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David B. Audretsch
Albert N. Link *Editors*

Essays in Public Sector Entrepreneurship

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Essays in Public Sector Entrepreneurship

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Between 2007 and 2009 he was general secretary of the Swedish Globalisation Council set up by the Swedish government. The objective of the Globalisation Council was to suggest economic policy reforms that enabled exploitation of the potential welfare effects associated with increasing globalisation and to broaden the national debate on issues related to globalisation. In May 2014 he was asked to serve as chairman of the Government Committee on Entrepreneurship Policy. The committee will present their results in October 2016. Braunerhjelm is also a member of the Royal Swedish Academy of Engineering Sciences (IVA) and a number of other boards and scientific committees.

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In 2011–2014, he was a commissioned expert on the Swedish Government Committee on Business Taxation, and in 2015, he became a commissioned expert on the Government Committee on Entrepreneurship Policy. He has also written a number of books, studies and articles within the framework of Swedish policy discussions. He has experience in international banking and has served as an advisor in both the public and private sectors. Henrekson is a member of the Royal Swedish Academy of Engineering Sciences (IVA), and he has been a board member of two public companies, one high-tech start-up and the Swedish public service broadcasting company.

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Chapter 1
Introduction

David B. Audretsch and Albert N. Link

Public sector entrepreneurship has been defined as the promulgation of 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 (Leyden and Link, 2015). In today's economy, public sector entrepreneurship affects that transformation primarily by increasing the effectiveness of knowledge networks, that is, by increasing the heterogeneity of experiential ties among economic units and the ability of those same economic units to exploit such diversity. Through policy initiatives that are characterized by public sector entrepreneurship, there will be more development of new technology and hence more innovation throughout the economy.

We have assembled in this volume four essays that deal broadly with public sector entrepreneurship. Because innovation is the driver of economic growth and development, we believe that future policy initiatives that build on this premise will be cast within a public sector entrepreneurship framework. Thus, the following four essays may well represent the pillars on which future policies are developed.

In Chap. 2, Richardson, Audretsch, and Aldridge explore how US federal institutions influence innovation in the knowledge economy in an effort to ask if any US agencies or particular policies could be replicated in other countries. Three key US agencies are identified as having significantly contributed to innovation and growth: the Small Business Innovation Research (SBIR) program, the Advanced Technology Program (ATP), and the Defense Advanced Research Projects Agency (DARPA).

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Richardson et al. offer a view for understanding why and how search and development does not necessarily lead to innovation and economic activity. To become a successful innovation, ideas must first pass through a knowledge filter. The use of a knowledge filter, which may impede the development of potential innovations, implies that the evolution from ideas to innovations is neither linear nor does it imply that innovations will be successful. Therefore, government agencies are needed to help firms pass through the filter, or perhaps even through the valley of death, if the transformation from ideas to successful innovations is to be realized. Richardson et al. conclude that the SBIR program is the one US program that could conceivably be replicated in other countries to assist in the idea to innovation transformation.

In Chap. 3, Cunningham, O'Reilly, O'Kane, and Mangematin argue convincingly that publicly funded principal investigators (PIs) are core actors in knowledge-intensive economies. PIs are lead scientists responsible for delivering transformative publicly funded scientific programs. Becoming a publicly funded PI is a career enabler for scientists and carries significant peer prestige. However, the role and expected impact of PIs have grown substantially beyond traditional scientific activities. Publicly funded PIs must be adept in the areas such as technology transfer, strategy, management, entrepreneurship, brokering, negotiation, and mediation. They must engage with a broader range of stakeholders including scientific peers, technology transfer offices, industry, policy makers, nongovernmental organizations (NGOs), and regulators.

