

## From integrating functions to integrating ideas

By: [Albert N. Link](#)

Link, Albert N. "From Integrating Functions to Integrating Ideas" in *The Routledge Companion to the Makers of Modern Entrepreneurship*, edited by D. Audretsch and E. Lehmann, Routledge, 2016: 167-171. <https://doi.org/10.4324/9781315734682>

**This is an Accepted Manuscript of a book chapter published by Routledge in *The Routledge Companion to the Makers of Modern Entrepreneurship* on 30 September 2016, available online: <http://www.routledge.com/9781315734682>**

### **Abstract:**

Math was my thing. I was fortunate to go to a high school in Virginia that offered advanced courses in calculus and matrix algebra, and I did well in those classes. So, majoring in math at the University of Richmond seemed like the logical path to follow. However, math was about all that I was interested in when I started college. By the end of my sophomore year I had completed my major requirements in math as well as my minor requirements in physics. The next step was to satisfy the university's core requirements; U of R is a liberal arts college. By my junior year I had grown an appreciation for the humanities and social sciences, so I began to dabble across the spectrum, constrained only by area requirements and a four-year time constraint. These explorations ranged from Pavlov to production possibilities and from the New Testament to neoclassical thought. In my senior year, with only a rudimentary understanding of supply and demand under my belt, I decided to give graduate studies in economics a try at Tulane University in New Orleans. Perhaps in the back of my mind was that a break from math would be a nice change. Little did I know at the time how useful my math background would prove to be.

**Keywords:** R and D | public-private partnerships | economics | entrepreneurship

### **Article:**

#### **What was in that residual?**

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in New Orleans. Perhaps in the back of my mind was that a break from math would be a nice change. Little did I know at the time how useful my math background would prove to be.

The core course work at Tulane was traditional, yet there were few field courses from which to choose because of the small size of the faculty. Production theory immediately captured my attention, and that interest led me to read the 1957 article by Robert Solow on technical change and the aggregate production function and then to ask the question: What was in that residual?<sup>1</sup> My dissertation attempted to address that question, and it focused me on static investments in research and development (R&D) as an initial answer.

After graduation, Southern roots took my wife and me to Auburn University. The interests of the faculty there were broader than the faculty at Tulane, and I took full advantage of that fact. One such step was to sit in on Bob Hébert's graduate class on the history of economic thought. I knew little about the history of economic thought at that time, save selected mentions about the classical economists in the margins of Samuelson's principles textbook back when. I remember being intrigued by one of Bob's lectures on Joseph Schumpeter, and afterwards at lunch I asked him about the origin of the concept of the entrepreneur. Well, that got it all started.

My fondness for New Orleans cuisine and Bob's Louisiana heritage and culinary skills were the glue (or perhaps the gumbo) that bonded us together on our quest toward understanding from an historical perspective who an entrepreneur is and what he or she does. This was quite an adventure; our quest began with Aristotle and has yet to end. Cantillon, Baudeau, Knight, and Kirzner, among others, were friendly acquaintances along the way. What resulted from this quest was *The Entrepreneur: Mainstream Views and Radical Critiques* (1982, revised 1988).<sup>2</sup>

It is interesting to think about now, in the afternoon of my research career, how an event here and event there has influenced my path. In my case, or so I think retrospectively, there was a confluence of relationships and events in the early 1980s that has indeed influenced the evolution of my scholarship to date.

I first met David Audretsch at a conference at Middlebury College in April 1981. We later reconnected at a conference at INSEAD, the European Business School in Fontainebleau, France, in June 1986. Perhaps it was those meetings, or perhaps it was my 1982 book with Bob, or perhaps it was both, but David was kind enough to invite Bob and me to write a paper for the inaugural issue of *Small Business Economics*.<sup>3</sup> Preparing that paper caused Bob and me to integrate the history of ideas about the entrepreneur in a way that we had not previously done. We are grateful for that challenge and have benefitted from it many times over. It was that reintegration of thought that eventually led us to rethink *Mainstream Views*, and that process culminated a decade later with *A History of Entrepreneurship* (2009).<sup>4</sup>

## **Public-private research partnerships**

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<sup>1</sup> See Solow (1957).

<sup>2</sup> See Hébert and Link (1982, 1988).

<sup>3</sup> See Hébert and Link (1989).

<sup>4</sup> See Hébert and Link (2009).

The other person I spent time with at the Middlebury conference was Ed Mansfield. He and I had met the previous December at the International Institute of Management Science in Berlin. We were talking the evening before the Middlebury conference started, and I confessed to him that I had been one of the referees on his 1980 paper in the *American Economic Review* (AER) on the returns to basic research, and he responded that he was one of the referees on my rejoinder to his paper.<sup>5</sup> It turned out that my paper would also appear in the AER later that year.<sup>6</sup> Small world. Obviously, the discussion during the rest of the evening went in the direction of: “What are you working on now?” It turned out that we both were working on similar topics. More accurately, that which was consuming my time overlapped with a small segment of Ed’s encompassing and forward-looking research agenda. One topic was what the literature has come to call public/private research partnerships, and the other topic was firm-with-university research partnerships.

