Research Risk and Public Policy: The Relative Research Efficiency of Government versus University Labs

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Dennis Leyden

University of North Carolina at Greensboro

Albert Link

University of North Carolina at Greensboro

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Research Risk and Public Policy

The Relative Research Efficiency of Government versus University Labs

Dennis P. Leyden* and Albert N. Link
Department of Economics
The University of North Carolina at Greensboro
Greensboro, NC USA

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* Corresponding author, dpleyden@uncg.edu

Abstract

Motivated by the question of which institutions within our, or any nation's, national innovation system will leverage economic growth in the greatest amount for a given investment in innovation, we compare and contrast the behavior of two types of research institutions: government research laboratories (hereafter, labs) and university research labs. Because of a unique blend of institutional structures and rewards, we argue that universities are in a better position than government labs to provide the research necessary to stimulate economic growth. We then test and validate our model empirically using a unique database on the research output from university and government information retrieval (IR) labs.

Keywords: R&D, university labs, government labs, information retrieval

JEL Codes: O31, H4

Research Risk and Public Policy

THE RELATIVE RESEARCH EFFICIENCY OF GOVERNMENT VERSUS UNIVERSITY LABS

I. INTRODUCTION

The public reaction to the 2008-2009 economic slowdown in the United States signaled a renewed era of both public accountability for government policies and demands for innovative means to stimulate economic growth and development. A primary US policy response with regard to growth and development has been to focus on job creation and investments in innovation.

The American Recovery and Reinvestment Act (ARRA) of 2009 (Public Law 111-5), also known as The Recovery Act, was signed by newly-inaugurated President Barack Obama in February 2009. The premise of this fiscal stimulus was that government spending would quickly lead to business investments and subsequent consumer spending, thus mitigating the current recession. One of the stated purposes of ARRA is to "preserve and create jobs and promote economic recovery." Another stated purpose of the Act is to "provide investments needed to increase economic efficiency by spurring technological advances…"[1]

In September 2009, the National Economic Council (2009) released *A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs*. This Executive Office of the President report lays "the foundation for the innovation economy of the future." The initiative "seeks to harness the inherent ingenuity of the American people and a dynamic private sector to ensure that the next [economic] expansion is more solid, broad-based, and

[1] The policy emphasis in ARRA on jobs, especially innovation-based jobs, traces at least to the National Academy of Sciences (2007) report, *Rising Above the Gathering Storm: Energizing and Employing America for a Better Economic Future*. This was a foundation report for the America COMPETE Act of 2007 (P.L. 110-69), which was reauthorized as the America COMPETES Reauthorization Act of 2010 in January 2011.

beneficial than previous ones" (p. i). Under the heading "A Vision for Innovation, Growth, and Jobs," the report states (p. 4):

> Innovation is essential for creating new jobs in both high-tech and traditional sectors. … A more innovative economy is a more productive and faster growing economy, with higher returns to workers and increases in living standards. … Innovation is the key to global competitiveness, new and better jobs, a resilient economy, and the attainment of essential national goals.

To accomplish this, *A Strategy for American Innovation* emphasizes that the economy must invest in the building blocks of American innovation by, among other things, restoring American leadership in fundamental research. Such building blocks will promote competitive markets that spur productive entrepreneurship, and that in turn will catalyze breakthroughs for national priorities.

While a near-term focus on job creation is understandable, the Administration's emphasis on innovation is important to sustain longer-term growth. This raises the obvious question about which institutions within our, or any nation's, national innovation system will leverage economic growth in the greatest amount for a given investment in innovation (e.g., in R&D).

As a first step toward addressing that issue, we compare and contrast in this paper the behavior of two types of research institutions: government research laboratories (hereafter, labs) and university research labs. Because of a unique blend of institutional structures and rewards, we argue that universities are in a better position than government labs to provide the research necessary to stimulate economic growth.

The essential reason for this argument is that the institutional structures of government labs and university labs differ. For government labs, this structure results in risk-averse behavior that increases the cost of conducting research and slows the research process down. By contrast, university research takes place in a highly competitive environment that results in risk neutral (or even risk taking) behavior that therefore avoids the inefficiencies associated with government labs and results in more efficient research that is more responsive to broad national, as well as more targeted (e.g., regional), needs.