Publicly funded PIs, according to Cunningham et al., are critical agents in the delivery of transformative public sector entrepreneurship through the creation of scientific networks responding to broad opportunities directed by government scientific programs and associated publicly funding bodies. In the implementation of publicly funded scientific programs, PIs either directly or indirectly create technology transfer and commercial opportunities that can ultimately be exploited by third parties. The activities of publicly funded PIs can thus create transformative social scientific networks that can respond effectively to public sector entrepreneurship initiatives as well as contribute to creating economic activity and prosperity. Given the importance of the scientists as publicly funded PIs, Cunningham et al. contend that it is surprising that their roles and activities have received little empirical attention. Accordingly, the authors use Irish data of publicly funded PIs to focus on four themes with respect to publicly funded PIs. Their roles are as public sector entrepreneurship linchpins, as research strategists, as managers, and as agents of technology and knowledge transfer. The authors conclude with some practical implications and reflections with respect to future research agendas that seek to integrate the emerging literature on public sector entrepreneurship and that of publicly funded PIs.

In Chap. 4, Braunerhjelm and Henrekson build on the widely accepted premise that innovation has increasingly been acknowledged as a key factor in raising prosperity and securing sustainable long-term growth. They examine policy measures that foster the creation of innovations with high inherent potential and that simultaneously provide the right incentives for individuals to create and expand firms building on such innovations.

Previous research thus suggests that to facilitate and further enhance the role of entrepreneurs in the innovation process, policies should be expanded to areas other than education and R&D outlays. Despite these new insights, the links between microeconomic dynamics and macroeconomic growth are still neither well conceptualized nor adequately modeled. Mapping this analytically fragmented terrain in a comprehensive framework for growth and combining a dispersed and diverse microeconomic setting with the macroeconomic outcome basically remain uncharted territory.

Policies to boost innovation have thus primarily centered on R&D, whereas entrepreneurial processes, where existing (or new) knowledge is combined with individual abilities in the search for new market opportunities, tend to have been neglected. However, a policy discussion focusing on a limited set of instruments or areas is inadequate. A far more fruitful policy question, according to the authors, is the following: What policy measures (1) foster the creation of innovations with high inherent potential *and*, simultaneously, (2) provide the right incentives for individuals to create and expand firms that disseminate such innovations in the form of highly valued products?

Braunerhjelm and Henrekson propose an answer to this two-pronged question. They stress that recognizing the importance of diffusing and exploiting knowledge investments opens a complementary policy field related to entrepreneurs, the expansion of firms, and the competence structure of supporting agents (e.g., financial market actors in different phases of the life cycle of the firm, legal advisors, and management specialists).

Specifically, the authors suggest an innovation policy framework based on two complementary pillars:

- *The accumulation, investment, and upgrading of knowledge*. The policy areas involved in this pillar relate to the institutions that are needed to encourage high-quality education at all levels, to prompt internationally leading universities and their research, to establish links between academia and the commercial sector, and to fund universities.
- *The implementation of mechanisms that enable knowledge to be exploited such that growth and societal prosperity is encouraged*. These mechanisms involve a completely different set of institutions, such as tax policies, the regulatory burden, competition, and the formation of clusters. These mechanisms also include policies that create environments and incentives for individuals to undertake entrepreneurial efforts, innovations, and firm expansion.

Braunerhjelm and Henrekson go on to demonstrate what is required to integrate these two interdependent pillars in a coherent innovation policy framework. Without the accumulation, investment, and upgrading of knowledge, the second set of policies is likely to generate less value. Without the implementation of mechanisms that enable knowledge to be exploited, knowledge investments can be expected to yield little, if any, growth. Successful exploitation of knowledge and new ideas depends on many complementary agents and institutions. Thus, they argue that a coherent innovation policy framework must include tax policy, labor market regulation,

savings channeling, competition policy, housing market regulation, and infrastructure to foster growth and future prosperity.

This collection of essays concludes with a Chap. 5 by Richardson, Audretsch, Aldridge, and Nadella. These authors note that there have been many studies measuring and analyzing technology transfer and knowledge spillovers from universities using data collected by the universities on the activities of the Technology Transfer Office (TTO). This chapter represents a methodological step forward. The authors examine university entrepreneurial activity by directly asking scientists in six fields of study, about their entrepreneurial involvement. While data from TTOs suggest that new firm start-ups from university research is an infrequent occurrence, this Richardson et al. study finds exactly the opposite. Furthermore, the authors report patterns with levels of entrepreneurial startups based on the scientific field, age, gender, and experience of the university scientists. Their evidence suggests that entrepreneurship is more prevalent among a broad spectrum of university scientists than had previously been identified in other studies that relied on TTO-provided data. The results from this pioneering effort suggest that knowledge spillovers from universities for commercialization, for innovation, and ultimately for economic growth, employment creation, and global competitiveness are substantially more robust than had previously been thought.

