

Motivation for Scientific Research in the Private Sector

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Article

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ABSTRACT

This paper introduces a model to understand the motivation of companies to conduct in-house scientific research activities. It takes into account both direct profit-maximizing objectives and other indirect ones. To build a full picture, the paper looks closely at the different sources of knowledge in companies then justifies why companies need to produce and publish new knowledge. The main premises of the model is that companies perform basic research to be part of the scientific community. The paper ends by shedding light on the private sector knowledge production in the age of Open Innovation.

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BACKGROUND INFORMATION

The traditional argument for why government intervenes in the scientific enterprise has been that the private sector has no interest in conducting research outside the scope of creating or enhancing marketable products (*Nelson, 1959*) (*Arrow, 1962*). Because increasing the body of knowledge is essential for the whole society, an inefficiency occurs and investment in scientific research is lower than what is socially optimal. This dominated the post-World War II science and technology environment and led to the dominance of government grants in the research funding landscape. This changed gradually. By the 1980s, almost half of the Gross Domestic Expenditure of R&D (GERD) in many countries came from industry. The ratio for some countries is even higher nowadays. In several advanced economies industrial R&D constitutes about two thirds of GERD (*OECD, 2015*). In principle, this increase in private sector's share of GERD can be attributed to (1) lower investment by governments due to changing focus in budget allocations, (2) increasing emphasis on applied research at the expense of basic research or (3) the emergence of new incentives for the private sector to invest in scientific research. The first two possibilities are not the focus of this paper and might prove to be very difficult to validate. The third one, however, is the main topic of this paper.

This paper introduces a model to understand the motivation of companies to conduct in-house scientific research activities. It takes into account both direct profit-maximizing objectives and other indirect ones. The model is based on surveying previous scholarly literature on private sector R&D. It tries to integrate the outcomes of different studies into a simple, concise framework. The paper has three sections. The first one introduces and describes the model. Then the second section discusses

knowledge creation channels at the company. Finally, the third section examines the model's implication on the issue of open innovation.

MODEL DESCRIPTION

In trying to understand the motivations of companies to perform basic research, the following model was constructed based on understanding the contributions of many experts in the field (*Hicks, 1995*) (*Rosenberg, 1990*) (*Merton, 1957*) (*Nelson, 1992*) (*von Hippel, 1987*) (*Sneker, 1994*). In the figure below, the main values resulting from private sector R&D are shown in boxes. Meanwhile, "spillover" kind of values are shown in oval shapes. They are considered to be externalities that come along with the main outcomes.

Ideally, companies do applied and development research to make their products better and introduce new ones. They also do basic research just to be part of the scientific community (for reasons explained here). In this case, profit-making (i.e. appropriable) results from basic research are considered an externality as they were essentially "unplanned for". These possibly appropriable results take the following forms:

- unexpected breakthroughs which signal the potential for new products or processes, in which case they can be patented
- better understanding of the fundamental principles behind the already existing products or processes
- Advantages related to having a head start in untapped areas of research (e.g. technical ability, setting standards...etc.)

A very significant process that comes after a successful basic research project is the decision on whether or not

to publish the results. Publication is commonly done in academia either by writing articles for scholarly journals or by giving presentations in technical conferences, or both.

At this stage, companies have the three options. They can file a patent, in which case they will effectively be publishing every single detail of the discovered technology, in return for time-limited monopoly rights. They can consider the technology a trade secret. Or, they can publish in a scholarly journal, which allows them to build credibility as performers of high quality research, while keeping important know-how in private within the company. In general, research papers include much less technical details than patent application. An interesting observation in this regard is that the decision on what to make public and what to keep private lies is based completely on the company's discretion. Nothing intrinsic to the produced knowledge itself (basic/applied) forces this selection. It is the company's own decision. Based on this understanding, we see that any knowledge resulting from scientific research can be classified into one of these three categories:

- published information (what the company decides to make public)
- publishable, but not published information (what the company keeps secret)
- unpublishable (tacit) knowledge gained during the research activity itself

All three categories of information are very important to the company. The first one is particularly so because it helps in building the company's reputation (in the academic and technical community) as a contributor of high quality research. The production and possession of knowledge (and the reputation thereof) then become the currency used by the company to negotiate collaborative research arrangements or when it tries to recruit high quality research staff (who guarantee the production of even more knowledge to barter with).

