

NECESSITY AND DIFFICULTY OF R&D PERFORMANCE MEASUREMENT

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– Abstract –

We are living in a globalized world with increasing population which is facing severe global economic and financial crises as well as serious environmental problems. The possibilities to overcome these difficulties can be interpreted as the need for sustainable development calling for innovation, increased R&D spending with increased R&D effectiveness and efficiency. Besides greater attention for the need of deeper understanding of the innovation process and the role of R&D in it, this paper has discussed the many analytical problems that confront a researcher in this area, and additionally calls for research on collaboration between universities and industry. Among other conclusions this paper also provides a new way of thinking for policy makers and performance monitoring committees.

Key words: R&D, innovation, measurement

JEL classification: O3

1. INTRODUCTION

The factors of economics growth are on the centre of economic literature since the industrialization. Traditional growths theories presume that change in quantity of traditional production factors (physical capital and labour) are capable of explaining a substantial part of economic growth. However several researchers in growth theory in the second half of 20th century hold that only 10-15 per cent of

economic growth is due to the accumulation in traditional production factors and large residual can be explained by technical and technological developments. The main sources of these progresses are the creation of knowledge (R&D) and innovation. However it is also widely accepted that the increase of knowledge and innovation does not automatically lead to progress in economic and/or societal welfare and not all innovation serve the sustainable development.

We are living in a globalized world with increasing population which is facing severe global economic and financial crises as well as serious environmental problems. The possibilities to overcome these difficulties can be interpreted as the need for sustainable development calling for innovation, increased R&D spending with increased R&D effectiveness and efficiency. In a rapidly change world the actors are facing increasing risk in investment to R&D and innovation and increasing financial resources required to be competitive. These facts consequently generate demand for effective measurement of R&D&I output.

2. PURPOSE AND DIFFICULTIES IN EVALUATION OF R&D PERFORMANCE

2.1. Success, motivation and decision making

The first question is the purpose of R&D measures and evaluation performance measurement, which can be different by measurement level (national, firm, manager, and personal, researchers) and types of R&D (basic, applied, engineering or commercial) as a measurement subject (Kim and Oh, 2002). Based on the literature overview it can be said that common, universal sets of R&D measures do not exist, and the ideal measurement may different from the current applied ones and includes a set of indicators (OECD,2010).

However, one thing is clear; all of actors of R&D activity have increased their expectation that R&D results will contribute directly to their success. But what is success? Higher growth rate, increasing competitiveness and welfare of a nation, competitive advantage getting extra profit or simply survival, increasing reputation of a university or a research institute, and personal advancement in professional career, and level of compensation. The measure of R&D outcomes is gaining increased importance in description of measurement methods and it is also necessary to pay more attention to the use of performance results in facilitating well balanced decision making. It also should be mentioned that performance measurement can serve the purpose of motivating individual researchers and increasing their success.

2.2. R&D contribution to economic growth and validation of the chosen investment level on R&D

The question how R&D investment rate is correlated with country growth rate and with income level is really an important, interesting as well as an intriguing issue.

According to the results of worldwide economic analyses on the relationship between the R&D effort and economic development, it has been shown empirically that there is no strong correlation (Michael et al., 1996, Boskin and Lau, 1996, EC, 2008, EC, 2009). Some countries with expectation of comparative advantage investing in R&D and innovation while other countries focusing on adoption and imitation R&D and maybe prospered as well, or they may have better results. The question is who is the winner, the leader or the follower. Results of R&D are embodied in goods and there is a knowledge surplus to buyers of them from their consuming. The international trade allows countries to benefit from new technology and new products developed elsewhere simply by importing resulting products. Knowledge externalities and new goods externalities are important drivers of economic development. Analysing the effect knowledge spillovers can point out as a new direction for future research (Fallah and Ibrahim, 2004). We agree that one of the central paradoxes of the information society is that it makes information easily reproducible, leading to a variety of control problems relating to intellectual property. This is related to the question patent protection as well. The competition increases the product differentiation, and makes easier the copy with a small change even in the cease of patent protection. As the ratio of adapters increases the marginal return of R&D is decreasing. The diminishing return on R&D investment both in the form of physical and human capital, effects on the decision of investors and change they behaviour that would lead to worldwide growth slowdown. These potential effects also need to take into consideration when analysing patent protection. We agree that deeper analysis is required, and some international actions are also essential.

As suggested by several research studies on the topic of R&D, innovation should managed and evaluate as a process. The major measurement difficulties, that there is no direct relation between the success of R&D and innovation. First of all not all R&D results in innovation and the problems of time lag should be noted as well. Following Schumpeter (1934), contributors to the scholarly literature on innovation typically distinguish between invention, an idea made manifest, and innovation, ideas applied successfully in practice (Wikipedia, 2010). According

to Luecke and Katz (2003) innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services. The wide range of factors determines if and a particular R&D project will result in commercial or other benefit. The recognition of R&D impact chain is also difficult.

