Research Policy 43 (2014) 179–189

Contents lists available at ScienceDirect

Research Policy

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

A dynamic auction for multi-object procurement under a hard budget constraint

Ludwig Ensthaler[a,1], Thomas Giebe[b,*]

[a] Department of Economics, University College London, Gower Street, London WC1E6BT, UK
[b] Microeconomics, Sekr. H91, TU Berlin, Str. des 17. Juni 135, 10623 Berlin, Germany

ARTICLE INFO

Article history:
Received 2 March 2012
Received in revised form 21 February 2013
Accepted 24 June 2013
Available online 18 July 2013

JEL classification:
D21
D44
D45
D82

Keywords:
Research
Subsidies
Auctions
Procurement
Budget

ABSTRACT

This contribution revisits the problem of allocating R&D subsidies by government agencies. Typically, the applicants' financial constraints are private information. The literature has recommended the use of auctions in order to reduce information rents and thus improve the efficiency of how scarce public funds are allocated. We propose a new open clock auction for this procurement problem. This auction is strategically simple, as it exhibits truthtelling in dominant strategies and satisfies ex-post rationality, while observing the budget constraint. We test the auction in Monte-Carlo simulation and discuss its applicability and limitations. Moreover, we highlight connections to recent advances in computer science.

1. Introduction

It is well known that innovation exhibits the classical properties of market failure (indivisibilities, inappropriability and uncertainty, see, e.g., Arrow, 1962), resulting in socially suboptimal R&D investments by private firms. As a response, various policy instruments are being applied, e.g., in order to lower the threshold where socially desirable projects become privately profitable or to step in when markets do not provide sufficient private debt or equity.

One of the most important tools is direct subsidization of private R&D.[2] For example, the Small Business Innovation Research (SBIR) program in the United States provides funds in excess of $1 billion annually to encourage innovation by small and medium-sized private enterprises.[3]

Accordingly, the effects of public R&D funding have received considerable attention in the literature (see David et al. (2000) for an extensive discussion). A central question is, to what extent public grants crowd out private R&D. Although the empirical evidence is mixed, the majority of studies seems to speak against the crowding out hypothesis, thus, validating this policy tool. Recent contributions, rejecting (full) crowding out, include Aerts and Schmidt (2008), Czarnitzki and Lopes-Bento (2011, 2012, 2013), Duguet (2004), Hall and Maffioli (2008).[4] David et al. (2000) is inconclusive, finding that the degree of crowding out depends on the aggregation level and type of industry. Wallsten (2000) finds that subsidies crowd out private R&D dollar for dollar in the SBIR program.[5]

* Corresponding author. Tel.: +49 3031425539; fax: +49 3031423732.
E-mail addresses: l.ensthaler@ucl.ac.uk (L. Ensthaler), thomas.giebe@tu-berlin.de, tgiebe@gmail.com (T. Giebe).
[1] Tel.: +44 2076795817.

[2] It is the most important instrument in, e.g., Germany and Finland (see Czarnitzki et al., 2007). Other instruments are, e.g., fiscal instruments like tax exemptions, or the patent system. See David et al. (2000) for a survey of arguments in favor of and against public R&D funding and the effects of subsidies on recipient firms.

[3] See Audretsch (2003), Cooper (2003), and Wallsten (2000) for an evaluation of the SBIR program as well as Binks et al. (2003) for a study of US and UK programs.

[4] Czarnitzki and Lopes-Bento (2011) take into account that firms often have a choice of different subsidy programs (e.g., EU and national programs), and present evidence that firms' decisions are correlated with their characteristics.

[5] However, he gives various reasons why that conclusion might be wrong or not generalizable: subsidies might help firms to sustain the level of their R&D spending, the time period studied might be too short, the 'halo' effect of subsidies has been

0048-7333/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.respol.2013.06.011

Apart from the direct effect of enabling socially valuable projects that would have gone unfinanced in the absence of subsidies, public R&D funding has other benefits. Innovation, especially in the area of new technologies, and by small firms or startups, exhibits substantial uncertainty and asymmetric information, making it hard to raise debt or private equity. In this situation, the granting of public funds, following an expert evaluation of the projects in question, might signal the quality or commercial prospects of the firms in questions, thus, enabling access to capital. This 'halo' or signaling effect of subsidies has been described and empirically studied by Lerner (1999), followed by Feldman and Kelley (2003) and Meuleman and De Maeseneire (2012), and theoretically analyzed by Kleer (2010) and Takalo and Tanayama (2010). A special form of this effect is known as the 'certification' effect. It implies that the *fact* of getting subsidies is more important than their actual *size*, see Feldman and Kelley (2003) and Meuleman and De Maeseneire (2012).

Another class of 'soft' or longer-term benefits of R&D subsidies are spillover effects, the forming of networks and cooperations (especially between firms and research institutions), acquiring expertise, establishing continuous R&D activities in smaller firms. Typically, these benefits are explicit policy aims of the various government programs, see, e.g., Feldman and Kelley (2003), Czarnitzki et al. (2007) and Aerts and Schmidt (2008).[6]

Apart from the inconclusive evidence on the crowding out effect, the literature has pointed out practical problems. Government policy might be distorted, due to lobbying (or 'regulatory capture', see Lerner, 1999) or political pressure, resulting in 'picking-the-winner' behavior of R&D programs, favoring projects with higher probability of success, rather than more risky, socially desirable projects (see Czarnitzki and Lopes-Bento (2011) and Wallsten (2000) for empirical evidence). Wallsten (2000) is one of a few to stress the need for oversight and evaluation of program managers.