There are a few more pieces of the puzzle that need to be put into place, keeping in mind that I am putting this puzzle together with both a well-intended memory and a retrospective eye. The paper that I presented at the INSEAD conference where I reconnected with David was on voluntary standards and the role of the public sector to provide a framework for such technology infrastructure.<sup>7</sup>

My research landscape by the mid-1980s looked like this. At the center was my appreciation for the historical roots of entrepreneurship. Over time both Bob and I came to the conclusion that an entrepreneurial effort – that is an effort by an individual, a firm, or even a public organization – can be described with reference to the attendant historical literature as encompassing both the perception of an opportunity and the ability to act on that perception. The conjunction *and* is important; perception *and* action. From that core are several branches. One branch leads to private-sector investments in R&D, another branch leads to public-sector investments in R&D, another branch leads to university research, and yet a fourth branch leads to public-sector investments in technology infrastructure. The vine that connects these branches is the notion of research partnerships.

Timing is everything. In the mid-1980s, the National Cooperative Research Act (NCRA) of 1984 gained the attention of theoretical and empirical researchers. The coincidental timing of this legislation, as well as the National Science Foundation’s interest in funding my exploratory research on research joint ventures, fit nicely within the landscape of my unfolding research agenda.<sup>8</sup> The NRCA was not to be viewed in isolation of other post-productivity slowdown policy initiatives, and so I became interested in related policies such as university technology transfer through the Bayh-Dole Act of 1980. Thus, the linkage among the research areas of private-and public-sector R&D, university research activity, and public support of technology were tightly in place in the mid-1980s within my research agenda, and they were in place within the literature by the late 1980s.

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<sup>5</sup> See Mansfield (1980). For those unfamiliar with the journal publication process, the time from submission to publication can easily approach a two-year time period.

<sup>6</sup> See Link (1981).

<sup>7</sup> See Link and Tassey (1987).

<sup>8</sup> See Link and Bauer (1989) and Link and Tassey (1989).

These interests brought about some influential research partnerships. One of the longest lasting and, from a friendship perspective, most important was with John Scott. He and I first met at a National Bureau of Economic Research (NBER) conference in the fall of 1981. It was not the focus of the conference, but rather our later mutual interest in the NCRA and in cooperative R&D that were the seeds that grew into more than a three-decade research partnership. From there, our independent and mutual interest in cooperative R&D expanded into our study of public/private partnerships. We were fortunate to have been invited to study a number of such partnerships that were supported by the National Institute of Standards and Technology (NIST) and its Advanced Technology Program (ATP), and those experiences evolved into our theory about program evaluation. This focus of our research partnership continued for nearly two decades.<sup>9</sup>

### *The Journal of Technology Transfer*

It was my research with John on the activities at NIST that fueled my interest in technology transfer activities. That interest, however, remained dormant for a number of years until a door unexpectedly opened for me to become the editor of the *Journal of Technology Transfer* (JTT). In 1996 that journal was little more than a practitioner vehicle for communicating ideas among the members of the Technology Transfer Society (which at that time was dominated by members from the Federal Laboratory Consortium). My challenge was to transform the journal into an academic vehicle for scholars. That was a slow, uphill process, but one aided initially through the help of Don Siegel at the University at Albany, SUNY and later through the help of Barry Bozeman at Arizona State University. I am proud of what the JTT has become, but more visible times are yet to come.

### **Public-sector entrepreneurship**

There is one more piece of the puzzle to describe before I explain how my research agenda has come full circle. In 2007, I began a benefit-cost study for the Department of Energy (DOE) on their improved vehicle combustion engine R&D investments.<sup>10</sup> During that project, which concluded in 2010, I was thinking about the sources of ideas that originally led to the creation of the advanced combustion engine R&D program and the impetus for its on-going funding. What gelled was that this program was an example of government as entrepreneur – the DOE perceiving an opportunity to fulfill a dimension of its mission and then having the ability to act on that perception. Before the project ended, I realized that my research endeavors had indeed come full circle. My early work with Bob Hébert on this historical origin of entrepreneurship and our synthesized definition of entrepreneurship as perception *and* action illuminated how I began to think about selected public policies, especially technology-based public policies.

In 2008, I began a retrospective look at a large segment of my prior research, especially my research on NIST-funded projects, and I arrived at the following definition (Link and Link, 2009, p. 4):

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<sup>9</sup> See Hall et al. (2001, 2003) and Link and Scott (1988, 2005, 2011).

<sup>10</sup> See Gallaher et al. (2012) and Link (2010).

Government acts as entrepreneur in the provision of technology infrastructure when its involvement is both innovative and characterized by entrepreneurial risk.

Here I was, back in Bob's lecture on Schumpeterian entrepreneurs!

