1.1.4 Star scientists: A virtuous circle of science and business creates new industries

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Abstract

From the perspective that basic research—the source of scientific and technological innovation—has a strong impact on society and the economy, a key point is to focus on the “stars” who excel in various aspects, from scientific discovery to technological development. In this paper, we review the research surrounding star scientists, which has mainly been conducted in the US, and compare it with the current situation in Japan to provide an outlook for the future. Research on star scientists can be used in the design of science, technology and innovation policies from two perspectives, namely, how to nurture and utilize stars.[3]

Keywords

Star scientist, basic research, university startups

1 Introduction

Just as the source of innovation lies in “science,” so the wellspring of science lies in “basic research.” It is scientists who are responsible for basic research. The scientific knowledge generated from scientists’ research activities leads to innovation, impacting society and the economy. In respect to creating a strong

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impact on society and the economy in particular, it is key to focus on the “stars” among the scientists who excel in various aspects, from scientific discovery to technological development. Research on star scientists can be used in the design of science, echnology and innovation policies in two ways, namely, how to nurture and utilize stars.

2 What is a star scientist?

There are many different criteria for evaluating a scientist, including the number or quality of papers published. The quality of the paper refers to it having a large number of citations (i.e., the number of references in academic papers, patents or non-patent documents) or being published in a top-level academic journal. Of course, this is reflective of academic value, which does not necessarily correspond to socioeconomic value in the sense that they have some sort of impact on society and the economy. For example, the socioeconomic value of a paper can be said to depend on whether it has led to a patent or not, and in turn, whether it has resulted in a valuable patent. Nonetheless, good academic results often lead to good patents, and academic value can be said to correlate with socioeconomic value in such cases.

Here, scientists with outstanding achievements are referred to as “star scientists”—that is, researchers who stand out from ordinary scientists in a number of ways, including the number of papers published, citations, and, by extension, patent applications. As a result of these efforts, they have received awards from academic societies or hold key positions in prestigious societies, which is also testament to their star power. This also includes educational contributions, such as educating doctoral students and postdoctoral fellows who stand out from ordinary scientists. As such, there are various aspects to being a “star.” A “star” cannot necessarily be defined. As shown above, there are various possible criteria for evaluating scientists, and the meaning of “star” will vary depending on which criteria are used.

Among the pioneers of star scientist research are Professors Lynne Zucker and Michael Darby at the University of California, Los Angeles. They have created a large database by combining data from papers, patents, and local companies to quantitatively identify the characteristics of star scientists and their impact on industry from various perspectives, one of which is a geographical perspective (Zucker et al., 1998). Focusing on the biotechnology field between 1976 and 1989, the authors identified 327 researchers who made discoveries involving gene sequencing as “star scientists,” and then analyzed the relationship between them and biotechnology startups from several perspectives. More specifically, they analyzed the geographic distribution of star scientists and startups and found that where there are star scientists, there are clusters of startups. This suggests that there is some correlation between the distribution of star scientists and the concentration of startup companies.

The second point is the startup performance perspective (Zucker et al., 2002). After discussing (1) patents, (2) products under development, and (3) products launched on the market as indicators of startup performance, they provided a general view of these indicators and (1) star scientists, (2) top research universities in the US (not necessarily star scientists), and (3) venture capital. They concluded that startup firms with more papers co-authored with star scientists also perform better, that firms generally perform better as they co-author more papers with top research universities, but not as well as when they co-author with star scientists, and that venture capital investment leads to better performance, although it has less impact than the other two factors. This suggests that co-authorship with a star scientist is the most influential factor in the performance of venture firms.

Zucker and Darby (2007) examine the impact of star scientists' involvement in startups on their research performance, findings that a star scientist's involvement in a startup improves researchers' performance. More specifically, they analyzed differences in the performance of star scientists in biotechnology who had been involved in startups (i.e., co-authored papers with or in which they had held positions). They identified a total of 207 star scientists in the biotechnology field in the US, of whom 69 had some form of corporate affiliation. Moreover, fifty-seven had co-authored papers with companies, while another twelve positions as scientific advisors or founders in startup companies. In terms of the number of articles and citations per paper per year, the average number of papers and citations per paper for star scientists with no connection to companies was found to be 1.67 and 13.15, respectively, while the average number of papers and citations for star scientists with some connection to startup companies was 2.53 and 22.52, respectively, thus revealing a clear difference.

Furthermore, among star scientists with some kind of relationship to startup companies, there was no significant difference between those who had only coauthored papers and those who had coauthored papers and held some kind of position in the venture company. The average number of published papers was 2.54 and 2.53, respectively. However, in terms of the number of citations, the former was 20.74, while the latter was significantly higher at 31.39. This suggests that the number of papers (quantity) and the number of citations (quality) are both larger for scientists involved in startup companies, and that the quality of research is higher for scientists who hold some kind of position and are more directly involved in startup companies. Additionally, time-series analysis revealed that research performance improved once a star scientist became involved.

