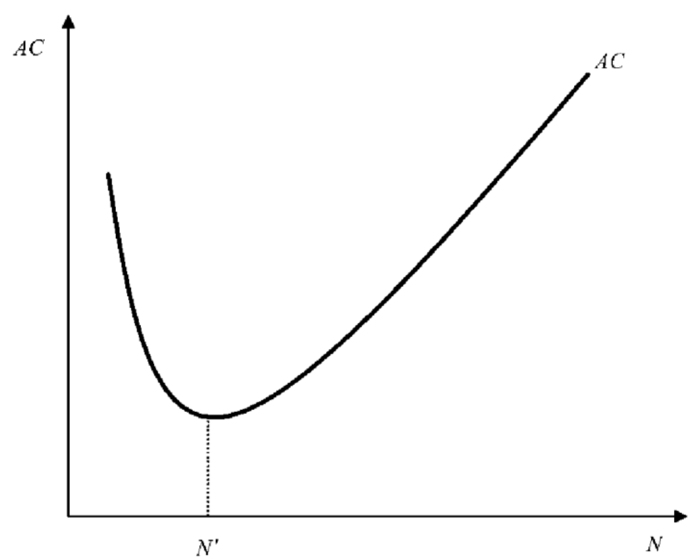

FIGURE 3 Average park costs and the number of park members.

The marginal effect on average cost of admitting a new firm (Fig. 4) into the park is:

$$\mathrm{AC}'(N) = -\frac{F}{N^2} + c_2 \tag{5}$$

For small values of N the marginal effect on average cost of admitting a new firm to the park is negative, but for large values of N it will be positive. Decreases in fixed cost cause the AC curve to shift downward, but from Eq. (5) it is clear that decreases in fixed cost cause the AC′ curve to shift upwards for all values of N. Also note that the AC′ curve is always rising with N:

$$\mathrm{AC}''(N) = 2\frac{F}{N^3} > 0 \tag{6}$$

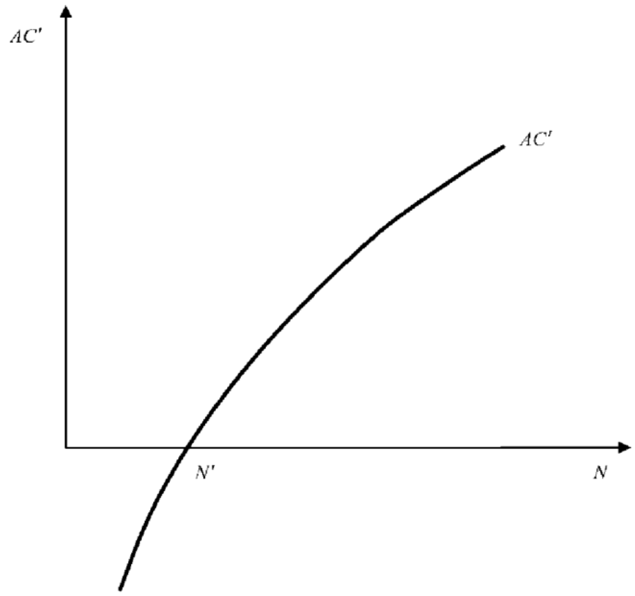

FIGURE 4 The effect of firm entry on AC′.

For a feasible private research park that has the potential to generate positive average net benefits for the firms, we assume the park's objective function is

$$\mathbf{Max\,ANB}(N) = \mathbf{AB}(N) - \mathbf{AC}(N) \qquad (7)$$

The first-order condition for this optimization problem is:

$$\mathbf{AB}'(N^*) - \mathbf{AC}'(N^*) = 0 \qquad (8)$$

As long as the AC′ curve intersects the AB′ curve from below, as in Figure 5, the value of N that satisfies the first-order condition will maximize the value of average net benefit. If firms were homogeneous in their ability to benefit from R&D collaboration each firm's benefit from joining the park would be the average benefit. With free entry into the park, firms would continue to enter until park members' average net benefit was driven down to zero. Figure 6 illustrates the free entry solution where the average cost curve intersects the average benefit curve from below. The equilibrium number of firms under free entry is denoted by N_e. Because the optimal number of firms (N^*) by assumption generates a positive ANB, $N_e > N^*$. A private research park will always seek to restrict the number of firms in the park below the free entry level.