The circle is now complete. My research career related to entrepreneurship began with my work with Bob and with *Mainstream Views*. Events and personal relationships developed my interest in public- and private-sector R&D; university research relationships<sup>11</sup>; public/private research collaborations; and technology-based policies, especially those related to technology infrastructure. Over time these threads became connected through an understanding of entrepreneurship. As a culmination, all of these threads are present in my most recent work with my colleague Dennis Leyden as evident through what we wrote in *Public Sector Entrepreneurship* (Leyden and Link, 2015a, p. 14)<sup>12</sup>:

[P]ublic sector entrepreneurship is a variant of the more general notion of entrepreneurship [in a private sector setting] . . . What makes public sector entrepreneurship different is not its fundamental *modus operandi* but rather its observable behaviors that are due . . . to the different institution environment in which it operates. Thus, the public sector entrepreneur, like his private sector counterpart, seeks to identify and exploit heretofore unexploited opportunities, and this means that the public sector entrepreneur engages in a process of innovation whose outcome is uncertain.

Therein we discuss not only the NCRA but also attendant public policies that were designed from an entrepreneurial perspective to affect public-sector as well as private-sector R&D.

What next? Chronically, I am in the afternoon of my academic career, but I hope I am not yet there in terms of that segment that represents my research career.

## References

- Gallaher, Michael P., Albert N. Link, and Alan O'Connor (2012). *Public Investments in Energy Technology*, Northampton, MA: Edward Elgar Publishers.
- Hall, Bronwyn H., Albert N. Link, and John T. Scott (2001). "Barriers Inhibiting Industry from Partnering with Universities: Evidence from the Advanced Technology Program," *Journal of Technology Transfer* 26: 87–98.
- Hall, Bronwyn H., Albert N. Link, and John T. Scott (2003). "Universities as Research Partners," *Review of Economics and Statistics* 85: 485–491.
- Hébert, Robert F. and Albert N. Link (1982). *The Entrepreneur: Mainstream Views and Radical Critiques*, New York: Praeger.
- Hébert, Robert F. and Albert N. Link (1988). *The Entrepreneur: Mainstream Views and Radical Critiques*, 2nd edition, New York: Praeger.

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<sup>11</sup> See Link (2015).

<sup>12</sup> See Leyden and Link (2015b) for a more formal theory of the ideas in Leyden and Link (2015a).

- Hébert, Robert F. and Albert N. Link (1989). "In Search of the Meaning of Entrepreneurship," *Small Business Economics* 1: 39–49.
- Hébert, Robert F. and Albert N. Link (2009). *A History of Entrepreneurship*, London: Routledge.
- Leyden, Dennis Patrick and Albert N. Link (2015a). *Public Sector Entrepreneurship: U.S. Technology and Innovation Policy*, New York: Oxford University Press.
- Leyden, Dennis Patrick and Albert N. Link (2015b). "Toward a Theory of the Entrepreneurial Process," *Small Business Economics* 44: 475–484.
- Link, Albert N. (1981). "Basic Research and Productivity Increase in Manufacturing: Additional Evidence," *American Economic Review* 71: 1111–1112.
- Link, Albert N. (2010). "Retrospective Benefit–Cost Evaluation of U.S. DOE Vehicle Combustion Engine R&D Investments: Impacts of a Cluster of Energy Technologies," final report for the Energy Efficiency and Renewable Energy (EERE) Program, Washington, DC: U.S. Department of Energy.
- Link, Albert N. (2015). "Capturing Knowledge: Private Gains and Public Gains from Universities Research Partnerships," *Foundations and Trends in Entrepreneurship* 11: 139–206.
- Link, Albert N. and Gregory Tassey (1987). "The Impact of Standards on Technology-Based Industries: The Case of Numerically-Controlled Machine Tools in Automated Batch Manufacturing," in *Product Standardization and Competitive Strategy*, edited by L. Gabel, pp. 217–238, Amsterdam: North-Holland.
- Link, Albert N. and Gregory Tassey (1989). *Cooperative Research and Development: The Industry, University, Government Relationship*, Norwell, MA: Kluwer Academic Publishers.
- Link, Albert N. and Jamie R. Link (2009). *Government as Entrepreneur*, New York: Oxford University Press.
- Link, Albert N. and John T. Scott (1988). *Public Accountability: Evaluating Technology-Based Institutions*, Norwell, MA: Kluwer Academic Publishers.
- Link, Albert N. and John T. Scott (2005). *Evaluating Public Research Institutions: The U.S. Advanced Technology Program's Intramural Research Initiative*, London: Routledge.
- Link, Albert N. and John T. Scott (2011). *Public Goods, Public Gains: Calculating the Social Benefits of Public R&D*, New York: Oxford University Press.
- Link, Albert N. and Laura L. Bauer (1989). *Cooperative Research in U.S. Manufacturing: Assessing Policy Initiatives and Corporate Strategies*, Lexington, MA: D.C. Heath.
- Mansfield, Edwin (1980). "Basic Research and Productivity Increase in Manufacturing," *American Economic Review* 70: 863–873.
- Solow, Robert M. (1957). "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics* 39: 312–320.