We address this issue in the following three sections. In Section II, we set forth a model of research activity in which the risk of engaging in research, and the associated reward structure for engaging in such research, is the essential element, and we examine the implications of our model for government labs and university labs. In Section III, we examine in a preliminary manner a new and unique database related to the output from government and university information retrieval (IR) labs to evaluate our model. Finally, in Section IV, we summarize our findings and discuss the implications of our paper for future research.

II. A MODEL OF RISKY RESEARCH IN GOVERNMENT VERSUS UNIVERSITY LABS

Consider a research lab that produces some knowledge *K* through a risky production process:

(1) $$K = K(E, \theta)$$

where *E* represents the lab's effort such that:

(2) $$\frac{\partial K}{\partial E} > 0$$

(3) $$\frac{\partial^2 K}{\partial E^2} < 0$$

and θ is an index variable representing the presence of production risk. θ is assumed to be a random draw from a set of possible states-of-nature with a known distribution function, $f(\theta)$, with greater values of θ resulting in higher levels of *K*:

(4) $$\frac{\partial K}{\partial \theta} > 0.$$

Assume for expositional convenience that the expected value of K is associated with $\theta = 0$:

(5) $$\int_{-\infty}^{\infty} K(E,\theta) f(\theta)\, d\theta = K(E, 0)$$

so that negative values of θ are associated with levels of K that are less than its expected value and positive values of θ are associated with levels of K that are greater than expected. Finally, assume that the total cost C of producing K is a strictly convex, positive function of the lab's effort E:

(6) $$C = C(E) \quad \ni \quad \frac{dC}{dE} > 0 \ \text{ and } \ \frac{d^2C}{dE^2} > 0.$$

The value that the lab places on K, and hence the amount of effort E that the lab will expend, depends on whether the lab operates within a governmental or a university institutional structure.

II.A. Government Labs

Many studies, in keeping with popular belief, assume that government enterprises are more risk averse than their private-sector counterparts (Mueller 1989). However, a review of the literature over the past several decades reveals that little work, theoretical or empirical, has focused directly on this issue. The extant literature is dominated by empirical analyses that suggest that government enterprises may be risk averse because people who are more risk averse reveal a preference for employment in the public sector (Bellante and Link 1981, Blank 1985, Katz and Ziderman 1986, MacCrimmon and Wehrung 1986, Wilson 1989). However, and the literature has ignored this point, it is not clear to what extent having risk-averse employees makes an enterprise act in a more risk-averse manner. Moreover, studies have found that the desire for greater job security is only a minor factor in the decision where to work (Baldwin 1987) and that, when other factors are controlled for, there is no observable (in a statistical sense) difference in the risk aversion of government versus private-sector enterprise behavior (Tucker 1988, Bozeman and Kingsley 1998).

We argue here that government institutions, such as government labs, do exhibit greater risk-averse behavior, and that behavior is explained by the presence of reward structures that elected officials impose in their attempts to solve the principal-agent problems between themselves and those government enterprises. [2]

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[2] We are using the phrase elected officials to indicate legislators or individuals in elected executive positions.

To formalize this argument, and following Leyden and Link (1993), assume a government lab is a Niskanen bureaucracy and that it seeks to maximize the budget B that it receives from elected officials.[3] These elected officials cannot directly observe the effort of the lab. As a result, they rely on the observation of actual production K in determining how much support to provide the lab. Thus:

$$(7) \qquad B = B(K).$$

In determining the structure of $B(K)$ the elected officials have in mind a target output K_0. However, they recognize that the production of K is risky, and therefore there may be times when they would like to encourage the lab to make additional effort (particularly when θ is negative). However, because they cannot observe the lab's effort, E, these elected officials also recognizes that there may be times when the lab can reduce its effort (particularly when θ is positive). As a result, they will structure $B(K)$ so as to reward to some degree output above K_0 but to penalize to a greater degree output that falls below K_0. Thus, we model the budget function $B(K)$ as a strictly concave function of K:

$$(8) \qquad \mathrm{B} = \mathrm{B(K)} \quad \ni \quad \frac{\mathrm{dB}}{\mathrm{dK}} > 0 \ \text{ and } \ \frac{\mathrm{d^2B}}{\mathrm{dK^2}} < 0.$$

Finally, to force fiscal discipline on the lab, the elected officials insist that the lab balance its budget.