In addition to it being a tool for building reputation and attracting talent, publishing also has some extra "spillover effects". One example is that it can be used to satisfy administrative requirements as is the case with pharmaceutical companies in Japan (who have to publish before putting a new drug on the market). In addition, some research has shown that publishing company R&D results can be driven by individual researchers working in the company. It is a very good way for them to build portfolios, especially in markets with high labor mobility (where researchers have the option to return to academia if they want).

Although the discussion here is mainly concerned with the company's reputation within the scientific community, it can still resonate in the wider society. Companies can make use of this reputation to build trust with its consumers and attract new ones based on claims (of the safety, durability

...etc.) of its products.

SOURCES OF KNOWLEDGE FOR THE COMPANY

The model described above justifies why companies need to produce and publish knowledge. However, such knowledge is not produced out of thin air. Companies need to develop ways to build (and maintain) a solid knowledge base that will enable it to further produce good research. The argument in this section is that companies cannot operate alone in building this knowledge base.

We begin the discussion by the traditional source of knowledge creation in the company. That is "in-house" R&D. Probably the most direct argument in support of having a research facility in-house is the need to develop the company's absorptive capacity (*Cohen Levinthal, 1990*). Both the amount of prior knowledge the company has and the diversity of such knowledge increase its ability to exploit other sources of knowledge (including those discussed below). Even at times when the independent research organizations were thriving, evidence has shown that companies without internal research facilities could not make the most benefit from contracts with those organizations (*Mowery, 1983*). Also, research activities are thought to have lower cost if organized internally than if bought on the market. This is of course not to mention the main benefit of producing knowledge that the company considers "its own". This can in turn be used as an "exchange currency" to barter with in the pursuit of acquiring more knowledge (as mentioned above). It can also be a "ticket of admission" to networks of potential partners, to borrow Rosenberg's expression (*Rosenberg, 1990*).

Other sources are borrowed from a survey developed by the Japanese National Institute for Science and Technology Policy (*NISTEP, 2013*). In its Survey on Research Activities of Private Corporations in Japan, NISTEP attempts to provide a comprehensive list of "external" knowledge sources for companies. This paper borrows from that list but groups the ten possible sources used into fewer categories. First is the category of companies in the same sector. These include:

- Suppliers: Knowledge can be acquired in an embedded form, included in the parts/machines the company buys from them.
- Consumer companies: Knowledge comes in the form of guidelines or standards which the company's products and processes should meet.
- Competitors: There are three channels for knowledge transmission in this case. One comes with the reverse-engineering of competitor products. The other one is when competitors join together in research consortia to develop early phase technologies before they get into prototyping. The third form of knowledge is that shared among competitors within their industrial associations and unions (e.g. in developing industry standards).

Companies outside our company's sector can also be very essential sources of innovation. In this case the company is viewed as "buying" innovation on the market. This category includes:

- Consultancies: These are temporarily "hired" by the company to provide advice on solving technical issues or improving existing techniques.
- R&D Services companies: The company usually deals with them on contractual basis, whereby the service provider is commissioned with a certain task and allowed the necessary time and money (and other resources) to deliver it.
- Start-ups: This is probably the most comprehensive process of "buying" knowledge. In this case, the company acquires the start-up and consequently all of its knowledge base (both codified and tacit) becomes the company's property.