Based on the foregoing, Zucker and Darby (2007) suggested a relationship of "virtuous circles in science and commerce" (Figure 1), in which research performance and corporate performance increase when star scientists and companies are in some way involved.

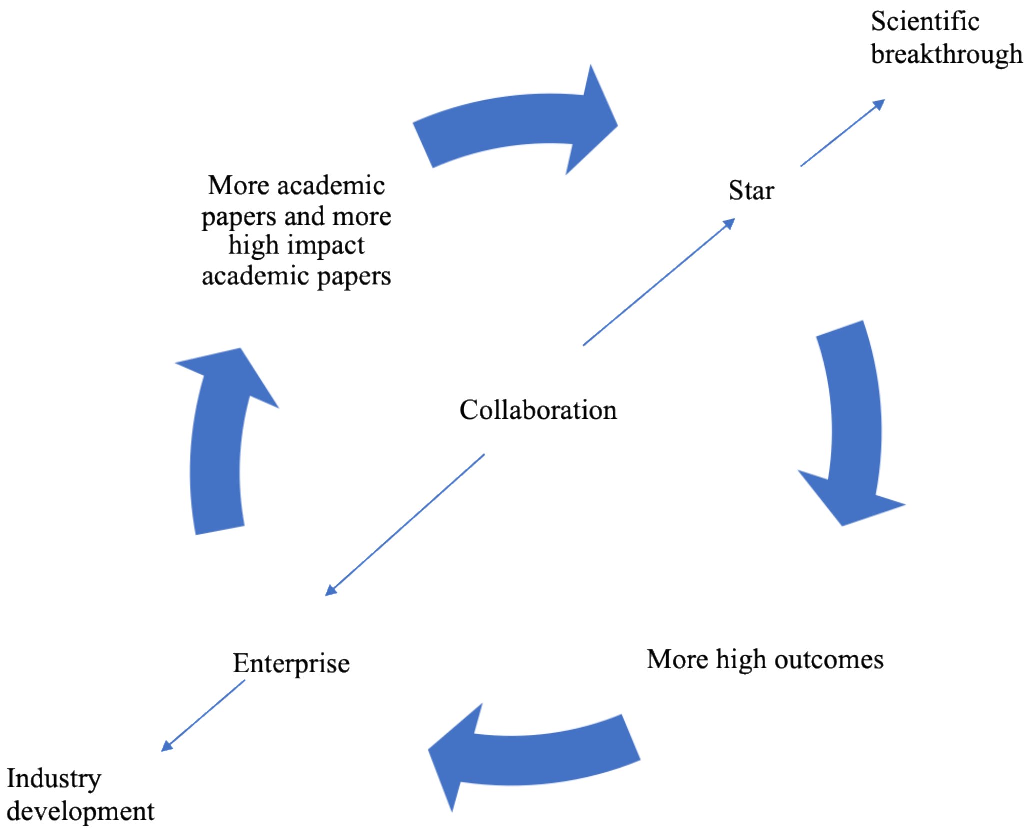

Figure 1. Virtuous circles in science and commerce.
Source: Reproduced from Zucker and Darby (2007); translated by the author.

3 Implications for Japan

The results presented in the previous section are based on temporal, country, and sectoral constraints primarily applicable to the 1970s and 1980s, the US, and the life sciences sector. Is this "virtuous circle in science and commercialization" really a universal phenomenon shared by all countries?

Zucker and Darby (2007) also conducted an international comparison of the biotechnology sector in the 1970s and 1980s. According to the results, the distribution of star scientists by country shows that the US ranks first with 50.2 percent, followed by Japan with 12.6 percent. The percentage of stars with corporate ties is 42.3 percent in Japan, compared to 33.3 percent in the US.

When focusing on the connections of star scientists with companies, studies have shown that were significant differences between Japan and the US in terms of industry-academia collaborators in the 1980s (Zucker and Darby, 2001). In the US, the majority of companies with which star scientists collaborated were startup companies, while in Japan, they were large corporations. One of the reasons for this is that the establishment of startup companies was very popular in the US, while there were few startup companies in Japan at the time. Therefore, the recipients on the industrial side, who transfer the knowledge generated from research results produced by scientists, differ according to the particularities of each country. In any case, what is important is the transfer of knowledge to the appropriate partner on the industrial side in order to put the research results produced by scientists to practical use.

An international comparison of the distribution of star scientists provides a new perspective on industry-academia collaboration in Japan. In the Japanese policymaking field, Japan's industry-university collaboration tends to be viewed as lagging behind that of the US, but this is not necessarily the case—at least, not in the field of biotechnology in the 1970s and 1980s.

4 Other star scientist studies

While Zucker and Darby's research focused on the impact of star scientists on industry, others have focused on their impact on the academic world. Azoulay et al. (2010) empirically demonstrated the spillover effect star scientists had on the researchers around them with a very novel idea. Indeed, researchers tend to gather around a star scientist and form a group. While star scientists exhibit a high research performance, the researchers around them also have higher research performance (i.e., number of publications and citations) than other researchers. In other words, groups tend to form centered around a star scientist, and there appears to be a boundary between the inside and outside of such groups. Such groups are called "invisible colleges."