The lab's problem then is to choose that level of effort, E, that maximizes the expected size of its budget subject to the constraint that the budget balances in expectation:

$$(9) \qquad \max_E \int_{-\infty}^{\omega} B[K(E,\theta)] f(\theta) d\theta \quad \ni \quad \int_{-\infty}^{\omega} B[K(E,\theta)] f(\theta) d\theta = C(E).$$

The solution to this maximization problem is characterized by the first-order condition that marginal benefit (in this case in expectation) be equal to marginal cost:

[3] Niskanen (1971) argues that public enterprises maximize budgets both because of a desire on the part of the manager of the public enterprise for such things as salary, power, and ease of managing the bureau and because it serves the interests of elected government officials who depend on the public enterprise to propose new and expanded programs among which the elected officials can choose to satisfy their constituencies.

(10) $\frac{1+\lambda}{\lambda}\int_{-\infty}^{\infty}\frac{dB}{dK}\frac{\partial K}{\partial E}f(\theta)d\theta = \frac{dC}{dE}$

with $\lambda > 0$ being the Lagrangian multiplier associated with the constraint. Of course, while the budget may balance in expectation, it may not balance after any particular realization of θ. Following Leyden and Link (1993), we assume that there is sufficient slack in the lab's budget to allow for any end of year deficits or surpluses to be resolved.

Given the above circumstances, the decision to engage in risk-averse behavior depends on whether that behavior allows the lab to increase its budget. We define risk-averse behavior to be a costly act that reduces the enterprise's exposure to future uncertainty in order to better achieve its objective.[4] Within the structure of our model, such behavior will allow the government lab to produce the expected quantity:

(11) $K^e = \int_{-\infty}^{\infty} K(E,\theta)f(\theta)d\theta$

with certainty, and thereby increase its expected revenues:

(12) $B(K^e) > B^e$

where:

(13) $B(K^e) = B\left[\int_{-\infty}^{\infty} K(E,\theta)f(\theta)d\theta\right]$

(14) $B^e = \int_{-\infty}^{\infty} B[K(E,\theta)]f(\theta)d\theta$

and where the inequality follows from the concavity of the *B(K)* function.

This reduction in risk can be achieved through a variety of methods: insurance (Leyden and Link 1993), privatization of the production process with performance guarantees (Leyden and Link 1993), or increased emphasis on hierarchy, internal control, and formalism (Bozeman and Kingsley 1998). Regardless of the method, the result is a slower production process and greater costs of production. Thus, the cost of production under risk-averse behavior can be modeled as:

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[4] Bozeman and Kingsley (1998, p. 110) define risk as "the exposure to the chance of loss from one's actions or decisions." Within the context of our model, a lab's decision centers on the level of output to produce.

(15) $\ddot{C} = \rho C(E)$

where ρ>1 indicates both the degree of risk averse behavior and the degree to which costs are higher under such behavior.

If for a given level of risk-averse activity, ρ, the increase in the size of the budget is no less than the rise in costs, it will be beneficial to engage in the risk-averse activity. Figure 1 illustrates this situation with a simple example in which the uncertain production process is one in which θ has the distribution function:

(16) $\theta \sim \begin{cases} \theta_{high} > 0 & with\ probability \quad p \\ \theta_{low} < 0 & with\ probability \quad 1-p \end{cases}$

If the lab does not engage in risk-averse activity, this will result in output K_1 with probability p and output K_2 with probability 1 – p, for some level of effort, E_0. Assuming that E_0 is the solution to the lab's problem in the absence of risk-averse behavior, expected output will be:

(17) $\mathrm{K^e = pK_1 + (1\text{-}p)K_2}$.

The expected budget in this case will be B^e:

(18) $B^e = pB[K_1] + (1-p)B[K_2]$,

with the balanced budget constraint being:

(19) $\mathrm{B^e = C(E_0)}$.

