Industry R&D intensity distributions: regularities and underlying determinants

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Abstract. This paper aims to examine the nature of the distributions of firm R&D intensities within industries and explore the factors that underlie the industry R&D intensity distributions. In particular, following the seminal study by Cohen and Klepper (1992) and using some new and rich data on firm R&D intensities for seven industries across six countries, this study examines the regularities in the industry R&D intensity distributions and demonstrates, based on a simple model of firm R&D, that the industry R&D intensity distributions are governed by the distributions of technological competence, a measure of firm R&D productivity, which corresponds to the notion of the “unobserved R&D-related capabilities” suggested by Cohen and Klepper (1992). This study found that firm R&D intensities within industries are lognormally distributed, displaying a strikingly regular pattern across industries, that the industry distributions of the levels of technological competence are also lognormal, and that, based on the formal model of firm R&D and the notion of the unobserved R&D-related capabilities, the distribution of firm technological competence within an industry underlies the industry’s firm R&D intensity distribution.

Keywords: R&D intensity distributions – Lognormal distribution – Technological competence

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1 Introduction

Understanding the variables that influence research and development (R&D) investment has long challenged researchers and policy makers. In a seminal paper,
Dorfman and Steiner (1954) presented in a simple and intuitive way how firm R&D expenditure is determined, by showing that a monopolist’s profit-maximizing R&D intensity can be represented as the ratio of the quality elasticity of demand to the price elasticity of demand. Since the inception of the Dorfman-Steiner theorem, a considerably large body of empirical studies has been accumulated regarding the effects of various factors that seem to influence firm or industry R&D effort.

Griliches (1957), Schmookler (1966), and Scherer (1982), among many others, emphasized demand-side variables, especially market size, showing that inventive activity is responsive to the pull of demand (i.e., the size of the market). Along with demand-pull, technological opportunity and appropriability conditions have also been found as important factors governing firm or industry-level inventive activity (e.g., Scherer, 1965, 1982; Levin et al., 1985). In particular, the effects of firm size and market structure on firm or industry R&D have been explored, mostly empirically, at a considerable length (e.g., Cohen and Levin, 1989; Scherer and Ross, 1990 for a summary). However, previous empirical findings are diverse and more often than not conflicting, thereby suggesting that much remains to be learned especially regarding the underlying factors influencing firm R&D intensity and their distributions among firms within industries.

In a pioneering study of industry R&D intensity distributions, Cohen and Klepper (1992) took an interesting approach to the understanding of the determination of firm R&D intensity and its distributions within industries. Their approach is based on the observation that “Firm R&D intensity has been related to firm characteristics such as size, cash flow, and degree of diversification, but none of these factors plays a consistent or sizable role across studies in explaining the heterogeneity in firm R&D efforts. ...The fact that it has been so difficult to identify observable correlates of firm R&D intensity further suggests that the key determinants of firm R&D intensity are unobservable and that the probabilistic process operates by conditioning the values of these unobservables.”

Indeed, Cohen and Klepper (1992) found several regularities in the distributions of firm R&D intensities within industries using firm R&D data for 1974–1977 from the U.S. Federal Trade Commission’s Line of Business Program. They found that industry distributions of firm R&D intensities are unimodal with an external or internal mode and are skewed with an extended tail to the right (i.e., to the high value side of R&D intensity). Based on the distributional regularities, they conjectured that there exists a common probabilistic process governing the distributions of what they called “unobserved R&D-related capabilities” among firms within industries. Then, they showed that a binomial distribution of the unobserved R&D-related capabilities could account for the distributional regularities.

Following the stimulating research by Cohen and Klepper (1992), this paper further explores and confirms the general idea that a common probabilistic process governing the distribution of some R&D-related expertise across firms underlies the distribution of firm R&D intensity. In particular, this paper seeks to characterize the nature of the R&D-related expertise and demonstrate empirically that the industry distributions of a variable representing the level of firm-specific technological competence – a measure of firm R&D productivity – closely conform to the