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An examination of the antecedents and implications of patent scope

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ABSTRACT

This paper focuses on the concept of patent scope, and contributes to existing research in three ways. First, it offers a re-examination of the construct and identifies two dimensions of patent scope, (1) the *number of variations* of the core inventive idea identified in the patent, reflected in the number of claims in the patent (e.g. Merges and Nelson, 1994); and (2) the *positioning* of those variations in the inventive space, which is reflected in the number of technological classes in which patent examiners classify those claims. Second, it investigates the implications of patent scope for the firm's subsequent inventive performance, and finds that, when the scope of a patents spans across a higher number of technological classes, the extent to which the inventing firm itself succeeds in building on the knowledge underlying its own patent is lower. Third, it investigates the antecedents of scope, and suggests that prior investment in scientific knowledge and in related inventive experience are two factors that affect the scope of the patents that firms develop. The theoretical predictions elaborated in this paper are supported by an empirical examination of a longitudinal sample of firms in the photonics industry.

1. Introduction

Let us imagine the inventive space as a space that holds all the ideas that have already been created, as well as and those that have yet to be generated. We can imagine that each invention occupies a certain area within this inventive space, and its position reflects the technological domain with which it is associated. In such a characterization, we can think of a patent as the temporary right to exclude others from making, using or selling an invention positioned in that area of the inventive space in exchange for its eventual public disclosure (Gilbert and Shapiro, 1990; USPTO, 2014a). The possession of this right (at least in principle) can allow an inventor to appropriate the benefits generated from their invention (Kitch, 1977). However, it would have limited value if it did not protect the inventor against mere variations to the original idea (e.g., Scotchmer, 1991). The patent system addresses this concern by allowing inventors to specify the patent's 'full scope' (Kitch, 1977; Lanjouw and Schankerman, 1997; Levin et al., 1987; Merges and Nelson, 1994; Walker, 1995).

Specifically, a patent application is composed of two main components. The first is the specification of the invention, which describes the techno-economic problem faced by the inventing firm and provides a "precise characterization of the 'best mode' of solving the problem" (Merges and Nelson, 1994, p. 9). The second is a set of claims, each of which specifies possible improvements or variations that could be made to the patented invention to adapt it for different uses (Merges and Nelson, 1994; Walker, 1995). Consequently, it corresponds to an additional area of the inventive space that the applicant claims should be protected by the patent. For instance, the claim of an invention consisting of an electrical component that contains magnetic particles and a matrix of fibers[1] can specify that the magnetic particles can have a diameter ranging from about 1 nm to about 10 μm.[2]

The positioning of patent claims in the inventive space can vary. They can refer to marginal variations to the invention (e.g. the diameter of a component) or to more 'diverse' variations – for instance, to completely different materials of which the same component

[1] This example is a simplification based on an existing patent in the field of photonics.

[2] Patent claims have a similar role both in the context of product and process innovation. In the first case they usually refer to variations to the invention's components, in the second usually refer to variations to the process that would lead to similar outcome(s). As the US patent law prohibits 'omnibus claims', i.e. those that are too general and do not provide clear guidelines as to what would constitute an infringement (Chiang, 2010; Walker, 1995), inventors are incentivized to specify explicitly in the claims section the potential variations to the invention that they consider to be part of the original invention (Walker, 1995). USPTO examiners also verify that claims refer to "enabling", "useful" and "operative" variations, in that they provide an advantage in genuinely solving the problem(s) that the invention addresses (Gambardella and Giarratana, 2013; USPTO, 2014a).

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could be made to adapt the invention to multiple applications. In spatial terms, if such alternatives were specified in the claims, the latter would be more distantly positioned from the original invention than the former. In the US patent system, the positioning of claims is captured by the technological classes to which the patent is assigned. When the patent examiners scrutinize the application documents, they attribute it to one mandatory classification, according to the class of the controlling patent claim, and then also to a variable number of additional classes, if the additional claims "fall" into other technological domains (USPTO, 2014b).

Building on these premises, this paper offers a re-examination of the concept of *patent scope* from the perspective of an inventing firm, identifying two dimensions to it: (1) the *number of variations* to the core inventive idea that are identified in the patent, which are reflected in the number of its claims (e.g. Merges and Nelson, 1994); and (2) the *positioning* of such variations in the inventive space, which is reflected in the number of technological classes in which the patent examiners classify such claims. While patents can vary along both dimensions, existing research has generally overlooked this issue. This paper argues that a higher number of claims might allow the inventing firm to build on its patented knowledge (e.g. Hall et al., 2005; Kitch, 1977; Merges and Nelson, 1994); but, when the patent claims are classified across multiple classes, the extent to which the inventing firm is itself able to appropriate and build on the knowledge underlying the patent may decrease.