Figure 1 also illustrates what happens if it benefits the lab to engage in risk-averse activity. Assume that the lab engages in ρ_0 level of risk-averse activity and that as a result it can produce the expected output K^e with certainty. Because the budget function *bb* is a concave function of output, the budget associated with this certain output will be $B(K^e)$, and this budget is greater than the expected budget B^e associated with producing K with risk. Because $B(K^e)$ exceeds the cost, $\rho C(E_0)$, of engaging in risk averse research production it pays to act in a risk-averse manner. And in this particular case, because the budget rises by more than the cost associated with the risk-averse behavior, there will be an expected surplus. Because the balanced budget requirement requires that this surplus be eliminated, the lab will find it in its interest to increase its effort which in turn will increase output and hence increase the lab's budget even more.

Finally, before turning to the case of university labs, it is important to make note of the dynamic process that often occurs in the funding of government labs from one year to the next. While this process depends on the budgetary processes used by elected officials, and while these processes can change as a result of shifts in political attitudes toward spending, it is common for officials, either explicitly or implicitly, to use an incremental budgetary process. Thus, the budget function offered each year depends on the actual budget from the previous year. If these officials view budgetary surpluses as evidence of less need for future funds and view budgetary deficits as evidence of inefficient production that should not be rewarded, then the lab has a strong incentive to come in at budget and to try to maintain as close to a steady budget from year to year. Particularly for labs that anticipate greater than expected output, there is an incentive to slow down the research process or attempt to spread that process out over more than one year to maintain a steady budget.

II.B. University Labs

While university labs must also balance their budgets and also seek to maximize the size of their budgets, they are not subject to the same political influences that give rise to the concave budget function that government labs see. The reasons for this are several. First, not all universities are publicly owned entities. Second, regardless of whether they are public or not, the social role that universities are expected to play leads to them being insulated to a greater or lesser extent from the political pressures that government labs are subject to. Third, a relatively large part of university research funding comes from sources outside the annual public-sector budgetary process.

Add to that the fact that university research is highly competitive both within the individual institution and between institutions, the fact that the benefits of university research include the ability to attract higher-quality students (particular graduate students) and faculty, and the fact that greater research results in generally higher prestige for the institution, and it is clear that the benefit function for the university of research lab activity will be at least linear if not convex with respect to research output.[5]

To formalize these observations and explore their implications, we can (as with the government lab) model the university lab as a Niskanen bureaucracy that seeks to maximize its budget B subject to a budget constraint. In the case of the university, the budget may come from a variety of sources: public sector allocations to be sure, but also private grants, tuition, and income from other enterprises whose success is directly or indirectly affected by the activities of the university lab. Thus, the budget will be a function of the level of output K of the lab and, following on the observations above, we can model this as a linear function:

$$(20) \qquad \mathrm{B} = \mathrm{B}(\mathrm{K}) \quad \ni \quad \frac{\mathrm{dB}}{\mathrm{dK}} > 0 \quad \text{and} \quad \frac{\mathrm{d^2B}}{\mathrm{dK^2}} = 0,$$

and thus, the lab's problem, like that of the government lab, is to choose that level of effort E that maximizes the expected size of its budget subject to the constraint that the budget balances in expectation:

$$(21) \qquad \max_E \int_{-\infty}^{\omega} B[K(E,\theta)]f(\theta)d\theta \quad \ni \quad \int_{-\infty}^{\omega} B[K(E,\theta)]f(\theta)d\theta = C(E).$$

The solution to this problem is characterized by the first-order condition that expected marginal benefit be equal to marginal cost:

$$(22) \qquad \frac{1+\lambda}{\lambda}\int_{-\infty}^{\infty}\frac{\mathrm{dB}}{\mathrm{dK}}\frac{\partial \mathrm{K}}{\partial \mathrm{E}}\mathrm{f}(\theta)\mathrm{d}\theta = \frac{\mathrm{dC}}{\mathrm{dE}}.$$

Finally, as with the government lab, while the budget may balance in expectation, it may not balance after any particular realization of θ. We assume that there is sufficient slack

[5] Indirect evidence that supports the idea that university research can attract better students and enhance university reputations can be found in O'Brien et al. (2010) that found that greater faculty research, in this case in business schools, was associated with higher salaries for their graduates. While the article argues that this is the result of differences in the quality of instruction, there may be a sample selection bias as well. To the extent there is a sample selection bias, it lends support for the idea that research attracts better students. And in either case, the higher salaries suggest that the general reputation of the university is higher as well.

within the lab's budget to allow for any problem with year-end deficits or surpluses to be resolved.