Another line of criticism is based on the conjecture that there is room for improvement in the way public funding programs allocate their R&D budgets, e.g., by evaluating programs, resp. allocations, in a different way, and by inducing more competition for funding among applicants.[7]

The typical procedure in these schemes is that applicants submit a detailed research proposal, stating their goals, expected cost for personnel, equipment, etc. There might be a deadline after which all proposals are evaluated by a panel of experts. This quality evaluation typically includes financial plausibility checks and an evaluation of the commercial, economic or social merits.[8] In many programs, cooperation partners and networking efforts are preferred or required.[9] Then, the winners receive funding from a given budget. The progress of those projects is then closely monitored and, finally, evaluated by the funding body.

The literature has discussed potential improvements on the current practice. First, rather than selecting winners purely on the basis of quality, one needs to take into account that lower-quality projects might make better use of scarce public funds than high-cost, high quality projects.[10] Second, the amount of subsidies granted is typically a fixed function of stated project cost ('matching grant'), and applicants are neither required nor given incentive to reveal to what extend they would pursue their proposals with smaller subsidies or no grants at all. Thus, the argument goes, successful applicants on average receive excessive information rents, due to the design of these programs.[11] These information rents, in theory, distort the allocation, wasting scarce public funds that could otherwise be used to enable additional innovation (with associated benefits, like the halo effect, spillovers, network effects, etc.). This criticism is related to the crowding-out hypothesis mentioned above.[12]

In order to address the first issue, the project allocation, Becker et al. (2004) and Giebe et al. (2006) recommend to define fixed quality classes (or grades, such as A, B, C) with associated welfare weights, such that each proposal (that is fundable in principle, by the program's criteria) is given one of the quality grades.[13] Then, the allocation of winners is chosen in order to maximize total welfare (according to the welfare weights of each budget-feasible allocation) with the given budget. The second issue, information rents, might be addressed by making the funding decision more competitive, giving applicants the option to increase their chances of funding by lowering the amounts of money they receive in case of being granted a subsidy. This could be done on a sealed-bid basis or in an open auction-like procedure, as recommended by Blum et al. (2001), Blum and Kalus (2003), Becker et al. (2004) and Giebe et al. (2006).[14]

neglected, and, the SBIR program might be biased in favor of commercially successful projects that would have been financed anyway.

[6] Hall and Maffioli (2008) find that subsidies have a particularly strong effect on new innovators. Lerner (1999, p. 291) surveys literature finding that spillover effects are particularly severe among small firms.

[7] There is evidence that spreading the budgets among a larger group of recipients would be beneficial. Czarnitzki et al. (2007) find unrealized benefits from cooperation among firms. Czarnitzki and Lopes-Bento (2011) report that non-funded firms would have invested more in R&D if they had received public funds. Moreover, on average, firms who have previously received subsidies seem to be different from firms who have not, in the sense that they have more patents, more permanent R&D, are more likely to cooperate, etc. (see, e.g., Czarnitzki and Lopes-Bento, 2012, 2013). The latter study also finds that the positive effect of subsidies seems to be stable over time. While these results are in favor of subsidizing more firms, they might also partially be due to a 'picking-the-winner' behavior of programs (see, e.g., Czarnitzki and Lopes-Bento (2011)). Lerner (1999) finds that "SBIR awardees receiving large subsidies did not perform better than those receiving smaller subsidies".

[8] See, e.g., Czarnitzki and Lopes-Bento (2013) for a description of evalution criteria of the IWT's programs in Flanders.

[9] See, e.g., Czarnitzki et al. (2007) for the case of Germany and Finland.

[10] In theory, low-quality projects might well be part of the 'first-best' allocation if they require relatively smaller subsidies. A group of low-quality projects might be more desirable than a single high-quality project, if the cost in terms of subsidies is the same. For example, suppose the budget is 150. Consider a single project that, if realized, generates a welfare of 100 and needs a subsidy of 140, as compared to three lower-quality projects that each generate a welfare of 33 and require subsidies of 50 each. Then subsidizing the lower-quality projects generates more welfare with the given budget.

[11] Obviously, it is unlikely that the amount of a matching grant is equal to the actual 'funding gap' of a given private R&D project. The question is how severe these information rents are. Blum and Kalus (2003, p. 271f.) note that "The addressee is not forced to reveal his/her preferences for the financial incentives.", and, "In most cases, the addressee thus cashes in a rent (. . .)." Hall and Maffioli (2008, p. 174) mention the problem of rent-seekers who only apply for grants in order to replace their own investments with public money. Lerner (1999, p. 296) reports on "SBIR mills", i.e., applicants who specialize in "identifying opportunities for applications" and "appear to commercialize projects at a significantly lower rate than other firms".

[12] Note that several empirical studies on the crowding out hypothesis only reject 'full' crowding out, but may be consistent with partial crowding out. The presence of information rents does not necessarily imply that there is one-to-one crowding out of private R&D. If an applicant receives a larger-than-necessary subsidy, then this might also have positive effects. The German program InnoRegio was analyzed by Eickelpasch and Fritsch (2005). They report that 40% of surveyed rejected applicants carried out their projects nevertheless. Of those cases, 61% found alternative public funds while 39% did not receive any significant public funding at all. On p. 1280, they also report on a related study of the EXIST program, with similar results. See also Feldman and Kelley (2003).

[13] These studies, as well as practitioners, point out, that determining the first-best allocation by ranking all possible project allocations in terms of welfare (or other program-specific criteria) is impossible.

[14] See, e.g., Blum et al. (2001, executive summary, p. 10): "scarcity of funds must be overcome by means of an auction-oriented determination of assistance quotas rather than by means of quota allocation." Similarly, Becker et al. (2004) was initiated by the German Federal Ministry of Economics and Labor, with the explicit aim of studying competitive mechanisms for the allocation of subsidies. That study, in turn, was a result of the systems evaluation by Blum et al. (2001).