

2001 Award Winners

Zoltan J. Acs' and David B. Audretsch's Contributions to Entrepreneurship and Small Business Research ¹

Hans Landström*

"In their research they have provided empirical analyses of an impressive number of important questions concerning the role of small firms in the economy."

Introduction

The aim of this essay is to present the research of Zoltan J. Acs and David B. Audretsch, the 2001 FSF-NUTEK Award Winners. Only research within the area of the Award will be presented. The main focus will be on their joint work on the importance of small firms for innovation and technical change. The presentation starts off with an introduction to the Winner's career and continues with an overview of the most important research contributions.

Zoltan Acs and David Audretsch are two of the most prolific researchers within the entrepreneurship and small business field. Both jointly and individually they have published a considerable amount of scientific articles and books and have made a number of significant contributions in the area of small business economics. Their single most important contribution is perhaps the establishment of *Small Business Economics* as a high quality outlet for small business research.

Zoltan J. Acs

Zoltan Acs was born in 1952 in a refugee camp in Austria of Hunga-

rian parents after the war. His parents immigrated to America in the same year. He wanted to be an engineer, but ended up as an economist.

When I finished college I really wasn't sure what I was going to do, but I decided to go to graduate school. I was interested in the big social picture ... the issue of capitalism and socialism, and I went to graduate school at the New School for Social Research in New York City.²

His PhD thesis *Price Behavior and the Theory of the Firm in Competitive and Corporate Markets* was presented in 1979 at the New School for Social Research. In his thesis Acs examined the price behavior of the large steel companies. After his dissertation, he became more and more aware of the importance of small firms. He discovered that there were some small firms in the steel industry – "mini-mills" – that could compete with the giant corporations. The way they did it was through the use of innovative production technologies and innovative ways of organizing their companies. Following this discovery, Acs re-wrote three chapters of his thesis between 1980 and 1982, and a new book *The Changing Structure of the US Economy: Lessons from the Steel Industry* was subsequently published in 1984. In 1985 Acs left New York and moved to the University of Illinois and tried to plan his future.

"I tried to figure out the next step in my career. I needed a large research project in order to look more closely into the importance of technological change. I wrote a proposal to the Small Business Administration, which, I found out, was also involved in another proposal to study innovations and in the process of compiling a database for that purpose. I received funding from the University of Illinois to buy the SBA Innovation Database. So, I ended up with a database with which to study the change in the structure of the US economy, not only from one industry but from the manufacturing sector as a whole. In addition, we bought the US SBA Database ... so I was able to pool the two databases, one on

¹ This presentation covers Zoltan J. Acs' and David B. Audretsch's main contributions in the area of the importance of small firms in innovation and technical change until around the year 2002. The emphasis is on their joint work.

* Hans Landström is Professor at the Department of Business Administration, School of Economics and Management, Lund University. He has been on the Prize Committee since the inception of the Prize. He is the author of the book *Pioneers in Entrepreneurship and Small Business Research*, New York: Springer, 2005.

² The quotes in this essay come from interviews I conducted.

innovations and the other on small firms. Together with a database on industrial data that David [Audretsch] had got from the Federal Trade Commission, we had an incredibly rich data set.”

It was thanks to these databases that Acs and Audretsch subsequently accomplished their pioneering work on the importance of small business for innovation and technical change. In 1989 Zoltan Acs moved to the University of Baltimore. His research interest changed in more or less the same direction as that of David Audretsch, and during the 1990s he focused his attention on the regional aspects of innovation, and more specifically the importance of cities.

Zoltan Acs was a research fellow at the US Bureau of the Census from 1988 to 2001. There he had access to the microdata of the Longitudinal Establishment and Enterprise Database. Together with Catherine Armington he examined the impact of entrepreneurship and geography on economic growth in a series of studies. In 1992 Zoltan Acs became the Dorris and Robert McCurdy Distinguished Professorship of Entrepreneurship at Merrick School of Business, University of Baltimore, USA.

