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The Economics of Subsidies for R&D: Implications for Reform of EU State Aid Rules

The primary aim of the reform of EU rules on research, development and innovation for the period 2014-20 is to ensure that aid stimulates more research and that it is kept to the minimum necessary. This paper develops a simple model that identifies a number of problems in the public funding of private research and demonstrates that the determination of the optimum subsidy for research is a complex task. The results suggest that research subsidies should be allocated in a way that reduces the amount of subsidy per recipient firm and ensures that the subsidies go to more efficient firms.

The member states of the European Union grant state aid to a variety of industries and for a variety of objectives. About 90% of the state aid granted to industry and services supports "horizontal" policy objectives. Research an development comes third with 19% of aid, after regional development (26%) and environmental protection (23%). In absolute numbers, member states spend about €10bn per year on R&D (figures from 2011). In relative terms, state aid to R&D corresponds to about 0.08% of the EU GDP.[1]

These numbers grossly underestimate the actual public support for R&D. This is because they count only the state aid element of public spending, i.e. public funding of private research undertaken by enterprises. They do not count the public funding of research undertaken by universities and other research organisations which are not classified as enterprises or, in state aid terms, "undertakings". Taking this funding into account, the total amount of public spending on R&D in the European Union is about 2% of GDP. The European Commission has repeatedly urged member states to raise their spending, as it currently falls below the target of 3% set by the EU 2020 strategy.

The EU prohibits in principle any public measure that constitutes state aid. Public funding of private research is in most cases classified as state aid. However, because private research generates benefits for society, EU state aid rules also allow, under certain conditions, public support for R&D. The Commission has developed special rules which define the conditions under which public funding of R&D generates common benefits while limiting the negative effects from distortions to competition. These rules are elaborated in the General Block Exemption Regulation[2] (GBER) and the Research, Development and Innovation (R&D&I) Framework.[3] Both the GBER and the Framework are due to expire at the end of December 2013, and the Commission is currently in the process of drafting new rules for the period 2014-2020.

As recognised by the GBER and the Framework, despite the gains that society obtains from stimulating private research, state aid can also cause significant distortions. Such distortions result from i) funding of inefficient companies or dominant companies, ii) state intervention that displaces private effort and risk-taking, and iii) predatory policies that harm other countries through rent-extracting measures.

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1 All the statistics quoted in this paper are drawn from three sources. The first source is European Commission: State Aid Scoreboard, Brussels 2012, http://ec.europa.eu/competition/state_aid/studies_reports/studies_reports.html. The second is European Commission: Mid-term Review of the R&D&I Framework, Commission Staff Working Paper, Brussels 2011, http://ec.europa.eu/competition/state_aid/legislation/rdi_mid_term_review_en.pdf. The third is European Commission: Revision of the state aid rules for research and development and innovation, Commission Staff Working Paper, Brussels 2012, http://ec.europa.eu/competition/state_aid/legislation/rdi_issues_paper.pdf.

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2 Commission Regulation No. 800/2008.

3 Both the GBER and the Framework can be accessed at http://ec.europa.eu/competition/state_aid/legislation/legislation.html.

In the EU the potential harm to other member states from such distortions is not negligible. One reason for this is that public spending on R&D&I varies substantially among member states. In absolute numbers from 2011, the member states with the highest annual expenditure on R&D&I are Germany (€3bn), France (€1.9bn), Spain (€1bn) and Italy (€0.8bn). In relative terms, however, the ranking is quite different. When considering public expenditure on R&D&I as a percentage of GDP, the member states with the highest percentages are Austria, Sweden, Finland and France.

There are also other reasons to be concerned about the impact of subsidies on competition. According to the European Commission, in the period 2007-11 large enterprises absorbed approximately 90% of state aid for R&D&I, with SMEs receiving the remaining 10%. Large enterprises are more likely to engage in extensive cross-border activities. Subsidies to these enterprises are therefore more likely to harm other countries.

