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Science in Business

Innovation and Growth - the role of R&D

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Abstract

The overwhelming consensus is that long term economic growth is dependent on technological innovation, usually expressed in terms of the investment made in research and development (R&D). This consensus arose initially from the growth accounting work of the Nobel Laureate economist Robert Solow who demonstrated that technological change is the largest factor influencing economic growth after taking into account capital deepening and labour productivity. Further studies over fifty years have sought to explain this phenomenon and recent use of endogenous models has indicated that the role of conventional scientific R&D is likely to be small, compared with informal/ general innovation based on management and business processes, marketing and promotion and organisational changes. Within firms, investments made in these areas are usually higher than on R&D and, because such innovations are disembodied, not patentable, and subject to a quicker diffusion, their externalities are larger and, consequently have more impact on economic growth than R&D outlays. The value of general innovations are now being realised and taken into account in international indicators of national growth. Interestingly UK companies rank highly in their ability to exploit such non-technological innovations relative to product innovations. The opportunity exists to boost economic growth through assisting firms adopt innovations based on new business models and processes, organisational, marketing, promotional and supply chain improvements. Market Innovation Centres represent one means by which this may be achieved in the UK.

Background

Scientists are largely unaware that they owe the continued investment made by successive governments into the UK science and research base to the American economist Robert Solow, the 1987 Nobel Laureate in economics. In the 1950's Solow formulated a theory of economic growth that emphasised the importance of technology. He argued that technology - broadly defined as the application of new knowledge to the production process - is the main factor responsible for growing an economy over the long term (Garfield, 1988). Since scientific research underpins the development of technology, the work of researchers has increasingly been seen to be crucial for economic growth, as well as having a role in raising overall levels of intellectual and cultural capital. However, recent analyses would suggest that the link between economic growth and formal scientific research might be more tenuous than previously thought and, while this may be perceived by some as a threat to the UK science base, it might better be viewed as a whole new opportunity for the University sector, for commerce and for the economy: this paper explains why.

Robert Solow (by Olaf Storbeck)

R&D: Whats Left-Over

The overwhelming consensus is that long term economic growth is dependent on technological innovation (Rosenberg 2004), with the latter, most commonly expressed in terms of the investment made in research and development (R&D). This belief is supported by some empirical evidence and simple regression models such as those that positively relate cross national Gross Domestic Expenditure on R&D (GERD) and the level of development measured by the GDP per capita (Pessoa, 2007). However, there are many factors that are omitted in regression analyses of this kind and so, even though they are sometimes highly correlated, this is not necessarily indicative of a causative relationship; R&D indicators could just be acting as a proxy for a range of other influencing factors.

Robert Solow's research in 1956 on growth accounting, led him to the conclusion that labour productivity and capital deepening accounted for as little as one eighth of the growth in the US economy between 1909-1949, the residual - the majority of growth, he attributed to technical change. Following Solow's analyses the challenge was to clearly refine both understanding and measurement of the residual, and a series of studies, most notably those of Denison

(1967), and Jorgenson and Griliches (1967) sought to reduce the size of the residual growth, taking into account factors such as, labour quality due to education. Although other components were considered in attempts to downsize the residual, these have not commanded widespread support (Crafts 2008). So Solow's growth accounting models focussed attention on the role of science and technology and the importance of the rate of technical change in economic growth but were unable to explain the causes of such technical progress (Cameron 1996). In the 1980s economists turned to the use of endogenous growth theory.

Endogenous Growth Models

Endogenous growth theory holds that economic growth is primarily the result of internal factors (over which some control may be exerted through government policy), rather than some unmanageable external force. Hence, government can use policy measures to influence R&D and long-term growth, and from which there may also be externalities or spill over effects that have a positive impact on the wider economy. For example, investment in university R&D in order to develop technologies, also facilitates improvement in education and hence, the quality of labour, as well as contributing to the overall stock of knowledge with wider benefits for society.

One such use of endogenous growth theory has been to evaluate the direct impact of R&D investment on economic growth using models which assume a free entry condition for R&D. Free entry refers to the condition in which at equilibrium, R&D firms break even, i.e. the cost of the investment in R&D equals the value of the newly developed technologies. It is also assumes that the technology leads to specific products or goods which can be protected - it is an embodied innovation. The company can only benefit from R&D by using the goods that result from the R&D activities, which has the effect of bounding the impact on externalities. R&D is also assumed to consist of activities carried out by persons trained, either formally or by experience in the physical and biological sciences, engineering and computer sciences, involving basic and applied research and development activities (NSF definition of R&D http://www.nsf.gov/statistics/randdef/business.cfm).

