Reflections on a Road not Taken

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Abstract: This paper summarizes the address I gave at the award ceremony for the 2026 Global Award for Entrepreneurship Research. My address chronicled my academic journey from being an undergraduate student at the University of Richmond in Virginia to the present day, highlighting key events and individuals who shaped my research efforts in the areas of entrepreneurship, innovation, and attendant public policy. This paper also summarizes the seminar topics and keynote addresses that I presented at various venues in Stockholm during the week following the award ceremony.

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1 Introduction

It is a great privilege to have been awarded the 2026 Global Award for Entrepreneurship Research, and it is an honor to be able to share my academic journey with those at this award ceremony and those with whom I will meet in the coming week through seminars and conferences at which I have been invited to speak. My sincere thanks to the Swedish Entrepreneurship Forum and its Chairman Lars Backsell, to the Royal Swedish Academy of Engineering Sciences, and to the distinguished members of the prize committee.

I am a classically trained economist who took the road less traveled, and that detour has made all the difference. My academic journey began at the University of Richmond in Virginia where I studied mathematics and physics. Having completed my academic requirements for my major at the end of my sophomore year, I had the time to explore other disciplines. My desire all along was to become a university professor; I was significantly influenced in this decision by the dedicated and nurturing faculty with whom I knew at the University of Richmond. While mathematics and physics seemed like the logical paths to follow toward my vocational goal, I simply could not see myself writing mathematical formulae all day on blackboards. But, as it turned out, I wrote mathematical formulae all day not only on blackboards, but also on white boards, overhead transparencies, and PowerPoint slides!

Of the disciplinary journeys that I took during my final two years at the University of Richmond, the field of economics caught my attention. With only a couple of introductory theory courses under my belt, I applied to the program at Tulane University in Louisiana in 1970 and entered the program in 1971. While the mathematical aspects of the course work came easy, I often found myself with a principles textbook in one hand and a nuanced journal article in the other.

When the time came to select a dissertation topic and a committee, I departed from a traditional model, that is from the road that my classmates took. What had captured my attention in a graduate elective course on neoclassical growth models was a 1957 article by Nobel laureate Robert Solow in which he found that output per man hour in the U.S. economy over the years 1909 through 1949 doubled, with only 12.5 percent of the increase due to the use of capital. Solow referred to the unexplained residual of 87.5 percent as being due to technical change. Others at that time referred to the residual as a catch-all measure of our ignorance.

2 In Search of Ignorance

My dissertation and much of my subsequent work has thus focused on the antecedents and consequences of technical change or *the measure of ignorance*. Specifically, my work focused on the correlation between residually measured technical change and R&D investments at the industry level and related social impacts. This topic was certainly not a road that had been taken by any of my professors, but, after the fact, it was a road that I believe made all the difference in molding my subsequent research career.

My first academic position began in 1976 at Auburn University in Alabama. Early on I was fortunate to receive research support from the National Science Foundation to conduct a manufacturing study of firm research and development (R&D) expenditures by character of use (e.g., basic research, applied research, and development). My final report caught the eye of Professor Zvi Griliches who invited me to a National Bureau of Economic Research (NBER) conference where I met Professor Ed Mansfield[1] and, among others, John Scott. John was also a newly minted assistant professor studying the economics of R&D.[2]

While at Auburn University, I became friends with my new colleague Bob Hébert, and together we embarked on a quest to uncover the intellectual history of who an entrepreneur is and what he/she does (see Hébert & Link 1982, 1989, 2006, 2009). This scope has formed the foundation for much of my subsequent research. During these projects with Bob, I began to think more broadly about technical change as an innovative phenomenon envisioned by entrepreneurial minds and supported through internal and external R&D investments and related public policies. The spillover of external R&D outcomes onto the innovative behavior of firms was certainly an example of the transfer of technical knowledge although the term *technology transfer* was not yet in my vocabulary. The research with Bob became the seed for how I thought about private-sector and public-sector entrepreneurial efforts that bent the arc of innovation (Link & Scott, 2013).

The next step along my journey was a move in 1982 to the economics department at the University of North Carolina at Greensboro (UNCG) in North Carolina. At that time the UNCG department was vibrant and open to a young full professor whose field of research interest was

[1] Over the years, Ed and I became virtual friends. See Link and Scherer (2005).

[2] John and I remained the closest of friends over the years that followed. We co-authored on a number of academic papers and scholarly books, and only a few years ago we came full circle and revisited the Solow model using laboratory data from the National Institute of Standards and Technology, NIST (see Link & Scott, 2020, 2021).

untraditional (although my mathematical tools for analysis reflected my classical training at Tulane University).