The European Commission has recently begun public consultations on the revision of the R&D&I Framework. The purpose of this paper is to contribute to these discussions in two ways. First, it develops a simple model that identifies a number of dilemmas in the public funding of private R&D and demonstrates that the determination of optimum subsidies is a difficult task. The costs of recipient companies are critical in the derivation of optimum subsidies. Second, in light of these findings, the paper proposes that the future state aid rules on R&D should limit subsidies to the most efficient companies.

There is a voluminous literature on R&D subsidies that ranges from the strategic behaviour of companies to the use of subsidies for achieving specific research targets.[4] This rich literature is both theoretical and empirical. However, there is hardly any analysis that links theory to the reform of the rules on R&D&I for the period 2014-20. This paper aims to fill this gap.

The primary issue in the current reform is to ensure that aid stimulates more research and that it is kept to the minimum necessary. The purpose of this paper is to demonstrate how to ensure that aid is not wasted on the basis of guidance drawn from a simple but fairly robust model.

EU state aid rules on R&D

The EU regulates the granting of state aid to research and innovation. As mentioned above, there are two sets of fairly similar governing structures: the R&D provisions of the GBER and the R&D&I Framework. Aid that is granted on the basis of the GBER does not have to be notified to the Commission and therefore is not subject to Commission assessment. In principle, the need for such aid is better established and its effects are better understood. Thus, the scope of the GBER is narrower than the scope of the Framework. For example, the Framework allows for aid to innovation clusters while the GBER does not.

In addition, when aid amounts exceed certain thresholds (e.g. €7.5 million for experimental product development or €10 million for industrial research), the Commission requires individual notification irrespective of whether they fall within the GBER or within an already approved scheme under the Framework. A scheme is a measure that provides for multiple awards of aid. Since larger amounts of aid can cause greater distortions of competition, their approval can be granted only after detailed analysis of their impact on competition.

Neither the GBER nor the Framework permit unlimited aid. Both of these sets of rules set maximum rates of aid intensity, which is defined as the ratio of aid to eligible costs. The rates of aid intensity vary according to the perceived severity of market failure for different types of research. The closer the research to the market, the lower the allowable aid intensity.

The current rules cover the period 2007-13. So far the Commission has approved about 220 R&D measures and another 60 individual or ad hoc grants. It appears that no measure has been prohibited by the Commission, although two measures have been withdrawn when the Commission expressed doubt as to their compatibility with the internal market. This very high rate of approval

4 For a selection of recent contributions see S. Afcha: Analyzing the Interaction between R&D Subsidies and Firm's Innovation Strategy, in: Journal of Technology Management & Innovation, Vol. 7, No. 3, 2012, pp. 57-70; R. Bronzini, E. Iachini: Are Incentives for R&D Effective? Evidence from a Regression Discontinuity Approach, Bank of Italy Working Paper No. 791, 2011; J. Caiado, T. Berghaus: R&D Subsidies: A Law & Economics Analysis of Regional and International Rules, Society of International Economic Law, 3rd Biennial Global Conference Working Paper No. 2012/37, 2012; G. Cerulli: Are R&D Subsidies Provided Optimally? Evidence from a Simulated Agency-Firm Stochastic Dynamic Game, in: Journal of Artificial Societies and Social Simulation, Vol. 15, No. 1, 2012; N. Duch-Brown, J. Garcia-Quevedo, D. Montolio: The Link between Public Support and Private R&D Effort: What is the Optimal Subsidy?, Document de Treball XREAP, 2011; Q. Fu, J. Lu, Y. Lu: Incentivizing R&D: Prize or subsidies?, in: International Journal of Industrial Organization, Vol. 30, No. 1, 2012, pp. 67-79; L. Herrera, E. Bravo: Distribution and effect of R&D subsidies: A comparative analysis according to firm size, in: Intangible capital, Vol. 6, No. 2, 2010, pp. 272-299; T. J. Klette, J. Moen: R&D investment responses to R&D subsidies: A theoretical analysis and a microeconometric study, Department of Finance & Management Science Discussion Papers, No. 2011/15, Norwegian School of Economics, Bergen 2011.

does not mean that the Commission authorises whatever measure is designed by member states. Rather, it indicates that member states have been complying faithfully with the Commission rules in the R&D&I Framework.