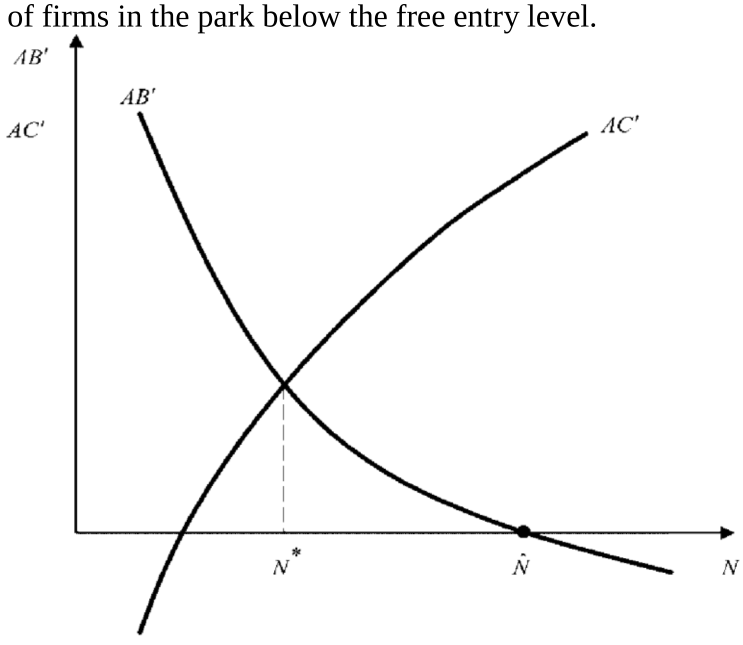

FIGURE 5 The marginal curves and the optimal number of park members.

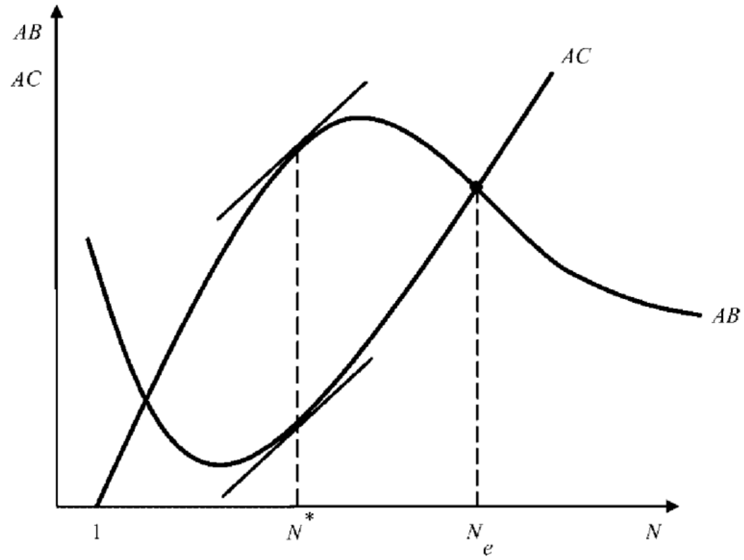

FIGURE 6 Free entry equilibrium versus the optimal number of park members.

3 THE EFFECT OF UNIVERSITY AFFILIATION

Universities provide a wealth of R&D infrastructure, knowledge, ability to synergize, etc. Within the context of the model above, the presence of a university increases the average benefits of R&D collaboration (AB) for any value of *N*, as shown in Figure 7. We assume it also increases the marginal effect AB′ for every value of *N* (Fig. 8).

University affiliation is assumed to reduce the fixed costs (*F*), borne by the research park members by making its infrastructure available to park members. University affiliation may also increase variable costs of park operations through agreements it makes with park firms, such as hiring a certain number of University students or graduates per year, etc.