We agree that one of the most critical motivations of measurement of R&D both at firm level and country level is the validation of the chosen level on R&D. The positive effect of suitable R&D investment on competitiveness is widely recognized both by policy makers and firms' R&D managers. In his works, writing about the disruptive innovation (Christensen, 1997) Mujumdar also calls for importance of risk analysis. Radical, discontinuous, disruptive or "game-changing" innovations are defined as those that transform current industries or technologies or products and generate entirely new ones. By definition they are few and far between. For those who are successful at it the rewards are enormous but they come at high risk. While the potential pay-off from successful innovations is clear, the risks involved are not always evident. Unknown market, inaccurate consumer input via surveys, and potentially long term investment with no clear indication of return-on-investment are some of the pitfalls. Having a new product or process that has better performance and cost-effectiveness does not guarantee it will capture the market overwhelmingly and replace existing products or technologies. The market and the consumer have to be ready to accept new products which must offer significant advantages. It means that success of innovation required new skills of management and new market and supply chains need to be formed as well (Mujumdar 2010 a, b).

2.3. The problems with output input ratio as tool of measurement

Most commonly to measure R&D performance tools of investment analysis or productivity measurements are used. Such performance measurement systems are built on the assumption of quantitatively measurable and comparable output and input used for R&D activity. The R&D productivity is also measured as a ratio of output and input. We agree with that both of numerator and denominator are hard to pin-point accurately. According to Hall (2007) there are important differences between R&D investment and ordinary capital investment. The most important difference is that the main result of R&D is creation of new knowledge about how to do something (Hall and Mairesse, 2009). The most important outcomes of basic and applied research are represented by new knowledge, a new body of competencies and capabilities that are intrinsically intangible. The assessment

based on the quantitative measurement values only the tangible results which are produced in the form of new products and generate revenues in the form of publications, citations or patents or a combination thereof. Additionally, the realized return to investors often differs from the value of the stock of knowledge created as a result of the R&D activity.

R&D creates a stock of knowledge on different level (society or and institutional, but also on personal, researcher level). Knowledge capital also should be thought of as knowledge disembodied or embodied (human and physical capital). Much of the knowledge created intangible and embedded in those scientist and engineers involved into to project, and less part is accumulating as an institutional knowledge or as public knowledge in cease of public financed projects (Karabay, 2011). The nature of R&D activities takes the measurable return the subject of researcher –manager-investor’s information asymmetry. The tacit knowledge embodied in people can be fruit in other institutions or countries through human capital mobility (Autant-Bernard and Massard, 2009). Increasing rate of knowledge which exist only in people also increase the difficulty of outcome measure.

Lag structure of R&D in generating return is mentioned in several scientific paper (Ravenscraft and Scherer, 1982, Mujumdar 2010,). The fact that the timescale required for measuring the outcome of R&D is typically long, it also create uncertainty in their return because of the uncertainty of economic depreciation (Hall, 2007). The speed of economic depreciation much depend on the factors which are endogenous to research team own behaviour, and that of the funding of further R&D and the result of R&D in its competitors elsewhere in the world. We agree that the research on the sustainable level of R&D support and also seems to be lacking towards this aspect future success. When we make estimation on future return of R&D the price impact of the results (increasing productivity may resulting in price decreasing of new products) should also be taken into consideration. The income tax rate and possibility of tax credit also can be mentioned as a factors influencing on net return of R&D activity.

The calculation of denominator (input) is likely to be as problematic as numerator. For denominator the monetary value of input is usually used. The expenditure on R&D can be divided into the following groups:

- current expenditures as wages and salaries of R&D personnel and the cost of materials used in the R&D process;

- capital expenditures incurred in R&D as the cost of machinery and equipment and facilities.

One of the reasons of difficulties in measuring R&D productivity index is that the structure of R&D investment spending and ordinary investment is different. More than half expenditure includes wages of highly trained scientist and engineers. The performance radically influenced by quality (creativity, experience, ability for teamwork buildings, communication skills) of labour applied in the project, which quality differences is not always mirrored in labour cost. The level of wages shows high differences by countries, but by industries or between the public and private sectors in the same countries. The differences between the input and output tax is also should be mentioned as a factor of making difficulties in comparison of R&D performance index. We also should keep in our mind that the effect of accounting for R&D spending also must to be controlled; the rule of depreciation of capital assets used in R&D can be mentioned as an example.

