



The impact of innovation activities on firm performance using a multi-stage model: Evidence from the Community Innovation Survey 4

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ARTICLE INFO

Article history:

Received 15 September 2010

Received in revised form 1 September 2012

Accepted 30 September 2012

Available online 31 October 2012

JEL classification:

O310

L25

Keywords:

Innovation

Firm performance

Multi-stage model

Community Innovation Survey 4

ABSTRACT

The impact of innovation on firm performance has been a matter of significant interest to economists and policy makers for decades. Although innovation is generally regarded as a means of improving the competitiveness of firms and their performance, this relationship has not been supported unambiguously by empirical work. This paper presents one of the first attempts to assess the drivers of the innovation process in two different institutional settings: mature market economies of Western Europe and advanced transition economies from Central and Eastern Europe. A multi-stage approach to innovation is applied to the firm level data from the fourth Community Innovation Survey (CIS4), covering some 90,000 firms. The findings reveal a positive relationship between innovation activities and productivity. Firms decide to engage in innovation and on how much to invest under pressure of competition. In making these decisions firms rely on the knowledge accumulated from previously abandoned innovations and cooperation with other firms and institutions and other members of their group. Subsidies lead to additional spending on innovation by firms but do not lead to additional innovation output. The results also show that larger firms are more likely to embark on innovation activities and invest more in innovation but innovation output decreases with firm size. Finally, results reveal several differences in behaviour of firms in two groups of countries.

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1. Introduction

Traditional economic theory predicts that in the long run all firms will converge to their steady state equilibrium position and optimum size. However, evidence from different industries suggests that firms which perform better today are more likely to perform better tomorrow. The main explanation for this non-transitory feature of firm behaviour is the different capabilities of firms to generate and implement new knowledge which determine their relative position in the industry. In the last few decades a large number of studies have attempted to map the channels and mechanisms through which new knowledge is transformed into better performance. However, the evidence from this literature is inconclusive thus calling for further research.

The interest in innovation spans from the firm level to the national level. It is argued that countries can achieve higher rates of growth and favourable terms of trade by specialising in knowledge

intensive products with higher added value (OECD/Eurostat, 1997). For this reason policy makers across the globe have been struggling to develop policies which would stimulate spending on R&D activities and increase the efficiency of the innovation process. In 2000 the EU set itself the goal of becoming the most competitive knowledge based economy in the world. The failure to achieve this goal can be traced to many factors including the inability to stimulate R&D spending and enhance the innovation activities of firms in EU countries, particularly new members from Central and Eastern European Countries (CEECs) which are seriously lagging behind.

This study presents one of the first attempts to compare the determinants of the innovation process in mature market economies of Western Europe with the transition economies that have recently joined the EU. A multi-stage approach to innovation is applied to the firm-level data collected by the fourth Community Innovation Survey (CIS4) in order to identify factors which drive each stage of the innovation process in different institutional settings. The rest of paper is structured as follows. In Section 2, we present the theoretical framework for the relationship between innovation and firm performance using a multi-stage framework. Section 3 reviews major findings from the innovation literature. The main characteristics of dataset for the two samples are analysed in Section 4, while Section 5 presents the methodology and model

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specification. The results of the estimation process are discussed in Section 6. The sensitivity of the model is examined in Section 7 before concluding in Section 8.

2. Theoretical framework

Innovation refers to all scientific, technological, organisational, financial and commercial activities which lead to, or are intended to lead to, the implementation of technologically new or improved products or services (OECD/Eurostat, 1997, p. 39). An innovation contains new ideas which influence the behaviour of economic agents in a previously unknown way. The introduction of new technology and human capital, and improvements in the organisation of production increase a firm's efficiency and enable it to produce at lower costs than its rivals. Similarly, the introduction of new products provides consumers with new goods and services which, in turn, leads to the expansion of firms in new segments of the market (OECD/Eurostat, 1997, p. 31). Innovations then enable firms to differentiate themselves from their rivals (by new products, processes, costs or organisational improvements).

The traditional model of firm behaviour postulates that innovations can have only a transitory effect on firm performance because the new knowledge will soon be diffused and imitated by rivals. Thus, from this perspective, in the long run all firms will converge to the steady-state equilibrium (Knight, 1921). However, there is a vast amount of evidence showing that some firms in different industries and in different institutional settings remain superior to their rivals for a considerable period of time, irrespective of the measure of firm performance used (Klomp and Van Leeuwen, 2001; Loof et al., 2001; Kemp et al., 2003).