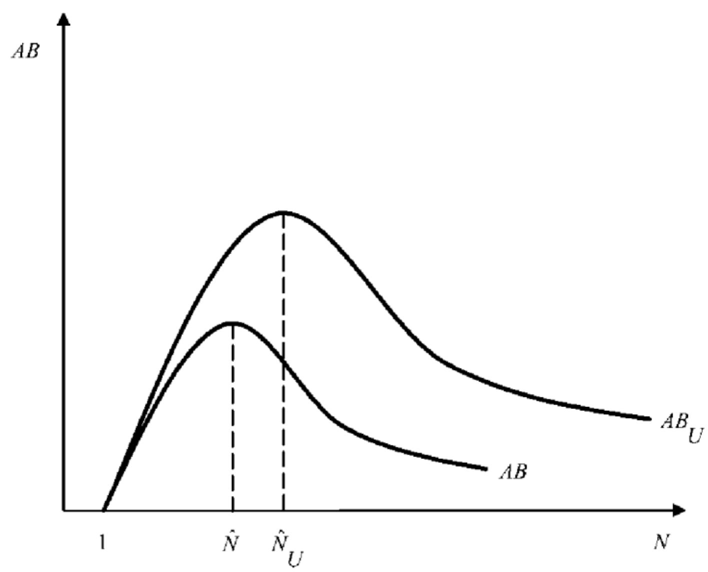

FIGURE 7 Effect of university affiliation on the average R&D benefit.

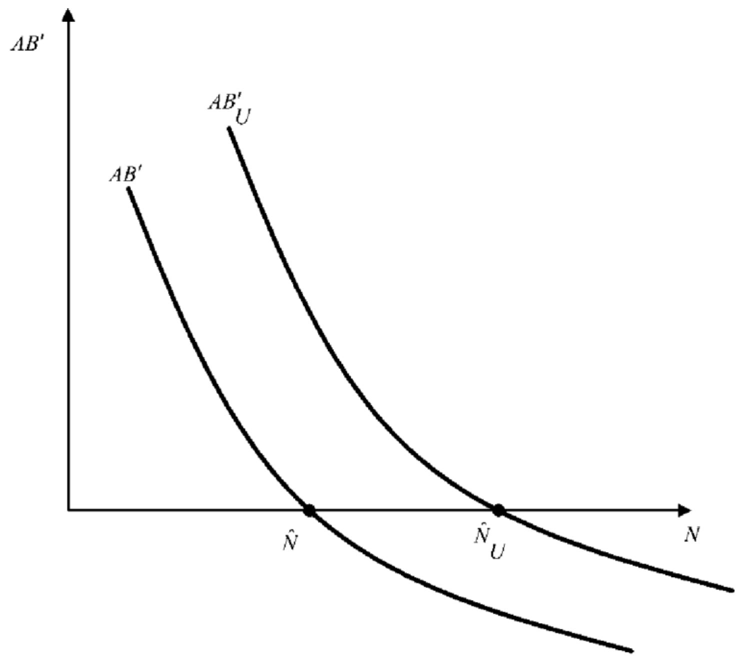

FIGURE 8 Effect of university affiliation on AB′.

For simplicity, we assume that University affiliation may increase the parameter $c1$ in the variable cost function, VC = $c_1N + c_2N^2$, but has no effect on the parameter c_2. With these assumptions, university affiliation reduces members' average costs for small values of N (less than N), but increases it for larger values, as shown in Figure 9. University affiliation, however, unambiguously shifts the AC′ function given by Eq. (5) upward for all values of N, as shown in Figure 10.

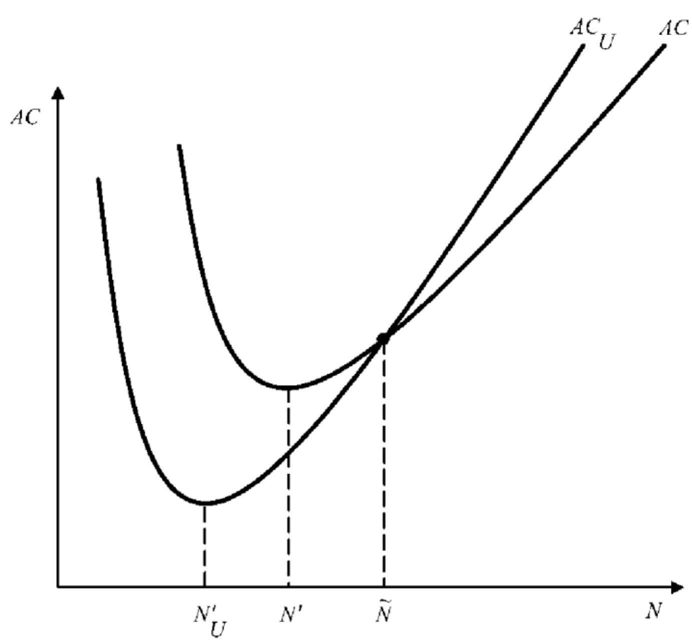

FIGURE 9 Effect of university affiliation on average member cost.

