Journal of Monetary Economics ▮ (▮▮▮▮) ▮▮▮–▮▮▮

Contents lists available at ScienceDirect

Journal of Monetary Economics

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

On the global supply of basic research

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ARTICLE INFO

Article history:
Received 2 July 2013
Received in revised form
16 February 2015
Accepted 16 February 2015

Keywords:
Basic research
Public goods
Economic growth
Coordination of governments

ABSTRACT

In a two-country Schumpeterian growth model, we study the incentives for basic research investments by governments in a globalized world. A country's basic research investments increase with the country's level of human capital and decline with its own market size. This may explain why some smaller countries invest so much in basic research. Compared with the optimal investments achievable when countries coordinate their basic research policies, a single country may over-invest in basic research. However, the total amount of decentralized basic research investments is always below the socially optimal investment level, which justifies policy coordination in this area.

1. Introduction

Basic research investments aim at acquiring new knowledge without any particular (commercial) application in view and are arguably a core driver of economic growth in industrialized countries. Traditionally, basic research investments are a matter of national policy-making. In some areas, however, international cooperation and coordination are playing an increasingly important role. This is most pronounced in the European Union, where large research programs are funded by member states and designed and operated at Union level in Brussels. Moreover, the basic research undertaken at several major institutes such as CERN in Geneva or by other high-technology ventures such as ARIANE are the result of joint efforts and agreements between several countries.[1] Whether international coordination on basic research investment is considered necessary depends both on the way we conceptualize basic research and on the way how investments in one country affect growth and welfare in other countries. There are arguments for and against the coordination of basic research across countries.

When basic research is viewed as a global public good whose output is freely available and whose consumption is non-rivalrous and non-excludable (Arrow, 1962; Nelson, 1959), the standard "free-rider argument" suggests that uncoordinated investment decisions will entail considerable under-investment.

Basic research may also be viewed as a regional good with international spillovers. The ideas created by basic research are non-rival goods in the country where these ideas have been generated. As a consequence, basic research may induce and increase prospects of success for regional firms' innovation efforts.[2] Moreover, firms with successful innovations may be able

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[1] Those projects rely on international cooperation since investments are large and lumpy.

[2] The positive side-effects occur through various channels whose outputs are: supply of trained scientists and problem-solvers, new scientific instrumentation, network for knowledge diffusion, enhancement of problem-solving capacities, start-ups and spin-offs from universities, prototypes of new products and processes (e.g., Salter and Martin, 2001; Brooks, 1994; Movery and Sampat, 2005 and Gersbach et al., 2009).

http://dx.doi.org/10.1016/j.jmoneco.2015.02.004
0304-3932/

to increase the rents generated by these innovations through exports or foreign direct investments. The possibility of capturing rents in foreign markets by taking away business from established firms suggests that basic research investments have negative externalities on other countries, which would cause over-investment.[3]

When the benefits of basic research are embodied in new products and services, and if a country is open to foreign direct investments, this country could benefit from the basic research of other countries. Foreign direct investments by leading-edge firms directly contribute to higher levels of productivity by transferring the best production techniques and products to the host country, thereby raising wages and consumer surplus. These positive externalities suggest that countries tend to under-invest in basic research.

This paper develops a framework to study the direction of externalities of basic research investments and examine whether there is an under- or overprovision of such investments when each country acts on its own. Two countries select their basic research investments in each period. Such investments foster the innovation prospects of domestic intermediate firms.[4] Firms that develop leading-edge technologies in one country obtain patents and can enter foreign markets through foreign direct investments to earn monopoly profits. When another country invests more in basic research, a country will experience positive and negative externalities of the kind described above. Moreover, if both countries invest in basic research, this increases the risk that innovation efforts may be duplicated in the world. Decentralized basic research investments are studied in a setting with governments maximizing the consumption of the current generation, and the long-term consequences of such decisions are explored. The basic research levels attained when countries coordinate their decisions are determined. Finally, the path of uncoordinated and coordinated basic research investments when governments maximize the welfare of all generations will be studied.

Our main insights are as follows: First, it is shown that the countries' basic research investments act as strategic substitutes. Further, a country's basic research investments will increase with its level of human capital, but decline with its relative population size. The reason for the latter is that a small country can earn large profits from gaining a monopoly position in a larger foreign country without sustaining the corresponding deadweight losses accruing abroad. This result may explain why some small open economies such as Korea or Switzerland invest a lot in basic research.

Second, comparing the decentralized basic research investments with the optimal ones when countries coordinate to maximize aggregate consumption, our finding is that both countries under-invest in the decentralized equilibrium if they are similar with respect to human capital levels and population sizes. Under asymmetry concerning either of these characteristics, one of the countries may over-invest in the decentralized equilibrium relative to the coordination optimum. From the cooperative perspective, however, the aggregate decentralized basic research investments are too low, even if one of the countries over-invests in basic research.

Third, our robustness discussion reveals that our results do not change qualitatively when a one-period or an infinite planning horizon of governments is considered. Of course, investments in basic research increase quantitatively when longer time horizons are considered. The appendix also discusses the implications of different welfare objectives under coordination and different assumptions on the costs of basic research.

The paper is structured as follows: The next section discusses the significance of basic research and relate our paper to the relevant literature in Section 3. Section 4 introduces the model set-up, and Section 5 discusses the households' and the governments' optimization problems. The decentralized equilibrium is derived in Section 6, while the dynamics of the model are described in Section 7. Section 8 compares the decentralized basic research investments with the ones optimal when countries coordinate to maximize aggregate consumption. Finally, conclusions are drawn in Section 9. The proofs and the robustness of our results with respect to infinite planning horizons are relegated to an appendix, which is provided online.[5]

2. Significance of basic research

It is useful to put the significance of basic research in perspective. The empirical pattern of basic research is shown in Table 1. In this table, basic research is defined by the OECD (2002) as "*experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view*". According to this definition,[6] basic research does not generally provide (commercializable) solutions for specific practical problems, but rather provides the ideas, methods, prototypes, and materials needed to tackle these problems. In the US, basic research is mainly conducted by the federal government and by universities and colleges, and about 80% of it is publicly funded (Cozzi and Galli, 2009 and NSB, 2012).

Two observations from Table 1 are worth emphasizing. First, basic research is mainly undertaken by industrialized countries that are at, or close to, the world technological frontier. Some of the emerging countries, such as Korea or Singapore, have considerably stepped up their basic research efforts. Second, large industrial countries such as the U.S. or

[3] The negative and positive externalities described in this paragraph are well documented in the literature (Baily and Gersbach, 1995; Keller and Yeaple, 2003; Alfaro et al., 2006).

[4] Hence, basic research is a non-rival good in countries at the technology frontier where new ideas are created. See Jones and Romer (2010) for systematic reasoning on why ideas in research should be viewed as partially excludable non-rival goods.

[5] Further robustness discussions can also be found in the Appendix.

[6] In practice, the distinction between basic research and applied research is not always clear cut.

Please cite this article as: Gersbach, H., Schneider, M.T., On the global supply of basic research. Journal of Monetary Economics (2015), http://dx.doi.org/10.1016/j.jmoneco.2015.02.004