Member states have used the GBER more extensively than the Framework. About 500 national measures have been adopted on the basis of the GBER. In theory, member states must conform fully with the requirements of the GBER. Given, however, that the measures which are adopted on the basis of the GBER are not notified to the Commission for prior authorisation, it is difficult to know how well member states comply.

As regards the R&D&I activities and the type of beneficiary for which state aid has been granted, available data for the period 2007-11 suggest that the largest proportion of funding was for activities in the domains of aeronautics (29%), microelectronics (21%), energy (14%), biotechnology (11%), automotive (11%) and ICT (9%). Activities in other domains (e.g. transport and food) make up the rest. About 80% of total R&D&I state aid has been for the development of key enabling technologies such as micro- and nanoelectronics, advanced materials, industrial biotechnologies, advanced manufacturing systems and, to a lesser extent, nanotechnologies.

In early 2012, the Commission launched a public consultation on the reform of R&D&I rules.[5] The Commission asked many questions to stakeholders. One of the main questions was, as always, how much aid could be granted. In the Staff Working Paper "Revision of the state aid rules for research and development and innovation" of 12 December 2012, DG Competition is rightly concerned about the incentive effect of state aid and whether it can induce aid beneficiaries to undertake more research.

In order to provide a reasonable answer to the question "how much aid", the next section develops a model of subsidies for correcting market failure and shows that quantifying the optimum amount of such subsidies is a difficult task.

A model of R&D subsidies

The justification for public subsidies to stimulate research by private firms is that the generation of new knowledge generates positive externalities. The problem for firms is that new knowledge cannot be fully protected by intellectual property rights. Firms, therefore, tend to under-produce such knowledge. Yet, new knowledge benefits society at large, especially when it is not protected by patents, so that it can be more easily disseminated.

Different types of knowledge are affected by externalities to a different extent. Firms tend to produce more knowledge which can be more easily protected by intellectual property rights or which can be used directly in the manufacture of new products or the provision of new services. Knowledge of a more general nature or with multiple applications tends to be neglected. Yet it is this type of knowledge that is probably more valuable to society at large. It appears reasonable that society should subsidise to a larger extent knowledge with larger external effects.

This intuitive conclusion can be formalised in a model of public subsidies to R&D. Assume that private benefits, B, from research, R, can be described by a concave function as follows:

$$B = fR - gR^2 \qquad (1)$$

where f and g parameters can take values from 0 to 1, i.e. $0 \leq f \leq 1$ and $0 \leq g \leq 1$.

Because of non-negative externalities, social benefits, S, from research are larger than B by a certain factor, m, which indicates the magnitude of externalities as a proportion of B. In other words, m measures the proportionate difference between social and private benefits and can also be considered to be a measure of the magnitude of market failure. Since the externalities are non-negative, $m \geq 0$. However, for algebraic convenience, the values of m are restricted to the range $0 \leq m \leq 1$. This is because later on m will be used to determine the rate of aid intensity.

The function of social benefits is also assumed to be concave and described by the following equation

$$S = fR - gR^2 + m(fR - gR^2) = (1 + m)(fR - gR^2) \qquad (2)$$

The private costs of research, C, are linear and given by the following function

$$C = aR \qquad (3)$$

where $a \geq 0$.

5 The texts of this consultation can be accessed at: http://ec.europa.eu/competition/consultations/2012_stateaid_rdi/index_en.html.