Reference

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Chapter 2
Motivating Entrepreneurship and Innovative Activity: Analyzing US Policies and Programs

Aileen Richardson, David B. Audretsch, and Taylor Aldridge

2.1 The Role of Innovation Policies in the United States[1]

2.1.1 Knowledge, Entrepreneurship, and Innovation

Government policy has undertaken a number of key initiatives, such as the Small Business Innovation Research (SBIR) program, the Advanced Technology Program (ATP), and the Defense Advanced Research Projects Agency (DARPA), with the goal of developing the innovative capacity and overall economic performance of the country. These agencies not only help firms innovate where they otherwise would most likely not have, but they also help to address the current and future needs of government agencies for innovative solutions. In order to understand how and why government intervention is needed, the chapter offers an explanation of why R&D and innovation necessitates governmental support.

[1] This contribution is largely based on the JRC Scientific and Policy Report, written by David B. Audretsch and Taylor Aldridge, "The Development of US Policies directed at stimulating innovation and entrepreneurship." The report prepared for European Commission and edited by Itzhak Goldberg, Federico Biagi, and Paul Desruelle. 2014.

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2.1.2 The Role of Knowledge, R&D, and Innovation

In what Zvi Griliches (1979) formalized as the model of the knowledge production function, the firm is assumed to be exogenous. The strategies and investments of the firm are then modeled as choice variables generating innovative activity and are therefore modeled as being endogenous. Thus, the model of the firm knowledge production function starts with an exogenously given firm and examines which types of strategies and investments generate the greatest amount of innovative output. Griliches, in fact, suggested that it was investments in knowledge inputs that would generate the greatest yield in terms of innovative output.

Griliches' seminal article prompted a large number of studies, which attempted to empirically test the knowledge production function. These studies were confronted with numerous measurement concerns. The innovative output had to be measured and knowledge inputs had to operationalized. While the economic concept of innovative activity does not lend itself to precise measurements (Griliches 1990, 2002), scholars developed measures such as the number of patented inventions, new product introduction, share of sales accounted for by new products, productivity growth, and export performance as proxies for innovative output. Developing measures that reflect investments in knowledge inputs by the firm proved equally challenging. Still, a plethora of studies (Cohen and Klepper 1992a, b; Hausman et al. 1984) developed proxies of firm-specific investments in new economic knowledge in the form of expenditures on R&D and human capital as key inputs that yield a high innovative output.

2.1.2.1 Cohen and Levinthal's Absorptive Capacity Argument

The literature empirically tests the model of the knowledge production function generated as a series of econometrically robust results which substantiated Griliches' view that firm investments in knowledge inputs were required to produce innovative output. Cohen and Levinthal (1989) provided an even more compelling interpretation of the empirical link between firm-specific investments in knowledge and innovative output. According to Cohen and Levinthal, by developing the capacity to adapt new technology and ideas developed in other firms, firm-specific investments in knowledge such as R&D provide the capacity to absorb external knowledge, termed *absorptive capacity*. This key insight implied that by investing in R&D, firms could develop the absorptive capacity to appropriate at least some of the returns accruing to investments in new knowledge made externally by the firm. This insight only strengthened the conclusion that the empirical evidence linking firm-specific investments in new knowledge to innovative output verified the assumptions underlying the model of the knowledge production function.

2.1.2.2 The Individual Entrepreneur

Audretsch (1995) challenged the assumption underlying the knowledge production model of firm innovation by shifting the unit of analysis away from the firm to the individual. In this view, individuals such as scientists, engineers, or other knowledge workers are assumed to be endowed with a certain stock of knowledge. They are then confronted with the choice of how best to appropriate the economic returns from that knowledge. Thus, just the appropriability question, identified by Cohen and Levinthal (1989), confronts the firm; an analogous appropriability question confronts the individual knowledge or skilled worker.