Given these circumstances, it turns out that there is no incentive to engage in any level ρ of risk-averse behavior because such activity necessarily results in higher costs (recall that ρ>1):

(23) $\rho C(E) > C(E)$

but, such activity does not result in a greater budget due to the linear budget function:

(24) $B(K^e) = B^e$

where:

(25) $B(K^e) = B\left[\int_{-\infty}^{\infty} K(E,\theta) f(\theta) d\theta\right]$

(26) $B^e = \int_{-\infty}^{\infty} B[K(E,\theta)] f(\theta) d\theta$

Figure 2 illustrates this situation with the simple example of the θ distribution function:

(27) $\theta \sim \begin{cases} \theta_{high} > 0 & with\ probability \quad p \\ \theta_{low} < 0 & with\ probability \quad 1-p \end{cases}$

If the lab does not engage in risk-averse activity, it will produce output K_1 with probability p and output K_2 with probability 1 – p, given some level of effort E_0 which we assume is the solution to the lab's problem in the absence of risk-averse behavior. Expected output will hence be:

(28) $K^e = pK_1 + (1-p)K_2,$

and the expected budget B^e (read off of the budget curve *bb*) will be:

(29) $B^e = pB[K_1] + (1-p)B[K_2],$

with the balanced budget constraint being:

(30) $B^e = C(E_0)$

As can be seen because of the linear budget curve *bb*, the expected budget with risky production B^e is no different than the budget with certain production of the level of expected output $B(K^e)$. Given that observation and given the fact that risk-averse activity is costly, any decision to engage in risk-averse activity will result in an expected deficit, and therefore the university lab is always better off choosing to engage in research without such activity. Moreover, because much of the funding for university research is the result of a competitive, entrepreneurial process in which funding is project specific, there is no advantage to engaging in the inter-temporal risk-averse activity observed with government labs. Thus, university labs are more efficient than government labs both because they avoid incurring expenses associated with risk-averse activity (which are socially undesirable even if of benefit to the government lab) and because they avoid the slowdowns and pacing that government labs find of benefit to assure a steady stream of funding.

III. EMPIRICAL EVIDENCE

Our model suggests that university labs are more efficient in research than government labs. We offer preliminary empirical evidence to support that conclusion using a new and previously unexamined database on the output from university and government information retrieval (IR) labs.[6]

IR is the science and practice of matching information seekers with information being sought. For example, web engines utilize IR techniques to retrieve and provide relevant information to users. IR techniques have been used to improve the process of finding information not only on the web, but also within a single computer (e.g., desktop search) or set of computers (e.g., an enterprise search), as well as within very large databases, such as libraries (e.g., a database search) (Rowe et al. 2010). Research on IR, in both university and government labs, is focused on improving the effectiveness and efficiency of retrieval techniques and evaluating competing retrieval mechanisms.

[6] These data were collected by the U.S. National Institute of Standards and Technology (NIST) and graciously provided to us for this project.

The National Institute of Standards and Technology (NIST) database contains IR laboratory output information, which can be segmented by institutional affiliation (e.g., government versus university) and by region.[7] To our knowledge the NIST database is a unique source of information that will facilitate an empirical comparison of research output (defined in terms of a standardized measure of efficiency) between university and government labs. Because our subsequent empirical analysis is based only on IR research efficiency, which is indeed a very small portion of R&D that is conducted within the national innovation system, we view our analysis as providing only preliminary evidence in support of our model.

