International Journal of Industrial Organization 37 (2014) 222–228

Contents lists available at ScienceDirect

International Journal of Industrial Organization

journal homepage: www.elsevier.com/locate/ijio

Search duplication in research and design spaces — Exploring the role of local competition

Kai A. Konrad *,[1]

Max Planck Institute for Tax Law and Public Finance, Munich, Germany

ARTICLE INFO

Article history:
Received 17 February 2014
Received in revised form 14 August 2014
Accepted 15 October 2014
Available online 23 October 2014

JEL classification:
O32
O33
D72
D74

Keywords:
Delegated research
Clustering
Product design
Design contest
Search strategy
Rent seeking

ABSTRACT

A lack of sufficient diversification in research strategies has been identified as an important problem for delegated research. We show that this problem can be solved by local competition (such as bribery, lobbying, rent seeking, competition at the patent office) among players who apply the same search strategies or develop the same design. Such competition can restore full efficiency in the non-cooperative equilibrium. Local competition interacts with the choice of whether to cluster or diversify, and rather than adding a further inefficiency to the existing ones, it eliminates inefficiency. The results are robust and hold under simultaneous search strategy choices as well as for sequential choices.

1. Introduction

Diversification in delegated, decentralized research and the problem of possible clustering are important dimensions in contests about ideas and design: researchers need to decide *where* to search. To reduce duplication of effort, they should search at different sites.[2] Clustering in the same 'search site' may occur naturally in the equilibrium and may result in too little diversification.[3] Erat and Krishnan (2012) suggest multiple prizes to partially improve the effectiveness of delegated research.[4] We take up their framework but allow for competition that emerges if several searchers arrive at the same 'site' leading to the same idea or design. The possibility of this local competition changes the nature of the equilibrium and yields a first-best efficient allocation of search: it eliminates clustering, avoids the duplication of search strategies and leads to efficient diversification. In addition, it yields efficient search effort choices. The results hold for equilibrium with simultaneous choices as well as for sequential choices. Hence, delegated design research may perform well: The choice of search sites and competition that emerges inside the same site are complementary activities. While each of them is a possible source of inefficiency, their interaction can lead to an efficient outcome.

The problem of parallel research has been explored in a number of contexts with a duplication of efforts. An early account is by Eidmann

* Max Planck Institute for Tax Law and Public Finance, Marstallplatz 1, 80539 Munich, Germany.
E-mail address: kai.konrad@tax.mpg.de.

[1] I thank Florian Morath and two anonymous reviewers for the helpful comments. The usual caveat applies.

[2] Duplication is an issue, and two prominent examples serve to highlight this. Sony and JVC both expended effort on different technologies for recording systems for marketable video players, and only one system was awarded the economic rent attached to this market (see, for a discussion, Chatterjee and Evans, 2004). The formation of Sematech in 1987, a research consortium by 14 major semiconductor firms in the U.S., was partially motivated as an attempt to reduce research duplication (Irwin and Klenow, 1996, p. 12739).

[3] Gaba et al. (2004) focus on the choice of stochastic success-interdependence of the contestants' efforts. Related to this, Hvide (2002) and Hvide and Kristiansen (2003) address risk-taking choices by contestants. Search-site choice is the focus of the analysis in Erat and Krishnan (2012). Related questions are addressed by Loch et al. (2001) who consider parallel versus sequential testing of design alternatives.

[4] Multiple prizes have traditionally been analyzed in the context of choosing how much research effort to expend. Pioneering work is by Glazer and Hassin (1988), Clark and Riis (1996, 1998), Moldovanu and Sela (2001, 2006), and Szymanski and Valletti (2005). Unlike Erat and Krishnan (2012), these approaches focus on 'how much' to search. They disregard the question of 'where' to search.

http://dx.doi.org/10.1016/j.ijindorg.2014.10.002
0167-7187/

(1931).[5] Also, it is at the center of the analysis of patent races (see, e.g., Loury, 1979; Lee and Wilde, 1980). If several researchers follow the same approach and choose positive effort to preempt the competitors in a patent race, then this may lead to a duplication of effort. The total sum of efforts expended by each contestant may also be too large. The survey by Adamczyk et al. (2012) documents the large and increasing importance of a delegated search for ideas or design solutions in a more structured process that gives a specified set of prizes to the winner of a tournament, typically described as an innovation contest, and Hutter et al. (2011) illustrate the role of different forms of interaction between the contestants in such set-ups. The issue of *where* to search, rather than the issue of how much to search, and, in the space of search approaches, the role of locational choice as a strategic variable is more explicitly studied in a few more abstract papers. Fershtman and Rubinstein (1997) look at a situation in which there are several sites with a prize hidden in one of them. They consider two competitors, each of whom can choose how many sites to visit before choosing, and the sequence of the search, assuming that they scrutinize one site after another. Chatterjee and Evans (2004) also focus on two competitors, but they analyze a different dynamic structure. Cardon and Sasaki (1998) analyze a similar problem in the context of patent races. They focus on how competitors sequence the visits of a number of sites and find that the strategic interaction between the contestants may induce them to cluster in how they sequence the search process. They study a structure by which the development of patents that are imperfect substitutes is feasible, and discuss how downstream competition affects the sequencing choice. They also touch upon the relationship between clustering and downstream competition, using a framework with two possible levels of R&D research intensity. Their policy focus is on the desirability of R&D subsidies in patent races. Erat and Krishnan (2012) consider multiple contestants in delegated research in design contests with many possible search sites of heterogeneous quality. The quality of a site is defined by the likelihood for the design alternative that is found at this site to be the one that is most preferred by the designer of the contest. In the context of design contests, it is consistent to assume that each competitor can choose one site only (i.e., turn in only one proposal). They find an inefficient choice of sites with search duplication in some sites and a lack of search in other sites in the non-cooperative equilibrium.