The concept of the entrepreneurial decision resulting from the cognitive processes of opportunity recognition and ensuing action is introduced by Eckhardt and Shane (2003) and Shane and Venkataraman (2000). They suggest that an equilibrium view of entrepreneurship stems from the assumption of perfect information. By contrast, imperfect information generates divergences in perceived opportunities across different people. The sources of heterogeneity across individuals include different access to information as well as cognitive abilities, psychological differences, and access to financial and social capital.

2.1.2.3 The Geographical Dimension

Recognition of the role that firm-specific knowledge investments could play in accessing, absorbing, and transforming external knowledge, and therefore enhancing the innovative output of the firm, triggered an explosion of studies which focused on potential sources of knowledge that are external to the firm. Some studies examined the role of licensing, cooperative agreements, and strategic partnerships, all of which involve a formal agreement and a market transaction for the sale of knowledge. Thus, these all represent mechanisms by which a firm can access knowledge produced by another firm. As Cohen and Levinthal (1989) emphasized, presumably internal investments in knowledge are a prerequisite for absorbing such external knowledge even if it can be accessed.

A different research trajectory focused on flows of knowledge across firms where no market transaction or formal agreement occurred or what has become known as knowledge spillovers. The distinction between knowledge spillovers and technology transfer is that in the latter, a market transaction occurs, whereas in the case of spillovers, the benefits are accrued without an economic transaction (Acs and Varga 2005).

While Krugman (1991) and others certainly did not dispute the existence or importance of knowledge spillovers, they contested the claim that knowledge spillovers are geographically bounded. Their point was that when the marginal cost of transmitting information across geographic space approaches zero, there is no reason to think that the transmission of knowledge across geographic space will stop simply because it has reached the political border of a city, state, or country.

However, von Hippel (1994) explained how *knowledge* is distinct from *information* and requires geographic proximity in transmitting ideas that are highly dependent upon their context and inherently tacit and have a high degree of uncertainty. This followed from Arrow (1962), who distinguished economic knowledge from other economic factors as being inherently non-rival in nature so that knowledge developed for any particular application can easily spill over to generate economic value in very different applications. As Glaeser et al. (1992, p. 1126) have observed, "intellectual breakthroughs must cross hallways and streets more easily than oceans and continents."

Thus, a distinct research trajectory developed in the late 1980s and early 1990s, which tried to identify the impact of location on the innovative output of firms. These studies addressed the question "Holding firm-specific knowledge inputs constant, is the innovative output greater if the firm is located in a region with high investments in knowledge?" The answer to this question was provided in a series of studies, which shifted the unit of observation for testing the model of the knowledge production function from the firm to a spatial unit of observation, such as a city, region, or state. Furthermore, how does a region play a role in the public sector entrepreneurship and innovative capacity?

2.1.3 The Knowledge Filter

Because of the conditions inherent in radical innovation based on knowledge, high uncertainty, asymmetries, and transaction cost, decision-making hierarchies can decide not to commercialize new ideas that individual economic agents, or groups of economic agents, think are potentially valuable and should be pursued. The characteristics of knowledge that distinguish it from information include a high degree of uncertainty combined with nontrivial asymmetries, fused with a broad spectrum of institutions, rules, and regulations. These differences distinguish between radical innovation and incremental innovation. Thus, not all potential innovative activity, especially radical innovations, is fully appropriated within the firm, which made the investments to create that knowledge in the first place.

The ability of decision-makers to reach a consensus tends to be greater when it is based on more information and less knowledge, as information is easily transferable, put in context, and timely; therefore, it is more pertinent to decision-makers' incremental decisions. A decision's outcomes and their associated probability distributions are more certain when the decision is based on information and, by definition, less certain when it is based on knowledge, as knowledge is inherently more difficult to share and transfer. Radical innovation typically involves more knowledge and less information than does incremental innovation.