Shortly after re-locating to North Carolina, another door opened. I was asked if I would be interested in writing the history of Research Triangle Park (RTP)—a science and technology park geographically located within the triangle formed by Duke University, University of North Carolina at Chapel Hill, and North Carolina State University. After some background reading about the park, it became obvious to me that the history of RTP was a history of public-sector entrepreneurial insight. After more than a decade of archival research, *A Generosity of Spirit: The Early History of the Research Triangle Park* and *From Seed to Harvest: the Growth of the Research Triangle Park* were completed. These volumes are a micro description of public-sector entrepreneurial leadership, public-sector support of private-sector entrepreneurs, firm-with-university transfers of technical knowledge, and the role of agglomeration in enhancing technology transfer and innovation-based growth. What was at first blush an odd road to follow, this redirection turned out to expand how I thought about entrepreneurship, technology transfer, and university research as a harbinger for the commonweal.

There was a significant spillover benefit that came from my archival research and my endless one-on-one interviews with the founders of Research Triangle Park. From interview-based research jointly conducted with our son, Kevin, I gained insight into the research value of both revealed preferences and expressed preferences when dealing with individual and firm responses to acquiring and creating sources of knowledge (see Link & Link, 2003, Audretsch & Link, 2019, and Link, 2026).

During my archival research hiatus, the National Research Council of the U.S. National Academies of Sciences, Engineering, and Medicine (the Academy) became interested in the topic of university research parks, and my earlier work on the topic gained policy visibility and thus opened a discussion for focused R&D innovation strategies in the United States and elsewhere (see Link & Scott, 2003a, 2003b, 2006, 2007).

3 *Journal of Technology Transfer*

Not all of one's academic activities follow a linear timeline. Thirty years ago, in 1996, when I became Editor-in-Chief of the *Journal of Technology Transfer* (*JTT*), it was a Technology

Transfer Society in-house publication.[3] The inaugural issue of the *JTT* was published in 1977, and most of the authors who published in the *JTT* in the early years were Society members. Over the 29 years during which I was Editor-in-Chief, I had the privilege of working with a number of scholars who had editorial responsibilities with me to influence the scope of emphasis of the *JTT* in a manner that reflected my journey down the road that I had traveled since 1976. What I have learned about the technology transfer discipline is that it is conceptually broad in scope; however, many in the discipline have been slow to transition from thinking about technology transfer only as an outflow of technical knowledge processes to thinking about technology transfer as an integrating process that embraces within an economic unit the inflow as well as the outflow of technical knowledge.

4 Public Sector Entrepreneurship

The past decade has seen my earlier learnings culminate to inform public policy on ways to enhance entrepreneurial behavior, innovation behavior, and technology transfer behavior. Perhaps my hallmark efforts are reflected in the conceptual and theoretical work done with our daughter, Jamie, and with my former colleague Dennis Leyden. See Link and Link (2009) and Leyden and Link (2015a, 2015b). Therein I returned to my classical roots of market failure, public goods, and mathematical models as well as to my accumulated knowledge of entrepreneurship, technology transfer, and public policy.

Much of the research that I have done over the past decade under the umbrella of public sector entrepreneurship pulls together the themes just described with an emphasis on public-sector initiatives. I defined public-sector entrepreneurship in Leyden and Link (2015a, p. 14) as:[4]

> [P]ublic sector entrepreneurship refers to innovative public policy initiatives that generate greater economic prosperity by transforming a status-quo economic environment into one that is more conducive to economic units engaging in creative activities in the face of uncertainty.

In the week following the Global Award ceremony, I was privileged to be scheduled to deliver a number of academic seminars and keynote addresses at venues in Stockholm. They are

[3] I stepped down as Editor-in-Chief in 2025.

[4] And this definition was later expanded by Hayter et al. (2018, p. 682): "Public-sector entrepreneurship refers to the formation of innovative public-sector initiatives that transform a *status quo* social and economic environment into one that is more conducive to creative change in the face of uncertainty."

summarized below. Most reflect my study of an example of public sector entrepreneurship, namely of the U.S. Small Business Innovation Research (SBIR) program.

