

Patents Innovative Activity

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INTRODUCTION

While a substantial literature has emerged trying to shed some light on the relationships between firm size, market structure, and technological change, empirical studies have been handicapped by the lack of comprehensive measures. Most of the previous work has been constrained by data availability, forcing researchers to proxy innovative activity either with some measure of the number of patented inventions (Scherer, 1965, 1983, 1984; Pakes and Griliches, 1980) or else an input measure, such as R&D (Bound et al., 1984; Soete, 1979; Scherer, forthcoming). By contrast, in our 1987, 1988, and forthcoming studies we introduced a new data set providing a direct measure of innovative activity. However, our studies provided little insight on the comparability between the traditional R&D and patent measures used to proxy technological change, and the direct measure of innovative output. Such comparisons are important, because patent and R&D data have greater applicability than do the innovation data. For example, both patent and R&D data exist over time, while the innovation data set is restricted to a single year. Similarly, comparable data exist in other countries for the R&D and patent measures but not for the innovation data.

The purpose of this paper is to shed some light on the reliability of patent data as a measure of innovative activity. We compare the relationships between the number of patented inventions, market structure, and firm size using the identical model as in our forthcoming study, where the direct measure of innovative activity is used. This enables us to examine the performance of patents as a proxy measure for innovative activity and evaluate the reliability of this measure for other applications.¹

MARKET STRUCTURE AND TECHNOLOGICAL CHANGE

As surveyed by Baldwin and Scott (1987) and Cohen and Levin (1989), a rich empirical literature has emerged relating market structure to technological change. In our forthcoming study, we develop a model positing that innovative activity is determined by factors creating knowledge, the ease of appropriability, and by firm size. To test whether the patent measure is a reliable proxy for the direct measure of innovative activity, we use the identical regression model as in our forthcoming study and then compare the results.

In operationalizing this model, technological change is assumed to result from three different sources of knowledge: 1977 company R&D expenditures/sales (RDC), government-supported R&D expenditures, which combine with RDC to comprise total R&D expenditures/sales (RDT), and the extent of skilled labor in the industry (SKILL). Both of the R&D measures are from the 1977 Federal Trade Commission (FTC) line of business data. Skilled labor is measured as the share of employment accounted for by professional and kindred workers, plus managers and administrators, plus craftsmen and kindred workers, 1970, and comes from the U.S. Department of Census.

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Four different surrogates for appropriability are included in the model which have appeared in numerous previous empirical studies. These are the 1977 capital-output ratio (K/O), defined as gross assets divided by value-of-shipments, the 1977 four-firm concentration ratio (CR), the advertising intensity (AD/S), which is defined as advertising expenditures divided by value-of-shipments, and the mean percentage of employees in the industry belonging to a union between 1973 and 1975 (UNION). While K/O and CR are taken from the Census of Manufactures, AD/S is derived from the U.S. Input-Output Table, and UNION comes from Freeman and Medoff (1979).² UNION is included on the basis of the arguments by Connolly, Hirsch and Hirschey (1986) and Hirsch and Link (1986) that unions capture rents from intangible capital investments, and, in particular, those accruing from innovation-producing R&D. To the extent to which unions are successful in such rent-seeking activities, the ease of appropriability by the innovating firm is clearly reduced.

The measure of firm size is PILF, defined as the percentage of an industry which is accounted for by firms with more than 500 employees in 1977. The Schumpeterian Hypothesis implies that PILF will be positively related to innovative activity.

In our 1987 paper we emphasized that absolute measures of technological change may be misleading, since they are not standardized by some measure of industry size. Thus, in both our 1987 and forthcoming studies, we standardize the direct measure of innovative activity by dividing the number of industry innovations by the value-of-shipments. Therefore, rather than using the absolute number of patents as the measure of technological change in the above model, we use the patent rate, or the number of patents registered per dollar of sales. The patent rate is presumably a superior measure because it is weighted by industry size. The patent data are from the Office of Technology Assessment and Forecast of the U.S. Patent Office.