Various constraints on the ability of a large firm to determine the value of knowledge prevent the firm from fully exploiting the inherent value of its knowledge assets (Moran and Ghoshal 1999). In fact, evidence suggests that many large, established companies find it difficult to take advantage of all the opportunities emanating from their investment

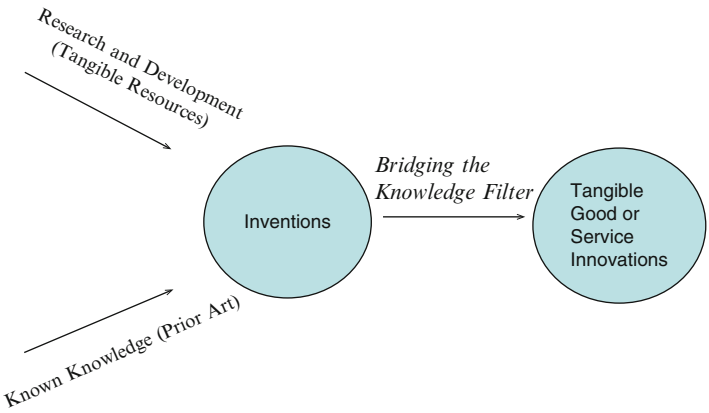

Fig. 2.1 The knowledge filter

in scientific knowledge (Christensen and Overdorf 2000). For example, Xerox's Palo Alto Research Center Incorporated succeeded in generating a large number of scientific breakthroughs (a superior personal computer, the facsimile machine, the Ethernet, and the laser printer, among others) yet failed to commercialize many of them and develop them into innovations (Smith and Alexander 1988; Chesbrough and Rosenbloom 2002). However, many incumbent firms have first-mover advantage, in that through their size and incremental innovation, they have the opportunity to acquire smaller firms, which tend to develop more radical innovations.

The knowledge conditions inherent in radical innovation impose what Audretsch et al. (2006a, b) and Acs et al. (2005) term *the knowledge filter* (see Fig. 2.1). The knowledge filter is the gap between knowledge that has potential commercial value and knowledge that is actually commercialized in the form of innovative activity. The greater the knowledge filter, the more pronounced the gap between new knowledge and commercialized knowledge in the form of innovative activity. An example of the knowledge filter which confronts a large firm is provided by the response of IBM to Bill Gates, who approached IBM to see if it was interested in purchasing the then struggling Microsoft. They weren't interested. IBM turned down "the chance to buy 10 % of Microsoft for a song in 1986, a missed opportunity that would cost $3 billion today."[2] IBM reached its decision on the grounds that "neither Gates nor any of his band of 30 some employees had anything approaching the credentials or personal characteristics required to work at IBM."[3]

Thus, the knowledge filter serves as a barrier impeding investments in new knowledge from being pursued and developed to generate innovative activity. In some cases, a firm will decide against developing and commercializing new ideas emanating from its knowledge investments even if an employee or group of

[2] "System Error," *The Economist,* 18 September 1993, p. 99

[3] Ibid.

employees think they have a positive expected value. As explained above, this divergence arises because of the inherent conditions of uncertainty, asymmetries, and high transaction costs, which created the knowledge filter. While Griliches' model of the knowledge production function focuses on the decision-making context of the firm concerning investments in new knowledge, Acs and Audretsch (1994), Audretsch (1995) proposed shifting the unit of analysis from the firm to the individual knowledge worker (or group of knowledge workers). This shifted the fundamental decision-making unit of observation in the model of the knowledge production function away from the exogenously assumed firms to individuals such as scientists, engineers, or other knowledge workers—agents with endowments of new economic knowledge. Shifting the focus away from the firm to the individual as the relevant unit of observation also shifts the appropriation problem to the individual so that the relevant question becomes how economic agents with a given endowment of new knowledge can best appropriate the returns from that knowledge. If an employee can pursue a new idea within the context of the organizational structure of the incumbent firm, there is no reason to leave the firm. If, on the other hand, employees place greater value on their ideas than the decision-making hierarchy of the incumbent firm, they may forgo what has been determined to be a good idea. Such divergences in the valuation of new ideas force workers to choose between forgoing ideas and starting a new firm to appropriate the value of their inherent knowledge.