The last category of sources of knowledge for the company includes the main producers of knowledge in society, Universities and Public Research Institutes (Uni/PRI). Gaining knowledge from these can be a very challenging task for the company, but is also very rewarding because it puts the company at the cutting edge of research. Collaboration with Uni/PRI can take several forms. Among the most common is collaborative research projects. Uni/PRI can also perform contract research for the company. Training is also a common form, where students from Uni/PRI can do internships at the company, or the company's research staff can take periods of training at a Uni/PRI laboratory. There are also indirect ways by which knowledge can transfer to the company from Uni/PRI. Access to research articles published by Uni/PRI around the world is definitely a great way to build the company's knowledge base. However, it is important not to forget that the most significant stream of knowledge flow between Uni/PRI and company is the graduates and researchers who get their education there then join the company as research staff.

IN CONTEXT OF OPEN INNOVATION

Open innovation is a new concept first promoted in the early 2000s (*Chesbrough, 2003*). The eminent review of literature in this field (Dahlander Gann, 2010) have categorized four types of "openness". This section attempts to test whether the model introduced above can account for these commonly accepted modes of building the company's knowledge base. Among the four types, two are outbound, whereby the knowledge from inside the company disseminates to the wider society.

- The first is the obvious "selling" of products that the company does. The model proposed in this paper accounts for this type under the appropriate results of research which is one externality of conducting basic research.
- The second one is the "revealing" type of

dissemination, whereby the knowledge flows outside the company but with no financial return. This is accounted for in the publishing of scientific articles and participation in scientific conferences for the reasons mentioned above.

The other two types are inbound. They account for the ways by which the company acquires knowledge from outside its boundaries.

- The first one is "sourcing", where the company is able to exploit knowledge found outside of it but outside of the market mechanism. In the model above, this happens when the company participates in research collaborations with different actors (Uni/PRI, research consortia) or if it has enough absorptive capacity to utilize publicly available information (like journal articles).
- The last type is "acquiring". This one is when the company uses market mechanisms to widen its knowledge base. This can be through direct acquisition of startups, mergers with competitors. It can also be through buying R&D services from specialized companies or consultancies.

CONCLUSION AND FUTURE OUTLOOK

Although companies performing basic research is a recent, "reborn" phenomenon, it has gained a lot of attention from experts in Science, Technology and Innovation (STI) studies. This paper has introduced a model to simplify the body of research about why companies conduct basic research. It made the distinction between real values and processes on the one hand, and accompanying externalities on the other. The main premises of the model is that companies perform basic research to be part of the scientific community. This provides the company with a strong foundation of knowledge (both internal and external) which is then utilized to continue the development of its products and production processes, as well as to introduce new ones. The paper also attempted to show that such a model can be applied within the framework of open innovation.

From a theoretical point of view, private sector R&D is a very interesting field of research. In our modern knowledge economy, traditional notions about knowledge and its production and utilization no longer hold. Despite this, researchers in STI are yet to establish a theory for knowledge in the modern day economy. Such a task is tremendous and it is common sense that a multidisciplinary approach needs to be taken to perform it. Contributions from other disciplines like the philosophy of science and sociology of science should be included. Concerning the specific topic of this paper, future studies should try to develop an even wider model to include all research activities of companies (not only basic research as in this paper). If such a model is developed, a much better image will emerge about modern-day companies and their role in the knowledge economy.

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الملخص العربي

دوافع البحث والتطوير في القطاع الخاص

الحسن الصبري

شركة مراقبة للبحث العلمي و الاستشارات الإدارية

هذا البحث يستطلع الجهود السابقة عن دوافع إنتاج المعرفة في القطاع الخاص، ويقدم نموذجاً تفسيرياً لفهم هذه الدوافع الربحي منها وغير الربحي ويوضح النموذج أهمية دخول باحثي الشركات أوساط الأكاديميين وكون البحث العلمي (داخل الشركة) هو الوسيلة لتحقيق ذلك وأخيراً يعرض البحث المصادر المختلفة للمعرفة بالنسبة للشركات ويضع الإنتاج المعرفي للقطاع الخاص في سياق الاتجاه العام الجديد نحو الابتكار المفتوح.