4.1 Seminar at the Research Institute of industrial Economics (IFN)

The topic of the seminar at the Research Institute of Industrial Economics (IFN) was the economics of ideas. This seminar built on my previous work on ideation (see Link, 2017, 2020). Using data on U.S. Phase I Small Business Innovation Research (SBIR) funded project data—and Phase I research is proof of concept research—I asserted that those Phase I projects that were not completed or were discontinued prematurely might be viewed as Phase I project ideas that failed.[5] The project data used came from Phase I projects funded through the U.S. Department of Defense's SBIR program, and the data pertained to the years 1998–2007. Using patent applications and publication submissions as performance variables, Table 1 shows the mean number of patent applications and publication submissions in both the subsample of Phase I project ideas that were discontinued and in the subsample of those that were not discontinued. The mean number of patent applications and the mean number of publication submissions was greater for Phase I project ideas that were not associated with discontinued projects.

Table 1
Mean Number of Patent Applications and Publication Submissions from Phase I SBIR Projects

	Patent Applications	Publications Submitted
Discontinued (Failed) Phase I Project Ideas	0.68 (n=117)	0.59 (n=115)
Not Discontinued (Non-failed) Phase I Project Ideas	0.98 (n=145)	1.70 (n=133)

Using these same data, I explored covariates with the number of patent applications and the number of publication submissions for the subsamples of discontinued and not discontinued Phase I projects. Based on the conceptualization of the philosopher John Locke, one's ideas emanate from one's experiences. One index of experience might be whether or not the funded firm had previously received any Phase I research awards on a topic similar to the topic of the

[5] A Phase I award supports research for determining, insofar as possible, the scientific and technical merit and feasibility of ideas submitted pursuant to SBIR program solicitations.

Phase I project for which the data pertained. Using the number of patent applications and the number of publication submissions from Phase I project ideas as the dependent variables in regression models, the estimated regression coefficients on the number of previous Phase I related technology awards was positive and significant for the samples of Phase I project ideas that were not discontinued, and it was insignificant for the sample of Phase I project ideas that were discontinued.

4.2 Seminar at the KTH Royal Institute of Technology

The title of the seminar at the KTH Royal Institute of Technology was "If you've seen one I-U research relationship, then you've seen one I-U research relationship." The acronym "I-U" refers to industry-with-university. The point of the seminar was to emphasize that entrepreneurial firms will engage in research relationships with universities for various reasons, but university involvement is not a homogeneous event. The collaboration might have been initiated for firms to access university human capital or to access university technical capital, or to do both. At a more disaggregated level, access to human capital might involve using university faculty to fill a principal investigator role or it might involve using graduate students to assist with the firm's research projects. Or, the collaboration might involve using university's technical equipment or it might license some of the university's technology.

Using data on Phase II SBIR project data,[6] I asserted that the relevant performance variable for Phase II research is whether or not the project resulted in a commercialized product, process, or service. The project data used also came from Phase II SBIR projects funded through the U.S. Department of Defense's SBIR program, and the data also pertain to the years 1998–2007.

For a sample of Phase II projects (n=1251), the mean commercialization rate for projects that relied on a university for research support was 52.4%; the mean commercialization rate for projects that did not rely on a university for research support was 60.5%.

Table 2 shows mean commercialization rate for Phase II projects that were only involved with a university for access to its human capital and that were only involved with a university for access to its technical capital.

[6] A Phase II award further develops the proposed ideas [in Phase I] to meet the particular program needs. Generally, commercialization of the developed technology is expected.

Table 2
Mean Commercialization Rate for Phase II SBIR Projects

	Involved	Not Involved
University human capital for research support	52.8% (n=286)	59.7% (n=965)
University technical capital for research support	60.0% (n=120)	57.9% (n=1131)