Of course, being in the vicinity of a star scientist and exhibiting a high research performance among researchers is a correlation, not a causal relationship. There are two possible hypotheses to explain the correlation. Hypothesis 1 holds that the researchers who gather around the star scientist are excellent by nature. In other words, because you are excellent, you will be recognized by the star scientist and have more chances to collaborate with them (i.e., be in the vicinity of the star scientist). Hypothesis 2 holds that star scientists have a positive impact on the researchers around them, such that the researchers around them become excellent.

Which hypothesis is supported? Azoulay et al. (2010) approached this question using the natural experiment method. Making a list of star scientists who died suddenly and accidentally, they examined how the performance of the researchers around them changed before and after the accident. Sudden accidental death is truly an exogenous factor, and it is hard to believe that it is caused by some causal factor. Taking this point, if the sudden disappearance of the star scientist caused a change in the performance of the researchers who were in the vicinity of the star scientist, we can conclude that the excellence of the researchers in the vicinity was not due to the inherent ability of the researchers, but because the star scientist had some influence on them. The result was that as soon as the star scientist disappeared, the research performance of the surrounding researchers declined. As such, Hypothesis 2 was supported, suggesting that star scientists have a positive impact on their surroundings.

How does a star scientist influence the researchers around them? That is, in what ways is a star scientist involved in the invisible college described above? The first theory is reflected by the idea of "spillover" from the star scientist. Star scientists always have new research ideas, which makes it easier for the researchers around them to come up with new research topics. The second theory is that a star scientist will act as a "gateway." As the star scientist is the hub of the community, it is likely that being in their vicinity will encourage researchers to meet one another in new ways and write papers together. A third theory points to the accessibility of research resources. Star scientists have a lot of resources, so being around them will make it easier to access resources, including research funding. The fourth theory claims that star scientists may be more likely to have their papers accepted because they have more influence over the peer review process. A similar mechanism, and a fifth theory, is that this makes it easier to pass scrutiny for research grants. Testing each of these hypotheses, Azoulay et al. (2010) concluded that only the spillover of ideas provides value to star scientists' invisible colleges.

Of course, there are still issues to be addressed. For example, even the term "star scientist" can be misleading if treated as a catch-all term. In the US, there is a common understanding that one should avoid selecting a postdoctoral fellowship from the office of a Nobel Prize-winning professor. The implication is that young researchers working under a Nobel Prize-winning star scientist will be used to support the star scientist's ongoing research activities, and not get a chance to write a paper as the lead author (i.e., the main contributor). Essentially, star scientists vary, and it is possible that there are "good star scientists" and "bad star scientists." In light of this possibility, it may be necessary to classify the characteristics of star scientists.

In this regard, Oettl's (2012) study extends the traditional concept of the star scientist and takes into account values besides research productivity. In this paper, we have added a new dimension to the assessment of scientists' performance in order to clarify the mechanisms by which scientists influence the productivity of other researchers. While the traditional classification of scientists relied on publishing productivity, Oettl (2012) considered a new social dimension: whether they help other researchers, that is, helpfulness. As a proxy indicator, they measured whether a name appeared in the acknowledgements in the paper. The impact of high helpfulness on surrounding researchers was clarified by analyzing changes in the co-authors of papers by helpful scientists who suffered accidental deaths. The results showed that co-authorship with a very helpful (deceased) scientist reduced the quality of output, while the death of a less helpful but highly productive scientist did not affect co-author output.

5 Issues for the future

Led by Lynne Zucker and Michael Darby, star scientist research is beginning to take on new dimensions. However, there remains a lack of such research in Japan. Although Zucker and Darby's study includes Japan, it primarily focuses on the 1970s and 1980s, and does not consider the phenomena after the 1995 Basic Act on Science and Technology—an important turning point in the history of Japan's national innovation system.

What makes a scientist a "star" and how do we classify the types of stars? What kind of image of a star scientist emerges as a result of examining various perspectives? How much of an impact can they have on society and the economy? These are issues in themselves for star scientist research. To answer these challenges, we need a large database that combines a variety of information, including star scientists' research activities and their connections to companies, as well as company performances and their impact on the region, as constructed by Zucker and Darby, spanning a wide range of time, countries, and fields. This is a pressing issue for the promotion of star scientist research in Japan. The creation of such a database will make it possible to clarify the impact of star scientists on the industrial and academic worlds, including the mechanisms of their knowledge production activities, the mechanisms of their scientific knowledge transfer, and the mechanism by which transferred scientific knowledge impacts society and the economy. Evidence gathered from such studies can be used in the design of science, technology and innovation policy.

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Related data sources

- Connecting Outcome Measures in Entrepreneurship, Technology, and Science (COMETS) (http://www1.kauffman.org/comets/9
- Nanobank (http://www.nanobank.org/)
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Information on related base course subjects and research projects

- National Graduate Institute for Policy Studies “Science and Technology and Entrepreneurship”
- JST-RISTEX “Star Scientists and Innovation in Japan” Project

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