

Market Power, Industrial Concentration and Innovative Activity

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Abstract

This paper discusses the paradox between the positive effect of industrial concentration on R&D spending, and its non-positive effect on the number of innovations. Also, I analyze whether concentration has different effects on small- and large-firm R&D. The analysis shows that the positive effect of industrial concentration on R&D spending is at least as strong for small firms as it is for large firms within an industry, which indicates that the possession of market power is not in itself conducive to innovative effort. In addition, high concentration appears to be attended with a loss of efficiency in R&D spending.

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Introduction

In Schumpeters (1942) view it was not only the expectation of some degree of monopoly power after a successful innovation that was a crucial incentive for firms to engage in innovative activity, but also it had to be accepted that "the large scale establishment or unit of control" had come to be the most powerful engine of economic progress and that some degree of monopoly power was a necessary but passing phase in the innovation process. In speaking of the large scale establishment or unit of control that does not work under conditions of comparatively free competition as the most effective innovator, Schumpeter did not clearly distinguish between effects of firm size and effects of market power on innovative activity, but his primary focus was on the effects of market power on innovation and of (successful) innovation on market structure in a dynamic process of creative destruction.

The majority of the empirical neo-Schumpeterian literature on the relation between market structure and innovation has focused on the link between industrial concentration and R&D. In most, a positive relationship was found, with a few exceptions. The arguments mentioned as an explanation for a positive influence of industry concentration on innovative behavior all pertain to the large firms in highly concentrated industries, i.e. the firms in possession of market power. However, if industrial concentration (C4, usually) merely acts as a proxy for the market power of the largest, more innovative firms, then the positive effect of industrial concentration on R&D spending must only hold for those large and not for small firms. Secondly, while industrial concentration is generally found to have a positive effect on R&D spending, its effect on innovative output is mostly found to be non-positive.

This paper discusses the paradox between the effects of industrial concentration on R&D and on innovative outputs, and the possible different effects of concentration on small and large firm R&D on the basis of an empirical study of R&D spending in the Dutch manufacturing industry.

Empirical Study

For the empirical study I have made use of data from the 1988 and 1992 national innovation surveys, supplying data on 1292 firms, and 648 firms, respectively, conducting some form of R&D in the Dutch manufacturing industry. R&D and firm size are both measured in terms of employment. These surveys were conducted by the University of Amsterdam Foundation for Economic Research (SEO) (Kleinknecht, Reijnen and Verweij, 1990; Brouwer and Kleinknecht, 1994). As a measure of industrial concentration I employed the 1986 and 1990 four-firm concentration ratios (employment share of the four largest firms) on the third digit SIC level.

I estimated the following basic model of R&D as a function of firm size and industrial concentration.

$$\log K = \log \kappa + \beta \log S + \tau \log C4 \quad (1)$$

where K = annual R&D expenditure
S = firm size
C4 = four-firm concentration ratio of corresponding industry

At first sight, we would expect concentration to have a positive effect on the profitability of success in R&D, which would have a positive effect on R&D spending intensity κ , because of the well-known expectation that a more concentrated market yields higher price-cost margins. This is the effect we expect if the protection period for the innovator is sufficiently secured, for instance by a patent period¹. If that is not the case, one could expect the presence of fewer and larger competitors (higher concentration) to reduce the protection period, on the

¹ This is not to say that patents are particularly effective for protection against imitation or to ensure license fees. Harabi (1994) finds that patents are generally considered to be less effective means of appropriation than first-mover

assumption that they are better able to circumvent or destroy protective measures, yielding a negative effect on parameter κ . This may depend on the industry.

I have taken industry effects into account by placing dummies on all parameters, representing the four classes of industries proposed by Pavitt (1984): Supplier dominated, Scale intensive, Specialized Suppliers, and Science based industries.

Basic Results

The regression results are given in table 1 below.