Private optimum

A firm that is acting rationally would determine its optimum research effort by maximising the difference between benefits and costs so that

$$max\ B - C = fR - gR^2 - aR \qquad (4)$$

The private optimum research effort, Rp^*, is derived by differentiating (4) with respect to R and setting it equal to zero so that

$$\mathrm{d}(B - C)/\mathrm{d}R = f - 2gR - a = 0$$
$$=> Rp^* = (f - a)/2g \qquad (5)$$

For a positive solution to exist, $f > a$.

Social optimum

The social optimum research effort, Rs^*, can be derived by maximising the difference between S and C.

$$max\ S - C = (1 + m)(fR - gR^2) - aR \qquad (6)$$

Differentiating (6) with respect to R and setting it equal to zero yields

$$\mathrm{d}(S - C)/\mathrm{d}R = f + mf - a - 2gR - 2mgR = 0$$
$$=> Rs^*=[(1 + m)\mathrm{f} - a]/(1 + m)2g \qquad (7)$$

By comparing Equations (5) and (7), it can be concluded that the socially optimum research effort is larger than the private optimum because $Rs^* > Rp^*$. To see that the inequality $([(1 + m)f - a]/(1 + m)2g) > ((f - a)/2g)$ holds, note that by simplifying both sides, we derive $- [a/(1 + m)2g] > - (a/2g)$, which implies $(a/2g) > [a/(1 + m)2g]$, which is true because $1 > [1/(1 + m)]$.

This shows the well-understood effect that, in the presence of externalities, firms tend to under-invest in research.

Subsidies to correct market failure

The typical policy response to remedy this market failure is to grant public subsidies to encourage firms to increase their research efforts. Assume that the subsidy aims to offset part of the costs of research effort, as is typically the case, and is determined as a percentage of private costs. In the EU, subsidies are always defined as a proportion of eligible costs and expressed in percentage terms.

In the context of this model, the subsidy expressed as a proportion of costs is the same as the percentage magnitude of externalities, m. Therefore, private costs after the subsidy, Cs, are smaller than C and given by the following:

$$Cs = aR - maR = (1 - m)aR \qquad (8)$$

For a subsidy-receiving firm, the new optimum research effort, Rps^*, is determined by maximising the difference between its private benefits, B, and subsidised costs, Cs.

$$max\ B - Cs = (fR - gR^2) - (1 - m)aR \qquad (9)$$

Differentiating (9) with respect to R and setting it equal to zero gives

$$\mathrm{d}(B - Cs)/\mathrm{d}R = f - 2gR - (1 - m)a = 0$$
$$=> Rps^* = [f - (1 - m)a]/2g \qquad (10)$$

A simple comparison between (5) and (10) shows that subsidies can indeed induce more private research because the subsidised research effort, Rps^*, is larger than the unsubsidised effort, Rp^*. That is, $Rps^* > Rp^*$ because $[f - (1 - m)a]/2g > (f - a)/2g$. This is true because after simplifying both sides, we derive $a > (1 - m)a$, which is true.

Sub-optimum subsidies

As already mentioned, the typical research-promoting policy sets the amount of subsidy according to the size of market failure. Such policies firstly identify the existence of market failure, then measure the magnitude of that failure and, lastly, grant subsidies which are proportionately equal to that magnitude.

When subsidies are equal to the magnitude of market failure, in our notation given by the factor m, it can be shown that the subsidised private research effort exceeds the socially optimum level *before* the subsidy is granted. In other words, $Rps^* > Rs^*$. To prove that this is true, consider that Rps^* and Rs^* can be rewritten as follows:

$$Rps^* = [f - (1 - m)a]/2g$$
$$= (f/2g) - [(1 - m)a/2g] \qquad (11)$$

$$Rs^* = [(1 + m)f - a]/(1 + m)2g$$
$$= (f/2g) - [a/(1 + m)2g] \qquad (12)$$

For the inequality $Rps^* > Rs^*$ to hold, it must be that $(f/2g) - [(1 - m)a/2g] > (f/2g) - [a/(1 + m)2g]$. By simplifying both sides of the inequality and by multiplying both sides by –1, it can be derived that

$$[1/(1 + m)] > (1 - m) \qquad (13)$$

which is true because $1 > (1 + m)(1 - m)$ and thus $0 > -m^2$, which is true.