Having shown that both these dimensions are important in affecting the strength of the protection a patent grants, this paper addresses the following questions: What enables the identification of a greater number of patent claims, and what determines the positioning of such claims across a greater number of technological domains? Surprisingly, there has been limited research exploring the antecedents of patent scope. In this paper, I build on research on the role of science in the inventive process (e.g., Fleming and Sorenson, 2004; Narin, 1994; Narin et al., 1997) and on analogical processes (e.g. Gavetti et al., 2005; Gick and Holyoak, 1980; Hofstadter, 2001), and identify firms' prior investments in scientific knowledge and in related inventive experience as two factors affecting patent scope. The theoretical predictions elaborated in this paper are supported by an empirical examination of a longitudinal sample of firms in the photonics industry.

The rest of the article is organized as follows. In Section 2 I explore the concept of patent scope, its implications and antecedents. In Sections 3 and 4, I describe the empirical setting, data, econometric specifications, estimation results, and in Section 5 I discuss the paper's contribution, implications for future research and limitations.

2. Theory and hypotheses

2.1. Patent breadth, patent width and patent scope: prior theoretical and empirical research

Using slightly different definitions, prior research has generally referred to the constructs of 'patent breadth', 'patent width' or 'patent scope' when referring to the level of leniency used by the regulator in granting exclusion rights to patentees (e.g. Denicolo', 1996; Gilbert and Shapiro, 1990; Green and Scotchmer, 1995; Klemperer, 1990; Matutes et al., 1996; Merges and Nelson, 1990, 1994; Scotchmer, 1991). Despite the value of these contributions, existing research in this area overlooks some important issues.

First, most of it builds on the idea that – given a certain degree of leniency on the part of the regulator in examining patent cases – an inventing firm will take full advantage of it, for instance by specifying in the patent claims all the possible variations to the invention that the regulator is likely to permit. This requires assuming that the full set of possible variations to an invention is known to (or could easily be identified by) the inventor at the time of the patent application (i.e. Merges and Nelson, 1990, 1994). This paper relaxes this assumption, in that it suggests that the scope of a patent is also determined by firms' ability to identify a higher number of variations. Because this ability likely varies across firms, this paper explores the antecedents of this heterogeneity – which have not been considered in most prior research.

Second, in investigating the implications of patent scope, most prior research has focused on its implications for social welfare (e.g. Denicolo', 1996; Green and Scotchmer, 1995; Klemperer, 1990; Merges and Nelson, 1990, 1994; Scotchmer, 1991). This paper extends prior research by showing how the scope of patents affects the extent to which the inventing firm is able to build on its own prior patents compared to other firms.

Finally, existing research has not provided precise guidance as to the operational interpretation of the construct of patent scope. Some studies have suggested that the scope of a patent can be measured as the number of technological classes in which its claims are classified (e.g. Lerner, 1994; Nerkar and Shane, 2003; Shane, 2001), building on the idea that a patent with broader scope would include more distant applications. Reflecting, instead, the idea that a patent with a broader scope covers a greater number of variations to the invention, other studies have measured the scope of a patent as the number of claims it includes (e.g. Lanjouw and Schankerman, 1997). This paper extends prior research by recognizing that the number of claims in a patent, and the number of classes in which those patent claims are classified reflect different dimensions of the patent scope construct, and suggests that its operationalization should take both dimensions into account. Table 1 provides a synthesis of prior research on these issues, and compares the assumptions and findings of prior studies.

2.2. The implications of patent scope

I argue that both the number of a patent's claims and their positioning across classes affect firms' ability to appropriate the 'inventive' returns from their inventions. Prior literature in this area has emphasized that all patents embody the opportunity for further development, and can act as a springboard for future inventions (Ahuja et al., 2013; Green and Scotchmer, 1995; Hall et al., 2005; Kitch, 1977; Merges and Nelson, 1994; O'Donoghue, 1998; Scotchmer, 1991). Existing research has identified an association between patents' scope and the subsequent inventive activity that builds on them, as measured by the number of 'forward citations' the patent receives (e.g. Lerner, 1994). However, this research does not distinguish between citations received from subsequent patents developed by the inventing firm itself (i.e. 'self-citations'), and those received from patents developed by others (i.e., 'external' citations). While self-citations reflect the firm's internalization of the knowledge underlying its own inventions (Belenzon, 2012; Hall et al., 2005; Trajtenberg, 2002), external citations indicate that other players have internalized part of the knowledge underlying the original invention and succeeded in building on it. Hence, from the standpoint of the inventing firm's appropriability, the value of self- and external citations differs substantially.

A deep understanding of both the codified and tacit knowledge elements underlying the patent should, in principle, give the original inventing firm an advantage in conceiving subsequent developments more easily and more quickly than other firms (e.g. Arora, 1996; Giarratana and Mariani, 2014; Katila and Ahuja, 2002). A higher number of claims should act as a deterrent to other firms from building on the knowledge underlying the patent, as it corresponds to an increased probability that a new invention in that area might infringe at least one of the patent's claims (Kitch, 1977; Merges and Nelson, 1994; Scotchmer, 1991). It might also reflect

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