Table 2: Basic estimation results

| Category of Firm | 1988 | | | 1992 | | |
|-----------------------|--------------------------|----------------------|------------------|--------------------------|----------------------|----------------------|
| | log κ (st.dv.) | 1+ μ (st.dv.) | c (st.dv.) | log κ (st.dv.) | 1+ μ (st.dv.) | c (st.dv.) |
| Supplier Dominated | -3.448 (0.363) | 0.708 (0.070) | 0.206 (0.048) | -2.662 (0.645) | 0.607 (0.120) | 0.260 (0.066) |
| Scale Intensive | -3.626 (0.399) | 0.780 (0.042) | | -3.296 (0.660) | 0.716 (0.049) | |
| Specialized Suppliers | -2.822 (0.478) | 0.749 (0.071) | | -2.969 (0.748) | 0.776 (0.089) | |
| Science Based | -3.957 (0.497) | 1.005 (0.071) | | -3.840 (0.702) | 0.976 (0.064) | |

advantages, superior sales and service performance, and secrecy.

| | | |
|--|---|---|
| | R-square = 0.44 All coeff's significant (1%) c not significantly (5%) different between industries | R-square = 0.53 All coeff's significant (1%) c not significantly (5%) different between industries |
|--|---|---|

As in most empirical studies of R&D and market structure, I find τ is significantly positive, meaning that market concentration has a positive effect on the rate of R&D expenditure, and the effect does not differ significantly between industries. Regarding the effect of market structure on innovation, according to the Schumpeterian paradigm innovation is greater in monopolistic industries than in competitive ones because firms possessing monopoly power are better able to appropriate the returns from innovation, and firms realizing monopoly profits are better able to finance R&D from internal sources.

A counterargument is that a firm with ex ante market power might be less motivated to innovate because it does not feel threatened by rivals (Scherer, 1980). However, this argument holds only if entry barriers are fairly high because it is not only the present competition that matters, but also the threat of potential competition from firms outside the industry (Cf. Baumol, 1982). So, higher concentration may stimulate innovation because of more favorable appropriability conditions, while on the other hand more competitive pressure (*ceteris paribus* associated with lower concentration) may also yield an incentive to innovate. The positive sign of τ indicates that the appropriability argument is the more important.

Concentration and market power

Next I allowed the effect of industry concentration to vary with firm size, by placing dummies representing four size-classes on the parameter τ . The sample was divided into size classes according to table 2. The inclusion of these size class dummies on C4 affects the estimates of the other parameters ($\log \tau$ and $1+\mu$), but our focus here is on the coefficients measuring the effect of concentration. The estimation results

are given in tables 3 and 4.

Table 2: Size Classes and Sample Composition

| Firm Size | 1988 | 1992 |
|--------------|-------|-------|
| 10-50 | 15.9% | 10.5% |
| 51-100 | 32.2% | 24.8% |
| 101-200 | 24.3% | 27.4% |
| >200 | 27.6% | 37.3% |
| Total Sample | 1292 | 648 |

Table 3: Estimation results with size class dummies 1988

| Category of Firm | log κ (st.dv.) | 1+ μ (st.dv.) | 10 \leq S \leq 50 c1 (st.dev.) | 50<S \leq 100 0 c2 (st.dev.) | 100<S \leq 200 c3 (st.dev.) | S>200 c4 (st.dv.) |
|---|--------------------------|----------------------|--|---|-------------------------------------|-------------------------|
| Supplier Dominated | -3.760 (0.448) | 0.779 (0.090) | 0.270 (0.058) | 0.189 (0.034) | 0.183 (0.043) | 0.179 (0.060) |
| Scale Intensive | -3.900 (0.399) | 0.842 (0.070) | | | | |
| Specialized Suppliers | -3.167 (0.478) | 0.827 (0.093) | | | | |
| Science Based | -4.240 (0.499) | 1.072 (0.096) | | | | |
| R-square = 0.45 All coefficients significant (1%) c2 and c3 significantly (at 5%) smaller than c1 | | | | | | |

