CAIRN Policy Brief

Canadian Agricultural Innovation Research Network Number 6, September 2007

R&D Subsidies with Spillovers, Environmental Externalities and Information Gathering

By James Vercammen

The Issue

Research and Development (R&D) decisions by firms are generally complex. First, a firm must gather information about the profitability of R&D for a particular project (e.g., cellulose ethanol). After this information has been collected, it must then analyze the information and decide whether to proceed with the R&D. If the R&D does proceed, the firm must then choose a level of R&D intensity (e.g., number of labs to create and scientists to hire).

Policy makers recognize that firms generally under-invest in R&D due to spillovers and environmental externalities. Spillovers exist because the innovating firm is not able to capture all the rents that flow from R&D. Environmental externalities exist if the market value of the innovation is less than its social value (e.g., a renewable energy project). Policy makers often use R&D subsidies, such as a tax credit, to increase private investment in R&D, especially in situations where R&D spillovers and environmental externalities are large.

Which economic factors determine the most efficient form of an R&D subsidy? Should the subsidy be based on research intensity (e.g., an R&D tax credit for eligible expenditures) or should an up-front subsidy such as a research grant be used to steer firms toward socially desirable projects? A theoretical model of the interface between information collection by an innovating firm and R&D decisions (project selection and intensity) is constructed and analyzed in order to address these questions.

Policy Implications and Conclusions

When designing an efficient R&D subsidy package, it is important for policy makers to account for the decision-making process of the innovating firm. Analysis reveals that with a spillover or an environmental externality, an innovating firm too frequently rejects a risky project that has a high social value in favour of a safe project with a low social value. And even when the high value project is selected, the firm will typically choose an inefficiently low level of R&D intensity. Information gathering is important within the innovating firm's decision-making process. The analysis shows that the collection of information by an innovating firm facing a spillover or environmental externality results in both losses and gains in economic efficiency. A loss results because the more information that is available to a firm, the more likely it will reject a risky project even if it is socially desirable. A gain results because additional information will induce the firm to increase R&D intensity toward a more efficient level.

So, from a project selection perspective, an innovating firm facing a spillover or externality collects too much information, but from an R&D intensity perspective, it is not collecting enough information. Providing an innovating firm with an R&D tax credit would induce the firm to collect more information, which, while bad from a project selection perspective, is good from an R&D

CAIRN

Canadian Agricultural Innovation Research Network
51 Campus Drive
Saskatoon, SK
S7N 5A8

General Inquiries:
306.966.4026
Fax: 306.966.8413
Email: cairn@usask.ca

Additional briefs at:
www.ag-innovation.usask.ca

intensity perspective. The opposite results emerge if the firm is provided an R&D grant. The policy maker must therefore assess whether the distortion is largest at the project selection margin or the R&D intensity margin before deciding whether an R&D tax credit or a grant is the most appropriate form of R&D subsidy.

Discussion

In many industrialized countries, firms receive generous tax treatment on R&D expenditures, as well as qualify for grants and other forms of implicit and explicit R&D subsidies. In Canada, for example, in addition to being allowed fully depreciating R&D capital expenditures incurred during the year, large businesses qualify for a twenty percent tax credit and Canadian small businesses a thirty-five percent tax credit on R&D expenses. In priority areas such as renewable energy production, a wide array of R&D grants is usually available. In Canada's 2007 federal budget, a $500 million fund was established for the commercialization of next generation renewable fuel technologies, such as cellulose ethanol. Ontario's "Alternative Renewable Fuels Research and Development Fund" is promoted as the most generous R&D tax credit program in the world because it reduces $100 of R&D expenditures to about $41.

There are strong theoretical arguments, backed by substantial empirical evidence, for public R&D subsidies. In the conventional spillover case, innovating firms are generally unable to appropriate all product development, quality improvement, and cost reduction benefits of their R&D programs. They therefore tend to under-invest in R&D. Technological spillovers are caused by information leaks from the innovating firm. Leaks occur for a variety of reasons, including licensing agreements, patent disclosures, hiring of employees away from the innovating firm, and reverse engineering. Estimates of domestic and cross-border spillovers for select Canadian industries reveals that the social return to R&D ranges from 2.5 to 12 times higher than the private return. Public subsidies of R&D are also justified in markets containing environmental externalities. Subsides for wind energy R&D, for example, are justified because of the negative externalities associated with conventional energy production and consumption.

Prior to making final R&D decisions, firms typically devote sizeable resources to collecting information about future market demand for a proposed product or technology to be developed. This is especially true in emerging markets such as biofuels, biosecurity, and various biotechnology applications within agriculture. Market assessment information is a key input into the R&D process. First, it enables a firm to make better extensive margin decisions by more efficiently selecting from alternative R&D projects, and second, it allows it to make better intensive margin decisions by more efficiently selecting the level of R&D intensity once a project has been chosen. The quality of information collected by a firm depends on the level of R&D subsidy that it receives, and this connection must be accounted for when designing an R&D subsidy scheme.

If a policy maker ignores the impact of an R&D subsidy on a firm's incentive to collect information, then the size of the subsidy provided to the firm will generally be inefficiently low or high, depending on whether the distortion is most severe at the R&D intensity margin or the project selection margin. If the most important function of information is to enable a firm to adjust R&D intensity across different information states, then a subsidy such as a research grant that targets the project selection margin will be inefficiently high, while a subsidy such as an R&D tax credit that targets the R&D intensity margin will be inefficiently low. On the other hand, if the most important role of information is to enable a firm to make project selection adjustments across different information states, then ignoring information gathering implies that a research grant will be provided at an inefficiently low level and an R&D tax credit will be provided at an inefficiently high level.

These results emerge because in the presence of an externality, additional information weakens the distortion at the R&D intensity margin but strengthens the distortion at the project selection margin. At the R&D intensity margin, additional information induces a firm to choose a higher level of R&D intensity. Therefore, a subsidy such as a tax credit that induces a firm to collect more information has a positive indirect marginal value and a subsidy such as a grant that induces a firm to collect less information has negative indirect marginal value. If these indirect

values are ignored, then the tax credit subsidy on offer is inefficiently low and the grant subsidy on offer is inefficiently high. At the project selection margin, additional information induces a firm to reject socially desirable projects in a larger number of information states, so a subsidy such as a tax credit that induces a firm to collect more information has negative indirect marginal value and a subsidy such as a grant that induces a firm to collect less information has a positive indirect marginal value. If these indirect values are ignored, then the tax credit subsidy on offer is inefficiently high and the grant subsidy on offer is inefficiently low.

In reality, it is difficult to imagine that a policy maker can fine tune R&D subsidies at the project selection and R&D intensity margins to the level described here. The above results should therefore be viewed more as a set of guiding principles for policy makers. In emerging industries such as biofuels, where private firms are ignoring socially desirable high-risk projects because of market externalities, R&D grants have a higher social value than originally believed because of the information collection incentives facing innovating firms. Similarly, in industries with established projects such as hydrogen fuel cells, where the social concern is a low level of R&D intensity, R&D policies such as tax credits and bonuses for successful innovation have a higher social value than originally believed because of information collection incentives.