Two models, one by Diego Comin (2004) and the other by Argentino Pessoa (2007, 2010) evaluate the impact of R&D to economic growth of post war USA, and OECD countries respectively, with each model revealing similarly interesting insights.

Comin (2004) based his analysis on the premise that R&D was the main source of the 2.2% average post war growth in the US economy. However, his model demonstrated that less than 0.3-0.5% of this was actually due to R&D, and it was non-R&D factors that were responsible for the largest share of productivity growth. Comin considered that because the US is the world leader in R&D, this finding was valid and applicable to other nations.


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Passoa (2007,2010) then also demonstrated, using the condition of free entry into R&D, that the relationship between R&D investment and economic growth in OECD countries was lower than expected thereby drawing attention to the importance of those investments that are not normally classified as R&D. As Passoa puts it 'the failure in finding a close relationship between R&D intensity and economic growth increases the probability that other investments directed at improving productivity can be more important." These he concluded involved innovations, such as marketing, design and engineering capabilities, organisational change, new production facilities all of which have been acknowledged to play an important role in a firm's innovation efforts and performance (Dosi, 1988; Kline and Rosenberg, 1986; OECD, 1997; Rosenberg, 1976). Given that investments in these areas are usually on a larger scale than R&D and, because the innovations that result from them are disembodied, not patentable, and subject to a quicker diffusion, the externalities associated with them are probably much larger and, consequently, may have more impact on economic growth than the effect of the R&D outlays. This view has been tested in a paper by Comin and Mulani (2009) which considered two types of innovation: conventional "idiosyncratic" R&D (embodied) innovation, and non-technological, general (disembodied) innovations.

Comin and Mulani (2009) were able to show how at the individual company level their volatility is affected primarily by the Schumpeterian dynamics associated with the development of R&D innovations, but the variance of aggregate productivity growth (of all companies) is driven by the arrival rate of general innovations. All things being equal, the share of the resources spent on the development of general innovations increases with the stability of the market share of the market leader. As market share becomes more variable the model predicted a shift in the internal allocation of resources from the development of general innovations to the development of R&D innovations. This resulted in an increase in R&D, but also an increase in company volatility. These findings have interesting implications for governments and business investments in conventional R&D relative to more general innovation.

Implications for the UK Economy

From a government perspective these studies present a scenario whereby it might be possible to achieve a larger positive impact on economic growth through supporting research that will lead to non-technological innovations rather than traditional science-based technological innovation through conventional R&D. And interestingly the UK business community may be more receptive to this approach than others in OECD countries. For example, OECD (2010) notes that over the period 2001-07, the average UK productivity growth was 2.1%, with up to two thirds of this being accounted for by factors associated with innovation. However, whereas UK companies derived little turnover from product innovation and indeed was below the OECD average, they had an above average 44% of firms adopting non-technological innovations during the same period. From a UK plc business perspective, more immediate growth may be achieved from general innovations, with additional spill-over affects to the whole UK economy, than through investing in conventional R&D. However, this would require firms to be able identify the gaps and opportunities for general innovations that are not currently being fully exploited.

A recent report by Dent and Theodorou (2011) considers how by analysing the market for innovation, including non-technological innovations, it is possible to take a more focussed and directed approach to delivery of innovations which can have a more immediate affect than the conventional, purely science-based approach to R&D. The report highlights the need to utilise methodologies which embrace market gaps, which will not only generate novel products and services, but also non-technological innovations based on new business models, processes, market positioning, organisational and structural improvements as well as supply chain innovations. Dent and Theodorou (2011) propose the establishment of Market Innovation Centres to promulgate more market-led approaches to innovation, which engage with a wider range of players, particularly utilising a wider range of academic expertise, to generate both technological and non-technological innovations. They argue that such an approach represents a cost effective way of stimulating growth in UK-based innovation and the nation's economy.

Conclusion

Economists now consider that both technological and non-technological innovations to be crucial for the growth of an economy with the latter probably contributing more to aggregate growth than the former. This provides governments and businesses with an opportunity to build on traditional R&D approaches to technological innovation, with a commitment to maximising benefits to the economy from non-technological innovations. Market-led Innovation Centres provide a mechanism by which this may be achieved.

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