Table 4: Estimation results with size class dummies 1992

| Category of Firm | log κ (st.dv.) | 1+ μ (st.dv.) | 10 \leq S \leq 50 c1 (st.dev.) | 50<S \leq 100 0 c2 (st.dev.) | 100<S \leq 200 c3 (st.dev.) | S>200 c4 (st.dv.) |
|--|--------------------------|----------------------|--|---|-------------------------------------|-------------------------|
| Supplier Dominated | -4.187 (0.702) | 0.924 (0.133) | | | | |
| Scale Intensive | -4.380 (0.193) | 0.946 (0.067) | 0.450 (0.073) | 0.313 (0.043) | 0.213 (0.047) | 0.138 (0.059) |
| Specialized Suppliers | -4.413 (0.226) | 1.077 (0.103) | | | | |
| Science Based | -4.943 (0.756) | 1.207 (0.079) | | | | |
| R-square = 0.55 All coefficients significant (1%) c4<c3<c2<c1 all differences (at least) significant at 5% | | | | | | |

The results reveal that the effect of industrial concentration is at least as strong for smaller firms as it is for larger firms, meaning that the greater research intensity is not merely the reflection of the largest firms' efforts. On the contrary, I find that the effect is strongest for the smallest of four size-categories of firms, and gets weaker for larger size classes.

There are several factors, which together can explain this result. First of all, concentrated markets are attractive for firms to innovate in because more concentrated markets yield higher price-cost margins. Bain (1953) noted that a less competitive market structure before innovation, leads to the expectation of less competition and higher returns in the post-innovation market. If however the protection period for the winner is not sufficiently secured, one might expect a negative effect of industrial concentration on innovative effort because the presence

of fewer and larger competitors would reduce the protection period, on the assumption that they are better able to circumvent protective measures. The consistent positive effect of industry concentration indicates that the protection period is not negatively affected by high industrial concentration, at least not to the degree that it would outweigh the attractiveness of the market due to higher profit margins. Also, the fact that the effect is positive for large firms as well as for small firms across industries, indicates that entry barriers are in general not so high as to permit firms with market power to slow down their innovative efforts. If this were the case, and the 'lack of competitive pressure'-effect suggested by Scherer (1980) would take the upper hand over the appropriability effect (which actually is the net effect of higher profit margins and possibly shorter protection periods), I would expect a negative effect of industrial concentration on R&D spending for the largest firms.

A totally different interpretation follows from the theoretical analysis of the effect of the number of competitors n on R&D expenditure by Nooteboom and Vossen (1995). It follows from their theoretical model, that n has a negative effect on R&D spending if the effect of the rate of R&D expenditure on profitability is lower on speed. In view of the intercorrelation between industrial concentration $C4$ and n ($C4$ also acts as a proxy for $1/n$, i.e. a negative effect of n means a positive effect of $1/n$, or $C4$), the results may also indicate that this is in fact the case.

Another factor that might exert a negative influence on the innovativeness of firms, is that the rewards from the introduction of a new product can be partially at the expense of sales from existing products, especially for firms with higher market shares. So, the cannibalization effect can be expected to be lower for small firms, thus explaining the finding that large firms' innovative efforts are not stimulated by higher industrial concentration to the degree that they are for smaller firms. Another explanation for this is that small firms appropriate their returns more on the basis of tacit knowledge, so that they would be less challenged by big competitors¹. Thirdly,

¹ For a discussion of the prevalence and effects of tacit knowledge in smaller firms, cf. Nooteboom (1993).

it is also conceivable that the positive effect of concentration on R&D spending is higher for smaller firms, because the larger firms in highly concentrated industries do feel a little less competitive pressure than the small firms. However, it is difficult to make a statement about that without explicitly accounting for the height of entry barriers, because also potential competition from outside the existing product market would contribute to the degree of competitive pressure in an industry.

R&D and innovation

As noted, most empirical studies find a positive effect of industrial concentration on R&D spending. If we look at studies on the relation between concentration and innovative output, we see a totally different picture, as the effect of concentration on innovative output is generally found to be non-significant (Weiss, 1963; Scherer, 1965; Allen, 1969; Brouwer and Kleinknecht, 1996) or even negative (Williamson, 1965; Acs and Audretsch 1988; 1990; Schwalbach and Zimmermann, 1991; Koeller, 1995). In these studies, a variety of different measures of innovative output were used, such as productivity growth rates, number of patents, new product announcements in trade journals, sales of products 'new to the firm' and sales of products 'new to the industry'. This unequivocally indicates that concentration exerts at least a non-positive influence on the number of innovations made in an industry. Apparently, in more concentrated industries, firms spend more on R&D, but this does not result in more innovative output.