Research output is defined for the purpose of this paper as the average annual percentage improvement in research productivity of the lab as measured by the average annual improvement in the lab's Mean Average Precision (MAP). MAP scores are calculated as follows. First, for a given data or topic search, the average of all the precision values at each recall point in the first ranked document or site (e.g., hits on the Internet) is calculated. Second, the mean of all the query average precision scores is determined. The resulting MAP value provides a single measure of quality across recall levels.[8]

Our empirical model to test for relative differences between the IR research efficiency of university and government labs is:

$$(31) \quad efficiency = f(lab, \mathbf{region}, resources)$$

where, *efficiency* is measured, as described above, as the average annual increase in the lab's MAP scores over the years that the lab has been involved in IR research (mean number of years is 11.2); *lab* is a qualitative variable equaling 1 if the lab in a university lab and 0 if it is a government lab; **region** is a vector of three qualitative variables identifying geographical location, equaling 1 for each variable if the lab is located, respectively, in the United States (*US*), in *Europe*, or in *Asia*, and equaling 0 if not (the location of labs that take

[7] Although continent information was available for all observations, the lab's country was not. Because of that, it was impossible to look at country specific effects. The one exception was the United States because Canadian lab data were missing sufficient information that they could not be used. Hence, all North American data used were from the United States. Finally, there was insufficient information to separate private universities from public universities.
[8] A detailed description for how MAP scores are calculated can be found in Manning et al. (2008).

values of 0 for all three of these qualitative variables is noted as *Other*); and *resources* is measured as the percent of the lab's total research budget allocated to IR research. Descriptive statistics on these variables are in Table 1.

Table 2 reports the least-squares regression results from equation (31). A variant of the empirical model includes additionally a squared *resources* term. In both cases, the estimated coefficient on *lab* is positive and significant at the 0.05-level or better. Other things held constant, university labs are more efficient in IR research than government labs, as our model predicts. Overall, the empirical model with the squared *resources* term fits the data better (column (2)). For that model, holding constant the type of lab, US labs and European labs are more efficient than Asian labs, and there is not a statistical difference between the estimated coefficients on *US* and *Europe*. Finally, labs with greater relative resources are more efficient, but there are diminishing returns to such resources.[9,10]

IV. SUMMARY AND IMPLICATIONS

From an efficiency perspective, our theoretical and empirical results suggest that shifting the research funding to university labs and away from government labs would result in greater output both statically and over time. Although not formally captured in the theoretical model above, universities, because of their greater entrepreneurial flexibility, are more adept at responding to changes in research needs, of being able to focus on specific needs be they regional or industry specific.[11] Because university research takes place within a broader educational structure (especially graduate education), research in universities not only results in greater knowledge for use in the economy; it also is more likely to increase human capital, both skill and intellectual, as well as increase the rate at

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[9] The variable *resources* has a positive marginal impact on research efficiency up to an IR research percentage value of nearly 40. Only 15 of the 126 labs have a greater IR research percentage.

[10] Conceptually, *efficiency* can take on a lower-bound value of 0% and an upper-bound value>100%. However, as shown in the descriptive statistics in Table 1, none of the 126 observations is censored at 0%. Equation (31) was nevertheless estimated as a Tobit model and, as expected, the pattern of results remained unchanged. These results are available from the authors.

[11] This conclusion does not alter our prior that government, much like the private sector, can act in an entrepreneurial manner. See Link and Link (2009).

which this capital is transferred. And, this increase will further increase the ability of national, regional, and sectoral economies to sustain themselves and grow.

These arguments, of course, are preliminary, and much remains to be understood. Our data are limited in scope and are certainly not the most representative of R&D conducted within universities and government labs. As a result, our empirical results should be interpreted cautiously. More empirical evidence, both quantitative and qualitative, is clearly needed to further test the relative research efficiency of university and government labs, as well as to explore important related questions such as whether public universities differ from private universities, whether there are measurable differences between countries, and of course why any such differences that might be found should exist. Our theoretical model is an attempt to begin to understand why there might be differences in the research efficiency of university labs versus government labs. But more is needed here as well, particular from an inter-temporal perspective, and it is our hope that participation in this workshop will help provide us with a deeper understanding of the various forces at play. Particularly if one wishes to contemplate institutional reforms in order to stimulate more a more efficient research process, such a deeper understanding is needed.