EMPIRICAL RESULTS

Table 1 shows the results for estimating the patent rate based on 247 four-digit SIC industries. Equation 1 includes company R&D expenditures only, while Equation 2 includes total R&D expenditures. Equations 3 and 4 provide a direct comparison with the patent rate measure by showing the results from Chapter Three in our forthcoming study where the innovation rate is used to measure technological change.

Private R&D intensity apparently exerts a similar influence on both the patent and innovation rates. The performance of total R&D intensity differs slightly. In equation 2 it is positive but not statistically significant, but in equation 4 it is both positive and statistically significant. Capital intensity and concentration have disparate effects on the patent and innovation rates. K/O and CR are positively related to the patent rate but negatively related to the innovation rate.

While UNION, AD/S, and SKILL all perform similarly in estimating the patent and innovation rates, the share of employment accounted for by large firms, PILF, exerts a negative influence on the patent rate but a positive influence on the innovation rate.

In general, these results suggest that patents are not a perfect measure of innovative activity. As Scherer (1983) and others have noted, the propensity to patent an invention varies with market structure and firm size. Scherer (1983) argues that firms in highly concentrated and capital intensive industries have an incentive to invest in patents in an effort to raise the cost of entry. Thus, as our results indicate, the propensity to patent an invention increases along with market concentration and capital intensity, other things constant. However, as equations 3 and 4 indicate, the propensity to innovate does not.

TABLE 1
Regressions of Patent Rates Compared with Results for Innovation Rates (t-statistics in parentheses)^a

	Dependent Variable			
	Patent Rate		Innovation Rate	
	1	2	3	4
RDC	0.6117 (1.7601)*	—	0.1773 (8.2448)**	—
RDT	—	0.1896 (0.6832)	—	0.0738 (3.9412)**
K/O	5.1585 (1.8668)*	5.3786 (1.9293)*	-0.2891 (-1.6903)*	-0.2147 (-1.1389)
CR	0.0748 (2.8248)**	0.0764 (2.8677)**	-0.0052 (-3.1534)**	-0.0048 (-2.6754)**
UNION	-0.0170 (-0.6890)	-0.0255 (-1.0496)	-0.0032 (-2.0617)**	-0.0054 (-3.3056)
AD/S	-61.6260 (-0.2252)	-60.1280 (-0.2185)	23.8900 (1.4136)	23.8440 (1.2847)
PILF	-9.4622 (-4.0000)**	-8.7710 (-3.7327)**	0.2372 (1.6155)	0.4140 (2.6008)**
SKILL	9.1731 (1.9400)*	10.5450 (2.1132)**	0.3735 (1.2803)	0.6132 (1.8236)*
INTERCEPT	0.8443 (0.4400)	0.7421 (0.3762)	0.2072 (1.7489)*	0.2123 (1.5968)
R ²	0.1048	0.0950	0.3580	0.2250

^aThe regressions estimating the innovation rates in equations (3) and (4) are from Chapter Three in Acs and Audretsch (forthcoming) and are reproduced here to facilitate comparison with the patent rate measure.

*Significant at the 90% level of confidence, two-tailed test.

**Significant at the 95% level of confidence, two-tailed test.

SUMMARY

The results of our paper reinforce our 1989 conclusion that patents provide a more than adequate, although not perfect, measure of innovative activity. In comparing patent rates with innovation rates in a regression model relating technological change to market structure and firm size, we find that the conclusions are quite similar. However, a limitation of our study is that we were not able to compare the two measures across various firm sizes. Chakrabarti and Halperin (forthcoming) find that alternative measures of technological change vary considerably between large and small firms. Additional research needs to be undertaken to determine the extent to which patents are a reliable measure of innovative activity across a wide spectrum of firm sizes.

NOTES

1. For a similar comparison between the patent and innovation measures, see our 1989 paper, where we compare their performance in a production function framework.
2. Note that the union data are reported only for three-digit SIC industries. We repeat these three-digit SIC values at the four-digit level.

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