This is an important conclusion. Public subsidies, determined according to m, can improve the state of the economy and stimulate more research. But they raise private research efforts to a level above the social optimum that was identified before the subsidy.

However, note now that with the granting of a subsidy, the socially optimum research effort also changes. If we assume that the subsidy is costless to the government and society (i.e. it represents a pure transfer with zero administrative costs), the social optimum, after the subsidy, is given by the maximisation of the difference between S and Cs

$$max\ S - Cs = (1 + m)(fR - gR^2) - (1 - m)aR \qquad (14)$$

By differentiating (14) and setting it equal to zero, we can derive the social optimum after the subsidy, Rss^*

$$\mathrm{d}(S - Cs)/\mathrm{d}R = 0$$
$$\Rightarrow Rss^* = [(1 + m)f - (1 - m)a]/(1 + m)2g \qquad (15)$$

A comparison between Equations (7) and (15) shows now that $Rss^* > Rs^*$, because $[(1 + m)f - (1 - m)a]/(1 + m)2g > [(1 + m)f - a]/(1 + m)2g$.

A comparison between Equations (10) and (15) reveals that $Rss^* > Rps^*$ as well, because $[f(1 + m) - (1 - m)a]/2g(1 + m) > [f - (1 - m)a]/2g$.

These results lead to a neat ranking of the various research outputs:

$$Rss^* > Rps^* > Rs^* > Rp^* \qquad (16)$$

This ranking indicates something rather surprising. Irrespective of how the social optimum is calculated (i.e. before or after the subsidy is granted), private research efforts (with or without subsidy) are never at the socially optimum level. Although subsidies increase research, they still do not increase it to the point where they equalise marginal social benefits and marginal social costs.

Cost differences between subsidy recipients

Now consider what happens when two otherwise similar firms have different research costs per unit of output, a_1R_1 and a_2R_2, where $a_1 > a_2$. If we plug these cost differences into equation (5) and (10), it follows that

$$Rp_2^* > Rp_1^* \qquad (17)$$

because $(f - a_2)/2g > (f - a_1)/2g$ because $(f - a_2) > (f - a_1)$, and

$$Rps_2^* > Rps_1^* \qquad (18)$$

because $[f - (1 - m)a_2]/2g > [f - (1 - m)a_1]/2g$ for the same reason.

Public support for less efficient firms results in less research effort than it does for more efficient firms.

The consequences of cost differences

The results above can also be interpreted from a different angle. If firms exaggerate their costs to receive larger amounts of subsidies (in order, for example, to cover more of their costs with public money), their research effort does not reach the level it could otherwise reach had they been more cost-efficient. In this case, subsidies are wasted, even if they appear to stimulate research effort. This is also an important conclusion. What matters for public policy is not how much research effort or research output is funded by subsidies but how much extra effort can be stimulated when subsidy recipients use their resources or assets in the most efficient way. Public policy should avoid funding unnecessary costs.

The difference in subsidised research is directly proportional to the difference in costs between subsidy recipients. Let us denote the difference between Rps_2^* and Rps_1^* as X.

$$X = Rps_2^* - Rps_1^*$$
$$= [f - (1 - m)a_2]/2g - [f - (1 - m)a_1]/2g \qquad (19)$$
$$= (1 - m)(a_1 - a_2)/2g$$

It can be seen now that the difference in subsidised research output depends on three factors: i) the extent of market failure m, ii) parameter g, and iii) the difference in costs.

