



NORTH-HOLLAND

# Patenting, R&D and Market Structure: Manufacturing Firms in Denmark

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## ABSTRACT

This article explores the link from firm size and market concentration to patenting and R&D in a sample of manufacturing firms in Denmark. The Schumpeterian notion of firm size and market concentration suggests that the combined effects by these structural determinants of industrial innovation are inductive to industrial innovation. Previous studies rely mainly on large-firm evidence, and most often evidence is based on truncated samples. In short, evidence on how structural determinants induce industrial innovation remains sparse at best.

On the basis of the two-stage correction procedure suggested by Heckman [1, 2] the impact of firm size and market concentration on patenting and R&D activity is investigated on new firm-level data developed in cooperation with the Danish Patent Office and the Danish Institute for Studies in Research and Research Policy. The results indicate that the Schumpeterian notion is more subtle than originally conceived. Hence, in a simple model setting both firm size and market concentration are found to induce increased patenting activity as well as increased R&D effort in manufacturing. Yet, because selection bias is likely to take place, we should not dismiss the discussion too hastily in favor of one school of thought for another. © 2001 Elsevier Science Inc.

## Introduction

One of the fundamental notions within industrial organization was already subjected to empirical testing by Scherer [3]. Being one of the first empirical studies to engage the Schumpeterian notions on firm size and market concentration, the study introduced a complex discussion on how market structure supposedly influenced industrial innovation. Using patents and R&D employment as proxies for industrial innovation, Scherer did not bring about decisive evidence. Yet he concluded: "Perhaps a bevy of fact-mechanics can still rescue the Schumpeterian engine from disgrace, but at present the outlook seems pessimistic," [3, p. 1122]. Put simply, the Schumpeterian hypothesis suggests that large corporations are the primary turning-wheels of technological change. In addition, large corporations have the necessary "internal demand," complemented by market power, which would expectably facilitate innovation even further. So, as new micro-economic data are being developed at an increasing pace throughout Europe and often can be coupled to information on industrial innovation, it remains a good starting point to sample information on industrial innovation and to test the combined effects of firm

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Technological Forecasting and Social Change 66, 47–58 (2001)

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0040-1625/01/\$-see front matter

PII S0040-1625(99)00064-5

size and market concentration. For further readings, see Soete [4], Cohen and Levin [5], and Baldwin and Scott [6].

Three decades after Scherer began looking for structural determinants of technological change, we realize that our insights regarding the incentives for firms to innovate and how they distinguish themselves compared to non-innovating firms remain sporadic. In Denmark, for example, only a few explorative studies on the patenting activity of firms residing in Denmark have been carried out since the late 1980s. However, within recent years, the computerization of commercial online patent databases has provided economic research an improved opportunity to retrieve large amounts of information on patents filed worldwide. Patent data are compiled by patent organizations, such as the European Patent Office, as well as other commercial patent databases designed for novice investigation of the current status of patent applications.

For the purpose of studying patenting firms in Denmark, a database containing a naturally confined sample of patenting firms filing applications according to the European Patent Treaty was developed during 1996–1997 as part of a three-stage research strategy. The first stage investigated the total distribution of active patents issued to firms or persons with domicile in Denmark according to their application dates. On this basis, patents were additionally tracked by the first filing countries evaluating the initial pattern of designated countries by patenting firms and persons with domicile in Denmark.

The second stage consisted of developing a database of the patenting activity of firms with domicile in Denmark, filing applications according to the European Patent Treaty. The raw data were retrieved from the INPADOC online database situated in Vienna, which is administered by the European Patent Office.

The third stage was initiated in March 1998, and resulted in a full-scale patent database containing the total patent stock of firms or persons with domicile in Denmark. By autumn of 1998, the patent database was operative as the result of three years' cooperation with the Danish Patent Office.

This article takes advantage of the Danish Patent Database for Economic Research and presents results from a follow-up study on the incentive for firms to become patent-active. Previous results from the United States and Great Britain, on firms' incentives to patent are based on truncated data and mainly on large firms. This article therefore investigates the potential bias that is likely to arise when, for example, industry-level variables according to market concentration are included in an empirical model of industrial innovation.

According to the two-stage procedure suggested by Heckman [1, 2], potential selection bias can be captured in terms of a specification error. This procedure takes advantage of the properties of the binary Probit procedure. As the available sample discerns between patenting and non-patenting firms, as well as R&D and non-R&D performing firms, it can initially be argued that the underlying competitive pressure of potential innovating firms is captured by a binary-dependent variable. Hence the dependent variable takes only two values representing whether the firms are observed as patent-active or not.

The arguments for this methodology in testing the Schumpeterian assertions on market structure and innovation account for several intuitive shortcomings of the LS-regression approach. First, one way of testing the simple Schumpeterian hypothesis that large, well-established firms are more innovative than small entrepreneurial-like firms would be to divide the sample into small and large firms (see Acs & Audretsch [7]). By grouping innovating firms into categories according to the observed variable, these

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