The effect of various tax jurisdictions in a perspective of globalization also should address. The large share of R&D carried out by private companies is concentrated in the large international companies. According to this the transfer pricing behaviour of these companies can lead a substantial distortion of input and also in output figures. Through the manipulation of transfer prices to the larger part of input cost have taken into account in the countries with large corporate tax, and at the same time the profits are shifted to low corporate tax economy. This behaviour increases the obscureness of measurement R&D performance and effects of that on the economy. This behaviour makes difficulties policy decision about supporting of R&D (Barry, 2005). We consider this a priority for future research.

2.4. Contribution and results of solving global problems: question of public goods

Among most critical points emphasised in innovation literature are the problems related to the global challenges. The effects of globalization and global problems on the dynamic and local needs of R&D are also mentioned in related literatures (Smith et al. 2010, Vollenbroek, 2002, OECD, 2010). We agree that global problems such as the climate change can only be solved by cooperation in R&D. It means by production of public good commonly. But the question, which related to the measuring of outcome of R&D, is that how can we calculate the monetary value of a public good, such as climate. But the question also is how we can destroy the barrier built by own interest which are varied by nation. It

seems to be higher willingness to cooperation in the field of mitigation than adaptation, because adaptation is much more beneficial on local level. It also raises the question “how and where to measure of output of R&D and innovation in international research?”.

2.4. Needs of cooperation and communication

What is the value of public good? Such question is also related to the evaluation of basic research of academies and universities. We find very important and interesting issues the drivers and their impacts on the effectiveness of academic and industrial R&D. The fact that academic research driven and dictated by granting body decision, cause problems not just because of changing in policy by the election cycle but because of decreasing sources of public finance the government switching their spending to more short term R&D project rather than long-term which has high potential broad based economic impact, but relatively high risk. This is in controversial of nature a basic research, and also decreases the return for the whole society. The governments should handle and support the basic research on different way, because this research may has purpose of to produce new knowledge about the principle underlying natural and social phenomena, without direct relationship with industrial application (Miller and Morris, 1994). It is also the question of measurement perspectives. More effort has to be making in measuring the impact of research. There are some progresses in building bridge between public financed basic research and industrial research and development activities in order to improve the effectiveness of R&D investments and to avoid expensive duplication and failures and increasing the efficiency of knowledge transfer (EC, 2008). One possible way used by several governments to support the R&D activity, make the decisions more market oriented through consortia between universities and companies (EC, 2009). We have no information about the additional yield of this cooperation but it can have positive effect on return to R&D investments, and also has some additional benefit both in the education and research. That is widely recognised in the related literature and empirical research that the certain way of technological discoveries are collaboration between universities and industry and it is also worth to invest into analysing of knowledge spillover of this cooperation (Christensen, 1997). The PPP (Public, Private Partnerships) is also can be fruitful for firms in order to benefit from public research, and it can make a channel for knowledge flows on both directions. Without effective cooperation the pure academic research does not always favour industrial innovation, the cooperation is a way in increasing of effectiveness of knowledge transfer and it may less

costly comparing with organization of technology transfer offices at the universities. However there is a controversy which is noteworthy to mention. One of the key issues of researcher concern is the opportunity for open discussions and the publication of research result and, whereas the industrial companies need to protect the value of their research investment.

We also agree with the necessity of peer review process at university and research institute level and also with that these are in several cases not as objective as we expected. It raises two important research questions: who should measure the performance of R&D scientist and engineers and what criteria should use to measure the performance. That is also questioned how can we combined the results oriented and process and impact oriented measurement system. The problems of motivation for R&D and innovation are also raise the question of measurement of contribution of individuals to the project results. These are important for work out the corresponding compensation system, and providing possibility for making sufficient the professional carrier plan. These factors also are regarded as important cornerstones of long-term success and or viability of nations, firms, university and research institute as well.

4. CONCLUSIONS AND RECOMMENDATIONS

The world's economies and society have been suffering from global economic, financial and also environmental crises. The different countries' policy and decision makers are desperately trying to find the solution and the best methods or financial recipes to overcome the problems and lead the economy out of the crises. Taxation and subsidy systems are changing in order to support the favored economic and social areas. All researchers, policy makers and players in the economy agree on, that research and development, innovation is one of the key factor for mid and long term success, therefore the R&D spending and R&D effectiveness should be increased. However, it is hard to foreseen which particular R&D activities would be worth to be subsidized by the state, which particular R&D projects should be decided by a company, by an institute or a researcher to be financed and worked out, because the R&D performance and the results are very difficult to measure and evaluate. To increase effectiveness and be able to target the spending more optimal, R&D process and suitable measurement and analysis techniques must be improved, and used more widely. This creates demand for more detailed research in this area.

Acknowledgment

Research was supported/subsidized by the TAMOP-4.2.2/B-10/1-2010-0011 „Development of a complex educational assistance/support system for talented students and prospective researchers at the Szent István University” project.

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