The above findings are more consistent with conceptualisations offered in other schools of thought, particularly Schumpeterian, evolutionary and the endogenous growth theory. According to Schumpeter's thesis of creative destruction, the introduction of new goods, new methods of production, opening of new markets, discovery of new sources of supply, and new organisational forms regularly result in the destruction of the existing economic structures and their replacement with new ones. In Schumpeter's early work, the entrepreneur's desire to constantly move boundaries and change the existing organisational forms was regarded as the main driver of innovation. However, later, he argued that large firms operating in concentrated industries are the main source of innovative activity (Schumpeter, 1942). It was suggested that the development of innovation requires the accumulation of knowledge and financial means; thus the small entrepreneur could no longer be the principal driving force of innovation. The entrepreneur's role was relegated to large firms and their R&D laboratories which were more likely to possess the necessary human and financial capital for innovation.

Another set of explanation is offered by the evolutionary model of the firm (Nelson and Winter, 1982) which maintains that the behaviour of any firm consists of, and is based on, a set of learned principles or routines. The quality of an individual firm's routines determines its position in relation to rivals, analogous to the position of species in the evolutionary chain. Firms cannot, of course, maintain their superiority permanently on the basis of their existing routines: innovations, which enable firms to develop new and upgrade existing routines, drive the continuous changes in the economic system and ensure the survival of innovating firms.

The endogenous growth literature introduced the concept of simultaneity in the relationship between innovation and performance. In this model the growth of an economy is determined by the level of technology and innovation which, in turn, depends on the share of GDP devoted to these activities (Romer, 1990; Grossman and Helpman, 1994; Aghion and Howitt, 1998). Here

innovation is seen as a non-rivalrous input in the production process. It is also emphasised that the incentive to innovate is closely linked to the functioning of institutional framework for innovators cannot acquire rents from their invention in an unsuitable institutional environment.

Building on these foundations, Klette and Griliches (2000) developed the multi-stage model of firm behaviour in which they argue that the growth of a firm is determined by the quality and price of its own and its competitors' products and that the quality of its products can be improved through innovation. The intensity of innovation, however, is postulated to be independent of the firm's size. Instead, it is related to the profit margin of the firm which, in turn, depends on the degree to which the firm can differentiate its products from its rivals' products. The model also identifies other industry characteristics such as the demand for high quality products and the availability of innovative opportunities which are likely to affect R&D intensity.

In recent years, the above insights have been synthesised in a number of papers through the multi-stage model of innovation process (Crepon et al., 1998; Loof and Heshmati, 2002, 2006). This stream of literature traces the innovation process from a firm's decision to innovate to its performance, bringing together features of innovation recognised in earlier models such as reverse causality, individual heterogeneity, etc. The present paper is based on this approach to modelling the innovation behaviour of firms.

3. Literature review

Earlier studies on innovation typically reported a positive relationship between innovation and measures of firm performance. Most of these studies used R&D expenditure as the principal measure of innovation. Using cross-sectional data for US firms between 1972 and 1977, Griliches (1986) finds that higher R&D investment leads to higher rates of productivity growth among firms. Basic research appears to be a more important determinant of productivity than other types of R&D and privately financed R&D expenditure appears to be more effective than those financed by the state. These findings were later confirmed by Lichtenberg and Siegel (1991) who used longitudinal data on US firms between 1972 and 1985. Similar findings have also been reported for other countries. On the basis of a sample of Japanese manufacturing firms in 1982, Goto and Suzuki (1989) find that the growth of productivity is positively related to the growth of R&D investment in a firm's core activity and also to the growth of R&D investment in supplying industries. Similarly, for a sample of UK firms between 1988 and 1992, Wakelin (1998) finds that R&D intensity had a positive and significant effect on productivity growth.

However, it has been suggested in several studies that R&D expenditure suffers from several shortcomings when used as the measure of innovation activity. The Oslo Manual (OECD/Eurostat, 1997) notes that measures of innovation input, although related to technical change, are not its direct measures. R&D expenditure does not encompass all the innovative efforts of firms such as learning by doing or the knowledge embodied in its investment in new machinery and also its human capital. Kemp et al. (2003) add that studies based on R&D expenditure are not informative about the actual process of innovation. Moreover, the expenditure approach to innovation might be misleading because the lower amounts of own expenditure on the innovations might simply reflect the fact that the innovation is being developed in cooperation with universities or other firms where an outside agency covers the cost of R&D expenditure. Another problem associated with R&D figures is the tendency towards understatement of R&D in smaller firms. Some studies have reported significant discrepancies between official statistics on the number of firms receiving R&D subsidies and

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