As could be expected, the larger the difference in costs, $a_1 - a_2$, the larger the difference in subsidised research. However, what is more surprising is that the larger the magnitude of market failure, m, and therefore the larger the subsidy granted, the smaller the difference in subsidised research. As m becomes larger and tends to 1, $(1 - m)$ becomes smaller and X also becomes smaller. This suggests that, other things being equal, the more fundamental the research, the smaller the difference in subsidised research output between firms of different costs. Conversely, the closer the research to commercial applications, the more significant the difference in subsidised research output. To put it slightly differently, the difference in the research output of two firms which only differ in costs is larger when the market failure is smaller, the research is closer to the market and the subsidy is smaller. This means that public authorities should be more concerned about cost differences when research has direct commercial applications, even though the amounts of subsidy granted are smaller.

But the task of public authorities that wish to promote research is even more complex. This is because the extra research output of the high-cost firm (firm 1) is larger than the extra research output of the low-cost firm (firm 2). Let D be the extra research output of each firm that is stimulated by the subsidy they receive. D can be expressed as the ratio of subsidised to unsubsidised research or $D = Rps^*/Rp^*$.

For firm 1, $D_1 = Rps_1^*/Rp_1^* = [f - (1 - m)a_1]/(f - a_1)$. Similarly, for firm 2, $D_2 = Rps_2^*/Rp_2^* = [f - (1 - m)a_2]/(f - a_2)$. By simplifying these expressions, it becomes obvious that $D_1 > D_2$ because $a_1 > a_2$.

Earlier it was shown that the subsidised research output of firm 2 was larger. This was due to the fact that its research output without subsidy was also larger. But now it can be seen that the extra research output that is stimulated by subsidies is proportionately larger for the high-cost firm. For society, however, it matters more that the overall level of research is higher, not that a firm makes more effort than another, given that that effort achieves a lower research output. These differences in absolute levels of research effort, X, and in relative research effort, D, can make the task of granting optimum subsidies very difficult. They also suggest that public policy should employ more sophisticated instruments than the simple comparison of private research efforts before and after subsidies.

How to prevent aid recipients from exaggerating their costs?

Let N be the net benefits from research accruing to a firm. Thus $N = B - C$. By deriving the optimum level of research before and after subsidies, Rp^* and Rps^* respectively, it is fairly easy to calculate the maximum amount of net benefits before and after subsidies, N^* and Ns^* respectively. By working out the equations, it is also fairly easy to show that $Ns^* > N^*$.

A firm that exaggerates its costs necessarily makes its N^* smaller than otherwise. By taking the amount of net benefits before subsidies as a benchmark, an aid-granting authority can stipulate that the subsidies should not lead to a situation in which the aid recipient increases its profits. The aid-granting authority, therefore, can impose a payback clause (just like a tax) where the amount of the payback, T, is equal to the difference between Ns^* and N^*, i.e. $T = Ns^* - N^*$. The smaller the benchmark N^*, the larger the amount of payback T for any given amount of Ns^*. Such a clause creates a dilemma for potential aid recipients. If they exaggerate their costs, they will have to pay back larger amounts. If they declare their true (lower) costs, they can keep larger amounts of the subsidy, because the net benefits before the subsidy, N^*, will be larger as costs are lower.

Admittedly, it may not be possible to use such benchmarks in all cases. Indeed, if a firm does not undertake any research, then the aid-granting authority does not have a benchmark to measure against. In this instance, it would be necessary to identify the firm that can undertake a given research project at the lowest possible cost. The next section examines the policy implications of the need to identify firms with relatively lower costs.

Policy implications

The model that is elaborated in the previous section is static. It does not take into account dynamic interaction between aid-granting authorities and aid-receiving firms. However, even this static framework reveals the difficult task of calculating optimum subsidies. The model leads to four important policy implications.