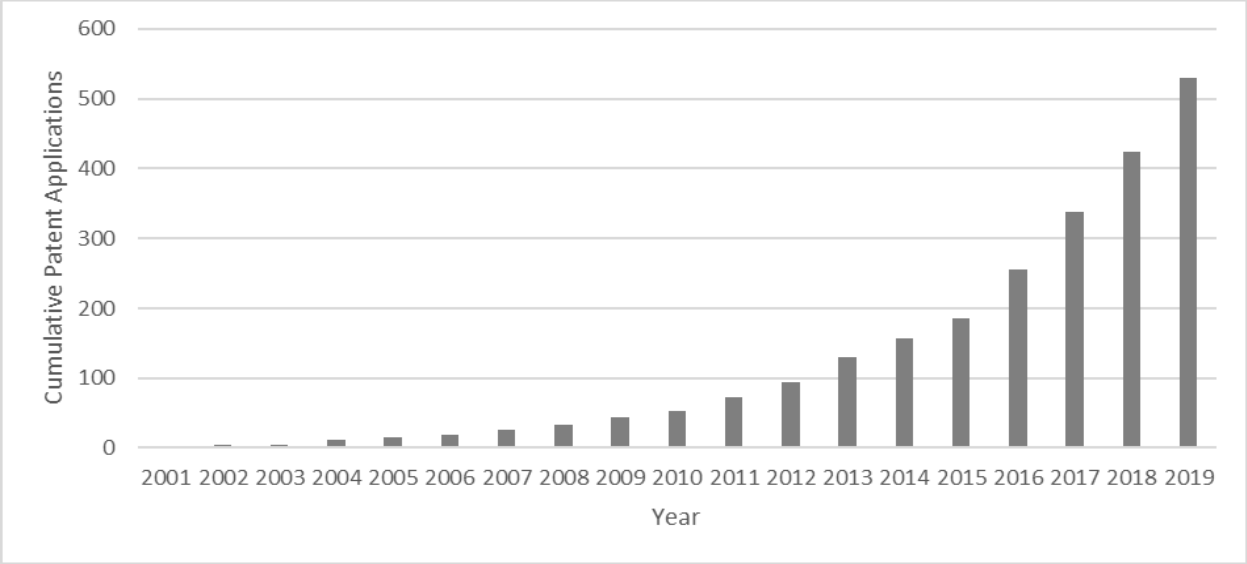
This seminar concluded with a discussion about ways in which the public sector might assist small entrepreneurial firms identify relevant sources for university technical capital.

4.3 Stockholm School of Economics, House of Innovation

The topic of the seminar at the House of Innovation was the growth of surgical robotic technology. I presented briefly the U.S. history of public sector support of this technology and of the entrepreneurial insights and efforts of the firms that developed the industry. Much of the early financial support for the private sector's development of this technology came from SBIR funding through the U.S. Department of Defense and the U.S. National Aeronautics and Space Administration (NASA). Funded firms, and follow-on firms, molded the technology through their patent applications. Figure 1 shows the exponential growth in the cumulative number of surgical robotic technology patent applications with the U.S. Patent and Trademark Office (USPTO) through 2019.

The statistical portion of the seminar is related to covariates with the growth of patent applications (an index for the growth of the industry) over the 19 years of available data. Building on extant theory on the economics literature, the key finding is that the accumulated stock of experience of incumbent firms in the industry is positively and significantly related to patent applications per year.

Figure 1
Cumulative Surgical Robotic Technology Patent Applications Filed at USPTO, by Year, Characterizes Growth of New Knowledge about the Technology (n=530)



The concluding aspect of the seminar is to emphasize that as of yet (through year 2019), there is not a developed ecosystem to support this industry, and to ask how small entrepreneurial firms that enter the industry will be able to survive.

4.4 Royal Swedish Academy of Engineering Sciences (IVA)

I was asked to deliver a keynote address related to what needs to be in place for Sweden's entrepreneurs to be able to convert innovation into growth, scale, and strategic building blocks. Toward that end, I reflected on sabermetrics (the statistical analysis of baseball data) as described in the movie Moneyball (starring Brad Pitt, Robin Wright, and Jonah Hill). The theme of the movie is that the portfolio of talent strategy of the 2002 Oakland Athletics professional baseball team adopted was similar to a financial strategy consisting of a number of different investments.

Table 3 illustrates an aspect of the economic benefits from a firm with a portfolio of external knowledge sources. There appears to be a positive relationship between richer portfolios and the percent of Swedish entrepreneurial firms (n=334) sales in international markets.

Table 3
Swedish Entrepreneurial Firms' Percent of Sales in International Markets and their Portfolio of Knowledge Sources (n=334)

	Percent of Sales in International Markets		
	0%	1% to 50%	Over 50%
Mean number of external knowledge alliances and agreements often or very often used	0.94	1.19	1.35

Note: External knowledge alliances and agreements include strategic alliances, R&D agreements, technical cooperative agreements, licensing agreements, and subcontracting

4.5 Nordic Research School in Innovation and Entrepreneurship (NORSI)

A successful keynote address to a group of PhD candidates from the Nordic region often requires the sharing of new ideas that the candidates can run with either for a dissertation or for follow-on research. The topics I discussed consisted of ideation, universities as research partners, homophily, public sector project managers, surgical robotic technology, and innovation capital.

5 Concluding Thoughts

My concluding thoughts are perhaps best summarized through what was eloquently discussed in the 2025/2026 Global Entrepreneurship Monitor:[7]

- entrepreneurship is a strategic pillar of national competitiveness and economic growth
- entrepreneurship is a powerful engine of resilience in times of uncertainty.

[7] See https://www.gemconsortium.org/reports/latest-global-report.

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