David B. Audretsch

David Audretsch, born in 1954, comes from an American middle-class one. After graduation from college at Drew University in Madison, New Jersey, in 1976 he went to graduate school at the University of Wisconsin. His interest in the large corporations was reflected in the thesis *The Effectiveness of Antitrust Policy towards Horizontal Mergers* in 1980, which was an evaluation of an anti-trust act from the 1950s that gave the Federal Trade Commission the power to prevent horizontal mergers. This anti-trust act was amended in the early 1970s and Audretsch empirically calculated the costs and benefits of this policy change.

After his PhD Audretsch became Assistant Professor at Middlebury College in Vermont. In 1980 Zoltan Acs arrived at Middlebury as Assistant Professor in Economics after his graduation at the New School University.

”Zoltan Acs and I became friends, we talked a lot about economic issues, what was going on in the world ... but most of all we were friends, we hiked in the mountains, played basketball ... we had a great time.”

Zoltan Acs left Middlebury College in 1982 but visited the school frequently, while David Audretsch stayed there until 1985. In 1984 he spent a summer in Washington D.C. to work for the International Trade Commission.

”When I was in Washington D.C. I met Joanne, my wife ... but she was on her way to Paris. I realized that Vermont was a long way from Paris. It should be added that my thesis advisor, Leonard Weiss, received a request from the International Trade Commission to write a recommendation for me. He quickly sent me a letter pleading me to stay in academia and not leave for government. Instead he suggested that I should go to the International Institute of Management in Berlin, where I could do research. I knew that Berlin was much closer to Paris than Vermont. So I went to Berlin. It was shocking ... I was 29 years old, had never been outside the US, except for Canada.”

At the International Institute of Management in Berlin they quickly offered Audretsch a two year research contract, and in 1985 he started to work on a project on how concentration and market power influenced performance in mature industries compared to new industries. He stayed in Berlin for 13 years at the International Institute of Management in Berlin, which was subsequently known as the Wissenschaftszentrum Berlin für Sozialforschung.

Both David Audretsch and Zoltan Acs have remained highly prolific researchers throughout the last decade of the 20th and the early years of the 21st century, both jointly and individually.

Contributions

Since the 1980s, Zoltan Acs and David Audretsch have been two of the most productive research scholars in the area of entrepreneurship and small business research. They have published several hundred scientific articles, books and reports jointly, individually or in collaboration with other researchers. It is virtually impossible to survey their entire output. For this reason, I have chosen to concentrate on their joint seminal research on innovation and small firms. First, I will present Acs and Audretsch's pioneering work in the book *Innovation and Small Firms*, published in 1990. Then follows a review of some of their joint research papers during the late 1980s and 1990.

Innovation and Small Firms

For a long time most research on innovation and technological change was based on the “knowledge production function”, originally formulated by Zvi Griliches in the article “Issues in assessing the contribution of R&D to productivity growth” (1979) where he argues that innovative activities are based on new economic knowledge. The knowledge production function assumes that the majority of industrial R&D is undertaken by the larger companies, and according to conventional wisdom large firms are the engine of technological change. There is substantial evidence that investment in R&D is positively related to firm size (Cohen and Levin 1989).

In the book *Innovation and Small Firms*, Acs and Audretsch base their reasoning on the paradox that small businesses more and more are the drivers of the economy at the same time as technological change appears to require the investment of large resources in R&D to an increasingly greater extent in order to exploit the global market – something that ought to benefit large companies. This raises an important question: What is the role of small businesses in innovation and technological change? The book concentrates on this issue, which represents the area where Acs and Audretsch have made their greatest empirical contributions.

Their contributions are twofold: First, a methodological contribution – experience from earlier research showed that innovation is not an easily measured activity and research so far mainly examined the innovative activity of relatively large firms. Zoltan Acs and David Audretsch developed a more direct measure of innovative output and used a new database developed by the US Small Business Administration, which also included data on innovative activities by small firms. Second, they contributed to our understanding of the role of small firms in the changes brought about by innovation and technology in different industries.

