



Does R&D performance decline with firm size?—A re-examination in terms of elasticity

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Abstract

There have been many previous studies exploring the relationship between R&D performance and firm size; however, to our knowledge, this issue has never been examined in terms of R&D output elasticity. This paper therefore sets out to re-examine the relationship of the two variables using R&D output elasticity as a measure of R&D performance. A total of 126 manufacturing firms, listed on the Taiwan Stock Exchange over the period from 1994 to 2000, are taken as the analytical sample. One practical consideration for choosing these particular firms is the relative abundance of data available for the variables for a longitudinal investigation. The estimates suggest that there is an approximating ‘U-type’ relationship between R&D productivity and firm size. This finding suggests that both large and small firms have higher R&D productivity, and even when the sample is divided into the high-tech and traditional sectors, such a finding still holds. Therefore, in contrast to the prior studies, this study shows that size offers advantage in R&D performance.

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1. Introduction

Fisher and Temin (1973) argued that the relationship between firm size and innovative outputs, as opposed to innovative inputs, can provide the Schumpeterian

hypothesis with a much clearer formulation. Several studies since then have tested the relationship between innovative performance and firm size (Pavitt et al., 1987; Acs and Audretsch, 1990, 1991; Cohen and Klepper, 1996a,b). We note, however, that innovative performance in these studies often refers to R&D productivity in terms of patent counts or patent to R&D expenditure ratios. In contrast to these studies, others have used the rate of return on R&D investment as a measure of R&D output in an effort to examine the same issue (e.g., Griliches, 1980; Link, 1981;

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Lichtenberg and Siegel, 1991). It should be borne in mind, however, that in examining this issue, these studies have not measured R&D performance as R&D output elasticity.

This study therefore sets out to re-examine the relationship between R&D performance and firm size and, in contrast to the prior research, measures R&D performance as R&D output elasticity i.e., the percentage change in the growth of total factor productivity (TFP) divided by the percentage change in the growth rate of R&D capital. Furthermore, within this study, firm size is treated as a moderator variable rather than an independent variable. A panel sample of manufacturing firms, listed on the Taiwan Stock Exchange (TAIEX) over the period from 1994 to 2000, is taken as the analytical unit. One practical consideration behind this sample choice is the relative abundance of data on the variables for a longitudinal investigation. Clearly, this paper aims to provide a contribution, from an unusual viewpoint, in order to add to the current knowledge on the relationship between innovative output and firm size.

The remainder of this paper is organized as follows. Following this introduction, the next section undertakes a review of the prior related studies, followed by an introduction to the methodology adopted in this study. Some descriptive statistics of the major variables and the analysis of the results of the model estimation are presented in the penultimate section. The major findings, implications, limitations and suggestions for future research are presented in the closing section.

2. Literature review

The relationship between innovative output and firm size continues to arouse controversy, with several viewpoints having been put forward to support the proposition of a positive relationship between the two. The first of these states that innovation is more productive in large firms as a result of complementarities between R&D and other functional activities, such as marketing and manufacturing (Cohen, 1995). Although the diverse activities are more specialized, the effects spawned from complementarities between them are more significant (Whittington et al., 1999). Since R&D and other functional activities become spe-

cialized as the firm grows (Mintzberg, 1993), one may expect that there would be a higher contribution from innovation to competitive advantage in large firms. The second claim is that larger firms can earn higher returns on R&D due to the advantages of cost spreading. Cohen and Klepper (1996b) demonstrated that the R&D expenditure of a firm can be spread over its outputs; hence, large businesses can gain higher returns on their R&D. Legge (2000) argued that through their R&D efforts, large firms clearly dominate process innovation, and then go on to improve their efficiency; as a result, their returns on R&D increase with the improvements in output levels over which their R&D expenditure may be spread. Link (1981) found a positive relationship between the returns on R&D and firm size in US manufacturing firms, whilst Henderson and Cockburn (1997) argued that large firms have a substantial advantage in terms of their ability to sustain an adequately diverse portfolio of research projects, and to make use of internal and external knowledge spillovers. Their empirical analysis suggested that larger firms in the pharmaceutical industry are more productive, in terms of their R&D outputs, than smaller firms.

Counter-arguments have also been provided on the relationship between innovative contribution and firm size, with one suggestion that as firms grow in size, efficiency in R&D is undermined either through loss of marginal control, or through excessive bureaucratic control which diverts the attention of the firm's technologists (Scherer and Ross, 1990). Another claim is that since large firms earn higher returns per unit of R&D expenditure due to cost spreading, they may be induced to carry out more R&D effort, and will thus be subjected to lower average R&D productivity (Cohen and Klepper, 1996b). Griliches (1980) found no significant evidence of any increasing returns to firm size, with the notable exceptions of the chemicals and petroleum industries, whilst Lichtenberg and Siegel (1991) could find no higher returns on R&D for larger firms over their smaller counterparts. Pavitt et al. (1987) suggested that innovation is more productive both in very small and very large firms than in moderate-sized firms; i.e. that there was a 'U-type' relationship between innovative performance and firm size. Cohen and Klepper (1996a) and Acs and Audretsch (1990, 1991) demonstrated that innovative performance tends to decline with

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