Nooteboom and Vossen (1995) have shown that, according to their model, firms spend more than the most efficient level, moving towards the most efficient point as the number of contestants increases. Also, Saarenheimo (1994) finds on the basis of a different (two stage) patent race model that concentrated oligopolistic market structures increase unnecessary duplication of R&D. Moreover, the finding by Vossen and Nooteboom (1996), and others, that smaller firms that do engage in R&D, do so at higher levels of intensity and more efficiently than larger firms, indicates that the presence of relatively more large firms in an industry (higher concentration) would reduce the overall effectiveness of R&D in that industry. It is

striking in this respect that running separate regressions for the four 'Pavitt-categories', I find a non-significant effect in the Science Based industry, i.e. the only industry in which no significant difference between small and large firms with respect to R&D efficiency was found for both samples ($1+\mu$ not significantly different from 1, see table 2). For the Supplier Dominated industry I find the effect of industrial concentration to be significant for the 1988 sample¹, and for the Scale Intensive and Specialized Suppliers industries the effect is significant for both the 1988 and the 1992 sample.

Conclusion and Research Agenda

The analysis shows that the positive effect of industrial concentration on R&D spending is at least as strong for small firms as it is for large firms within an industry, which indicates that the possession of market power is not in itself conducive to innovative effort. The combination of the results of this study and other empirical studies on the influence of industrial concentration on R&D with the results from studies on the influence of industrial concentration on innovative output suggests that high concentration is attended with a loss of efficiency in R&D spending. While R&D spending is higher in more concentrated industries, innovative output is only as much or less than in less concentrated industries. The explanation offered here is twofold. First, it has been shown theoretically that firms spend more than the most efficient level as the number of contestants is lower (Nooteboom and Vossen, 1995), which is *ceteris paribus* associated with higher concentration. Secondly, if small firms are the more efficient innovators one can expect R&D efficiency to be lower in more highly concentrated industries because they consist of relatively fewer small firms and more large firms. In fact, separate regressions for the different industries show that a significant positive effect of industrial concentration is only found in the industries where R&D expenditure increases less than proportionately with firm size (which means, according to Nooteboom and

¹ For the 1992 sample the effect is not significant, but there are only 83 observations in the Supplier Dominated industry.

Vossen, that smaller firms are more profit/cost efficient). The effect of concentration is not significant in the Science Based industry, where I find no significant difference in spending intensity between smaller and larger firms.

There is still a lot of empirical work to be done on the highly complex mechanisms of innovation, especially with respect to the influence of market structure on innovative inputs and outputs. The only way to attain real clarification on this subject would be a systematic integral analysis of the different elements of market structure in relation to different aspects of innovation. Elements of market structure include industrial concentration, number of current competitors, height of entry barriers. Some of the questions that might be answered in this way are the following. What are the differences in the means of protecting innovations between industries with high or low degrees of concentration? Do small and large firms use the same means of appropriation within those industries? Is it true that the average protection period is shorter (but profits higher) in more highly concentrated industries? If the height of entry barriers is taken into account, is concentration a valid measure of perceived competitive pressure?

The ratio of the number of innovations produced to R&D is higher for smaller firms in most industries. Next to a higher efficiency of smaller firms, one of the possible explanations for this, is that large firm innovations may have higher average quality (economic value), which is something that remains to be investigated empirically. This ratio of the number of innovations produced to R&D also appears to be higher for industries with lower concentration. This raises another empirical question. Does the average innovation in highly concentrated industries have a higher economic value? And if yes, is this attributable to the fact that these industries consist of relatively few small firms and more large firms? Or is the average value of innovations also higher across the whole range of firms of different sizes?

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