Methodology – New Measures of Innovation and a New Database

In order to empirically estimate the knowledge production function, it became evident that measurement issues played a major role, and that the state of knowledge within the area had been shaped by the nature of the data available to scholars for analysis and typically involved one of three major aspects of the innovative process – aspects that have evolved over time (Acs and Audretsch 2003):

– The early attempts to quantify technological change in the late

1950s and early 1960s involved measures of the input into the innovative process, notably R&D expenditure or the share of the labor force involved in R&D activities.

- Intermediate output, such as the number of inventions patented which were publicly available by the mid 1960s.

- In the 1970s attempts were made to provide a direct measure of the innovative output, for example, using a panel of experts who identified innovations representing significant new products and processes that had been successfully commercialized.

These measures were not without limitations. The use of R&D activity as an indicator of technological change merely takes account of the resources devoted to innovation but not the actual amount of innovative output, while the use of patented inventions is also no indicator of innovative output, nor does it reveal whether or not the knowledge generated has a positive economic value. In addition, not all innovations are actually patented.

Thus, such measures are associated with a range of problems. Acs and Audretsch's pioneering contribution meant, among other things, the development of a means of measuring innovation that quantifies the number of innovations introduced on the market at a certain point in time.

Another methodological problem encountered in previous research was the lack of data on small businesses. Acs and Audretsch utilised a new database developed in the US during the 1980s. The US Small Business Administration's Innovation Data Base (SBIDB) consists of 8,074 commercial innovations introduced in the US in 1982. The Futures Group, a private firm, compiled the data for the US Small Business Administration by examining over one hundred technology engineering and trade journals listing innovations and new products. The database made it possible to distinguish between data from large and small businesses (< 500 employees). In their research, Acs and Audretsch have utilized and developed this database in a robust way.

Results

By their systematic research and robust use of methodology, Acs and Audretsch in many respects clarify and erase a number of question-marks in earlier research. Their results can be summarized as follows:

- The contribution of small businesses to technological change in society is significant but there seems to be no single firm size that is optimal. While large companies are launch more innovations than smaller ones, when related to the number of employees, the situation is reversed. Moreover, the importance of small and large businesses in terms of innovative activity in different industries appears to differ. In some industries small companies are more innovative, whereas in others large companies account for technological change. Large businesses tend to have some advantages in capital intensive industries characterised by strong concentration.

- In manufacturing the number of small companies varies dramatically across lines of business. Not surprisingly, there are few small companies in capital intensive lines of business with high R&D intensity and where there are sizable economies of scale.

- The relation between an industry's level of innovation and new firm formation is complex. Even if the start-up rate is high in technological environments that promote the innovative activities of small businesses, the results show that both the total innovative ac-

tivity and the R&D intensity of an industry have a negative impact on start-up frequency.

- Several studies have shown that small businesses often exhibit a higher growth rate than larger ones. Is the growth rate of a company dependent on its size? The answer seems to be no; in at least two thirds of all industries small and large businesses grow at a similar rate. While small businesses appear to have a higher growth rate, they also have a tendency to exit the industry more rapidly. In most industries these two tendencies offset each other, which is why small businesses do not exhibit a higher growth rate than large companies at an aggregate level.

- The study indicates that the knowledge on which innovations are based is of great importance for the dynamics of an industry. If the innovative activities are primarily dependent on knowledge accumulated through experience within the industry, incumbents will have an advantage in terms of innovation, thus making the industry less attractive to new companies. When few companies are established in the industry, relatively few companies will fail or exit, leading to low dynamics. On the other hand, if knowledge is mainly generated outside the industry, the industry will be accessible to new companies. However, this does not mean that these new companies will survive within the industry. Innovation is an ongoing activity and learning is critical for its success.

Acs and Audretsch's Research during the Late 1980s and Early 1990s

Zoltan Acs and David Audretsch's results have also been published in a number of journal articles. Some of the most often cited works in their joint production are summarized below. It should be mentioned that the majority of these works are based on the same data as the above-mentioned book. In some cases the contents are similar, while in other cases the articles constitute a further refinement and test of the reasoning presented in the book.