First, subsidies that appear to be reasonable because they are equal to the size of market failure are not even the second best policy intervention (the best intervention is to remove the cause of market failure by internalising externalities). In this case, firms choose their optimum research effort in relation to their private benefits. This research effort falls short of the socially optimum level if the benchmark is the social optimum after the subsidy, and it exceeds the socially optimum level if the benchmark is the social optimum before the subsidy. Depending on the benchmark which is used, research output is either too low or too high.

The second implication is that research policy should not only consider the presence of externalities but also the internal efficiency of subsidy recipients. The problem here is that it is rather difficult for public authorities to identify the real costs of firms and to distinguish between firms of varying degrees of efficiency.

Third, differences in efficiency among subsidy recipients are more serious when, other things being equal, the degree of market failure is smaller. Presumably market failure is smaller when research is closer to the market. Indeed, the risk of competition distortion rises as research has more immediate and direct commercial applications.

Fourth, even though relatively high-cost firms increase their research efforts proportionately more than relatively low-cost firms, the research efforts of high-cost firms are lower than those of low-cost firms in absolute terms. So policies that reward relative effort do not necessarily achieve a high absolute level of research output.

It follows that all four of these findings suggest that the general policy approach should be to grant fewer subsidies than what either market conditions indicate or firms demand, even when the amounts of such subsidies are small. For this reason, public policy should be using instruments that tend to lower the amount of subsidy that is granted. In the presence of asymmetric information between policy makers and market participants, an approach that rations subsidies to the relatively more efficient firms is competitive bidding for subsidies.

At present in most EU countries, the allocation of subsidies is on a first-come, first-serve basis. That is, after an overall budget is decided upon (in most cases, agreed to jointly by the legislature and the relevant ministry), money is given sequentially to any firm that fulfils the criteria of eligibility until the budget is exhausted. Although national criteria must always comply with EU state aid rules, additional national requirements are often introduced. In most cases, however, these national requirements do nothing more than identify sectors or research programmes which are considered to be important for the country or ensure that funded projects fall within the priorities of national research or development plans. It is rare for member states to adopt competitive procedures for the granting of subsidies. France and the UK (for environmental pilot or demonstration projects) are notable exceptions in this respect.

The model developed in this paper suggests that research subsidies should be allocated differently. The sequential method should be replaced by bidding for the entire amount of available money at pre-determined points in time. This should achieve two results. The amount of subsidy per recipient firm would be reduced, and the subsidies would go to the more efficient firms.

Admittedly, there is a non-negligible difficulty in the proposed approach. For competitive selection to be effective, public authorities must be capable of distinguishing meaningfully between bidding firms. This is not easy if the various firms that apply for subsidies pursue different research programmes. When programmes vary, the amount of requested subsidy cannot be the sole criterion for selection. This is because both the magnitude of market failure and the social value of research are likely to vary across research programmes. For example, a firm may request a larger subsidy not because it is less efficient but because it undertakes a riskier project which may be able to generate more benefits for society. So for competitive bidding to be an efficient method for allocating subsidies, it is necessary for the granting authorities to use criteria that can compare like with like and rank projects in terms of their social contribution. This is not an easy task. But the problem can be made more manageable with the use of scoring methods with multiple criteria.

Conclusions

The purpose of this paper is to show that the determination of the optimum subsidy for research is a complex task with no simple solutions. The socially optimum level of research effort very much depends on the benchmark employed and whether this benchmark is measured before subsidies or after subsidies.

In the presence of asymmetric information, policy makers should induce firms to reveal their true costs and should grant subsidies to the relatively more efficient firms by allocating subsidies not on a first-come, first-serve basis but rather through a competitive process.

The competitive selection of subsidy recipients, however, is not a panacea, as it may not be possible to be effectively employed in all cases and for all research programmes. This is because public subsidies should in principle support those programmes with the largest value for society rather than those with the lowest costs.

Although this paper focuses on R&D, its findings are likely to be relevant to any subsidy that aims to remedy market failure caused by positive externalities.