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Table 1
Descriptive Statistics (n=126[a])

Variable	Mean	Std. Dev.	Minimum	Maximum
efficiency	28.645	24.578	0.15	115.0
lab[b]	0.833	0.374	0	1
US	0.349	0.479	0	1
Europe	0.397	0.491	0	1
Asia	0.175	0.381	0	1
Other	0.071	0.259	0	1
resources[b,c]	26.254	25.734	0.05	94

Notes:
[a] The NIST database contains partial information for 264 labs, information on the output efficiency of the labs was available in 169 instances, and information on all of the variables in the empirical model was available for 126 labs.
[b] 83% of the labs in the sample are university labs. By region, 87% are university labs in the United States (n=44) (e.g., the largest university IR lab is at Carnegie Mellon University within the computer science department and one of the largest government labs is part of the National Institutes of Health); 78% are university labs in Europe (n=50); 86% are university labs in Asia (n=22); and 78% are university labs in other countries (n=10).
[c] The NIST database codes the percent of the labs total research budget allocated to IR research as follows: 1=0–0.9%, 2=1–9%, 3=10–19%, 4=20–29%, 5=30–39%, 6=40–49%, 7=50–59%, 8=60–69%, 9=70–79%, 10=80–89%, 11=90–99%, 12=100%. The midpoint of the categorical range was used in the estimation.

Table 2
Least-Squares Regression Results

Variable	**(1)** **Coefficient (Std. Error)**	**(2)** **Coefficient (Std. Error)**
lab	14.996	10.766
	(5.185)***	(4.916)**
US	8.853	12.763
	(7.525)	(7.054)*
Europe	9.993	11.868
	(7.485)	(6.973)*
Asia	−6.991	−1.287
	(8.218)	(7.750)
resources	0.228	0.712
	(0.077)***	(0.131)***
resources^2	--	−0.009
		(0.002)***
Intercept	3.803	1.287
	(7.977)	(7.440)
R^2	0.199	0.313
F-level	5.91***	8.97***

Notes:
*** 0.01-level or better, ** 0.05-level, *0.10-level of significance

Figure 1
The Advantage of Risk-Averse Behavior for a Government Lab

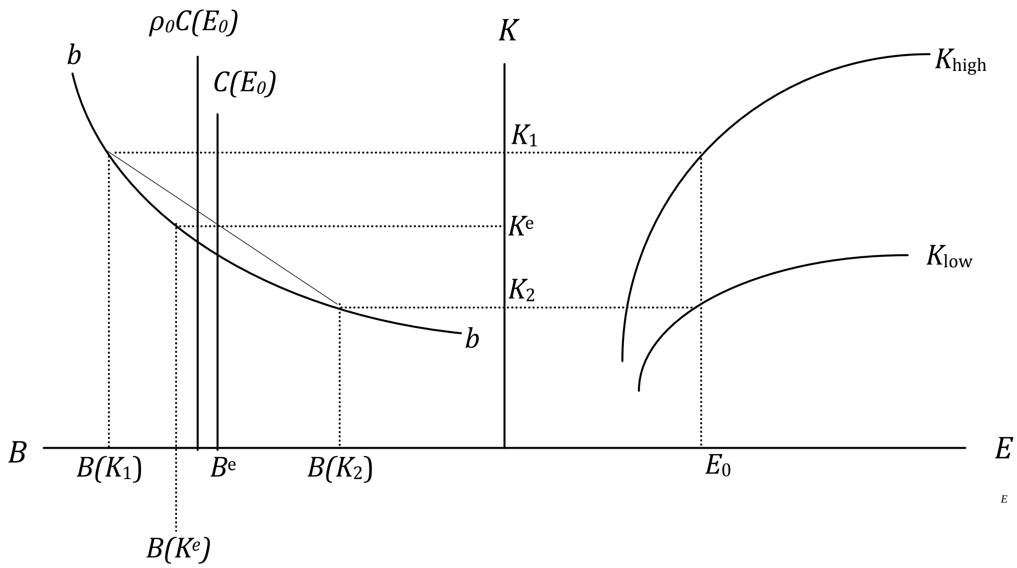

Figure 2
The Advantage of Risk-Neutral Behavior for a University Lab