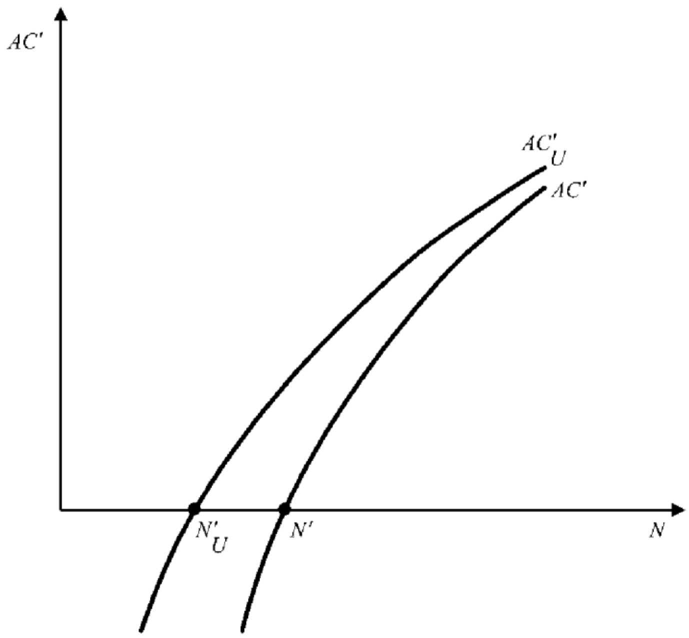

FIGURE 10 Effect of university affiliation on AC′.

Because university affiliation causes both the AB′ curve and the AC′ curve to shift upward, university affiliation has an ambiguous effect on the optimal number of park firms. Figure 11 illustrates the special case where the optimal number of firms remains unchanged by university affiliation. However, if the AB curve (AC curve) were to shift up by more than what is indicated in Figure 11, the optimal number of firms would rise (fall).

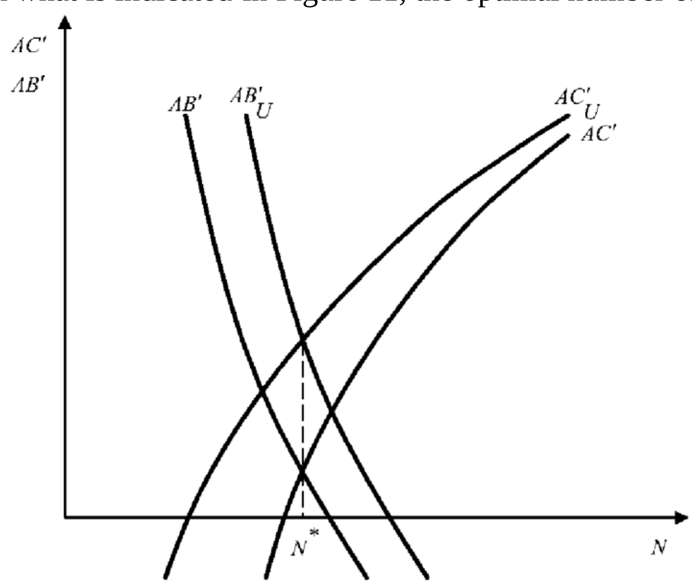

FIGURE 11 Effect of university affiliation on the optimal number of member firms.

Up until now we have assumed that the research park is economically feasible without university affiliation. Without university affiliation it is possible that the park's average cost curve lies everywhere above the average benefit curve. Because university affiliation raises the average benefit and lowers the average cost, university affiliation may be necessary for the existence of a research park. Obviously, in this important special case university affiliation increases the optimal park size.

4 CONCLUSION

In a model where the objective of a research park is to maximize the net average benefits of each member firm, the optimum number of firms is determined by the marginal effect that firm entry has on average member benefits and costs. We find that a private research park will always seek to limit the number of firms in the park to a smaller number than would occur if there were free entry into the park. We also find that university affiliation has an ambiguous effect on the optimal number of firms in the park.

Notes:

1 According to Link and Scott (2006), the term science park is more common in Europe and Asia and the term research park is more common in the United States. See Link and Scott (2003, 2006) for alternative definitions of a university research park.

2 For support of these assertions about the economic role of a research park, see Link and Scott (2007).

3 Link and Scott (2006), 44–45.

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