Because radical innovative activity is based more on decisions involving knowledge and less on decisions involving information, it is accordingly more vulnerable to being impeded by the knowledge filter. By contrast, incremental innovation is based more on decisions involving information than knowledge and therefore is less vulnerable to being impeded by the knowledge filter.

By focusing on the decision-making context, which confronts the individual knowledge worker, the knowledge production function is actually reversed. Knowledge becomes exogenous and embodied in a worker. The firm is created endogenously in the workers' efforts to appropriate the value of their knowledge through innovative activity. Typically, an employee in an incumbent large corporation, often a scientist or engineer working in a research laboratory, will have an idea for an invention and ultimately for an innovation but will only act on the idea, or present it to the incumbent firm, if there is an expected return. Accompanying this potential innovation is an expected net return from the new product. The inventor would expect compensation for the potential innovation accordingly. If the company has a different, presumably lower, valuation of the potential innovation, the firm may decide either not to pursue its development or that it merits a lower level of compensation than that expected by the employee. In either case, employees will weigh the alternative of starting their own firm. If the gap in the expected return accruing from the potential innovation between the inventor and the corporate decision-maker is sufficiently large, and if the cost of starting a new firm is sufficiently low, the employee may decide to leave the large corporation and establish a new enterprise, such as the case with SAP.

The knowledge filter approach has important consequences concerning the role of policies. Particularly, Arrow (1962) identifies three types of market failure: those

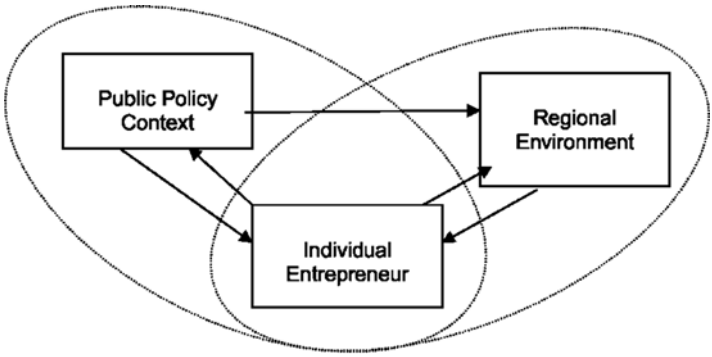

Fig. 2.2 The public policy/individual entrepreneur/regional environmental nexus. Source: Adapted from Feldman and Kelly 2001

associated with indivisibilities, inappropriability, and uncertainty. Public policies should try to correct for market failure associated with uncertainty, which demonstrates a problem with entrepreneurship. While in the classical knowledge production function approach, public policies are supposed to correct for failures in the market for the financing of innovation and for the positive externalities arising from the public good nature of R&D activities (which add to the stock of existing knowledge), according to the knowledge filter approach, public policies should also try to correct for the market failure associated with entrepreneurship Audretsch (2003) (see Fig. 2.2).

Such market failures might result in low levels of regional entrepreneurship capital that preempt scientists and other knowledge workers who perceive and recognize an entrepreneurial opportunity from actually pursuing that opportunity by starting a new firm and entering into entrepreneurship (not all regions, as a result of historical, institutional, and other reasons, are endowed with the same amount of entrepreneurial capital). Thus, public policies such as ATP and SBIR, but also regional and local policies, including science and technology parks and incubators, can serve to augment and enhance regional entrepreneurship capital, allowing companies, which require additional assets of capital, knowledge workers, or other missing ingredients, to develop their ideas into successful market innovations (more on this in Sect. 2.1.6).

Summarizing, when considering the different approaches, we have to recognize that each separate strand of literature focusing on technological innovation makes a distinct contribution to understanding the determinants of firm innovation. In particular, these different approaches to innovation suggest that four key units of observation are crucial in understanding the innovation process—the firm, the region, the individual, and the institutional/public policy context.

New-firm start-ups are important to innovation, because they embody a mechanism which facilitates the spillover of knowledge produced with one intended application in an incumbent corporation or university laboratory but which is actually commercialized by a new and different firm.

The individual matters to innovation because the individual scientists or engineers are confronted with a career trajectory decision—should they remain in a university