Schumpeter (1942) argued that large companies are primarily responsible for the innovative activities in a society and even more so in industries where competition is limited, i.e., where high entry barriers can be expected. Acs and Audretsch (1987) attempt to test these two assumptions. In contrast to Schumpeter's first assumption, the results show that, generally speaking, large companies are not more innovative than smaller ones. Hence, the relevant question is not which firm size is the most innovative but "Under what conditions have small and large companies an innovative advantage?" The authors concluded that within manufacturing, large companies appear to have some innovative advantages in sectors where competition is limited, while small companies enjoy similar advantages in sectors more exposed to competition, which lends support Schumpeter's second assumption.

In another frequently cited article "Innovation in large and small firms" (1988), Acs and Audretsch continue the discussion on the impact of industry structure on innovative activity. The results show, among other things, that the total number of innovations in an industry is negatively related to industry concentration but positively related to the intensity of R&D, the ratio of skilled employees and the proportion of large companies. An interesting observation is that industries with a high share of large companies exhibit more innovative activity despite the fact that it is mainly the small businesses that are responsible for this activity. A possible explanation is

that where an industry is dominated by large companies, the small companies will have to be innovative in order to survive.

The majority of start-ups are very small – in most cases too small to survive within the industry. Another question that Acs and Audretsch were interested in was: Why are companies started, whose size is disadvantageous and how can they still survive? Audretsch and Acs (1990; Audretsch 1991) find that the technological preconditions prevailing within an industry determine the ease by which newcomers can innovate and establish themselves within the industry. In situations where industry experience is crucial for the innovative activity, few firms will enter and few of the existing companies will therefore be squeezed out. The result is limited industry dynamics, or what Audretsch and Acs define as a “routinized regime”. Conversely, when external knowledge is crucial, there are more new start-ups, leading to increased industry dynamics, which the authors term an “entrepreneurial regime”. This indicates that many firms of suboptimal size are set up in cases when innovations can be generated based on external knowledge.

A reason for the survival of these firms can be found in their learning strategy. Even if the companies tend to be below optimum size, they can survive and grow by continuous learning and adaptation. Many of the new firms will of course fail, resulting in comparatively high industry dynamics. The results indicate that industry dynamics are positively related to the possibility for new entrants to become successful at the same time as less successful companies are forced to close down. Another finding was that the dynamics of small firms – as opposed to large firms – is greater in capital intensive industries. Small firms that are successful tend to flourish and grow, whereas less successful small companies are usually squeezed out. On the other hand, the dynamics in large companies are low, in most cases due to a greater accumulation of experience in these companies.

The entry of new companies into an industry often leads to increased dynamics and growth. What is it, then, that encourages new companies to enter an industry? In a number of articles (Acs and Audretsch 1989a, 1989f), Acs and Audretsch have described how the start-up differs in some respects between large and small businesses. All companies, irrespective of size, appear to be attracted by a high growth rate in an industry. However, contrary to what one might expect, high capital intensity does not deter companies from entering an industry whereas high R&D intensity and market concentration tend to do so in the case of small firms. On the other hand, small businesses tend to establish themselves in industries that are not dominated by small firms.

In subsequent studies (Audretsch and Acs 1994), Audretsch and Acs focus on start-ups in different industries, which they believe are largely influenced by both macroeconomic and industry-specific conditions. For example, macro economic growth appears to act as a catalyst for the establishment of new firms, and start-ups are also stimulated by low capital costs and a high rate of unemployment. The results also indicate the importance of universities for new firm formation, as industries where academic research is important and where small firms in general tend to be innovative constitute a good breeding ground for start-ups. The authors conclude that new businesses mainly fulfil the requirements of the “creative destruction” described by Schumpeter (1942), where start-ups introduce new products as a result of a high level of innovative activities as well as reemploying people who had become redundant in the former companies.

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