Using a variant of the model of Erat and Krishnan (2012) we highlight the importance of competition among researchers who develop the same invention. Such competition is a strong force that drives researchers to differentiate in their research strategies. In the specific framework we consider, such competition can completely solve the duplication problem in decentralized design research and can lead to a first-best efficient outcome.

An important assumption adopted from Erat and Krishnan's framework is perfect coordination among the players. Whether players can coordinate should depend on the context. Communication between R&D intensive firms may facilitate coordination. Small accidental differences in when they start their R&D projects, together with information flowing between firms (e.g., because firms are in the same regional neighborhood and employees of different firms talk to each other) may allow for coordination. Strictly speaking, these timing differences together with observability or communication change the set-up from simultaneous to consecutive site/entry choices by players. But as we show in a robustness section, this consecutive choice behavior leads to precisely the same non-cooperative equilibrium outcomes as simultaneous choices both for the case with, and without, in-site competition.

[5] Eidmann (1931, p. 309) noted: "There is a surprising amount of duplication of effort in industrial research. In many cases, practically the same investigations are made in a number of laboratories. For instance, in one industry with which the author has been identified, there were, at one time, at least 15 competitors independently investigating a certain problem. They were all conducting practically the same experiments and each hoped to be the first to find the solution and to apply the resulting improvement to his product."

Our approach is not specific regarding the source of competition among players at the same site. Competition may emerge along the dimension of small quality improvements that allow the contest procurer to make a choice if several players offer the same design or idea. Competitors at the same 'site' may also lobby the procurer: they may engage in bribery or in a rent-seeking contest and expend efforts to influence the procurer's decision.[6] Also, players arriving at the same site may start quarreling or fighting about who has the highest priority in the site. Property rights issues have received considerable attention in the theory of conflict (see, e.g., Skaperdas, 1992; Garfinkel and Skaperdas, 2012). In the context of R&D and innovation contests, players with the same innovation may enter a competition at the patent office. Finally, the competition between players offering the same idea or design may be staged more formally by the procurer. The procurer may adopt an all-pay auction or another competitive process to allocate the prize between players who chose the same design/site. The adoption of such an incentive instrument is another means by which the procurer influences the choice of 'where to search' and by which the problem of clustering in delegated design contests can be solved.

2. A formal analysis

We consider a 'space' M consisting of a finite number m of different design 'search sites' j. Depending on the specific application, sites could be seen as a disjunct set of 'designs' or 'ideas,' like in an architecture competition, as discussed in Erat and Krishnan (2012), with ex-ante uncertainty about which design would eventually win.[7] We use a metaphorical geographical interpretation: M is a partition of the design landscape into sites $j = 1, 2, \ldots, m$, where searchers have to decide which site they choose for their search. Each searcher can choose only one site. The procurer of the design contest awards one well-specified prize. More formally, the award-winning 'idea' is located in at most one of the non-overlapping sites. All other sites are, in that sense, empty and searching there is futile. The prize itself has an economic value and this prize value is normalized and equal to 1 and is the same for all searchers. The ex-ante probabilities of the different sites being the prize-carrying site are

$$p_1 \geq p_2 \geq \ldots \geq p_m, \quad \text{with} \quad p = \Sigma p_j \leq 1. \tag{1}$$

This describes that at most one site hides a prize, but we do not rule out the case that all sites are empty, which happens with a probability of $(1 - p)$.

Consider now searchers, their possible actions and outcomes. The set of agents who may become active as searchers is $N = \{1, 2, \ldots, n\}$. If an agent decides to stay out, the agent receives a payoff of zero. This is a normalization. If an agent decides to enter, he or she must choose one and only one search site. The choice of a given site j causes a fixed cost c, which is the same for all sites and all players. First, we consider simultaneous choices and non-cooperative coordination equilibrium. We

[6] Suppose searchers generate the same idea or design, but only one of them can be given the prize. They may expend effort ('wining and dining', competition for attention, bribes) to influence the decision-maker in their favor. Such effort may be ineffective as regards a choice between substantially different designs, but may be particularly relevant for designs that are almost indistinguishable from an objective point of view. This type of rent seeking has been explored more generally in many contexts. See Tullock (1967, 1980) for early contributions, Konrad (2009) for an extensive survey, and Congleton et al. (2008) for a two-volume reprint collection of the most important papers.

[7] Research duplication is welfare-reducing here. For an empirical account of the role of the number of competitors for the trade-off between encouraging innovation speed and avoiding duplication effort, see Boudreau et al. (2011). Simmonds (1985) discussed whether research duplication is good or bad. He uses the context of the U.K. potato breeding to suggest that research approaches by the Scottish Crops Research Institute and by the Plant Breeding Institute, Cambridge, may have started with similar objectives, but their research led to innovations that are both useful and complementary to each other. His example hints at the fact that 'programmes with similar titles and objectives are likely to take different routes and to attack problems in different styles …' (Simmonds, 1985, 55).