

Commentary

Firm Size and Efficiency in Innovation:

Comment on van Dijk et al.¹

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ABSTRACT. Van Dijk et al. found different results for some variables explaining the large/small firm innovation advantage in a number of Acs and Audretsch publications. Their own research adds to this variety. However, the differences van Dijk et al. found between the Acs and Audretsch studies can be largely attributed to specification and sample differences. The same applies to the observed differences between Acs and Audretsch and van Dijk et al.

A considerable amount of research has been devoted to the question, whether large or small firms are more innovative. Schumpeter's hypothesis that large firms have an advantage in innovation has sparked this debate (Schumpeter, 1942). However, this seems to contradict his earlier contention that new, entrepreneurial firms are more vigorous innovators (Schumpeter, 1939).

The first hypothesis is based on the appropriability advantages from which large firms benefit. Obviously, an innovation will produce more profits at larger quantities sold, if profit margins are identical. Since new firms are on average smaller than established firms, they have a disadvantage in this respect. But, small and new firms have more to gain from innovation, since innovation will boost their profits more. This applies with the greatest force when new (and small) firms can reach large size quickly.

The empirical research on the relationship between firm size and innovativeness did not produce unambiguous answers to the question which firm size is most conducive to innovation. Which

firm size has the innovative advantage varies by industry and by the dependent variable used.

Research has shown, that large firms predominate in R&D. The largest firms (over 10,000 employees) performed 81.3% of all company financed R&D in 1982. Among firms conducting R&D, the broad picture is that R&D does not increase more than proportionally with firm size (Scherer and Ross). Research conducted at the industry level shows that R&D increases proportionally with size in most industries. The number of industries, in which R&D spending increased more than proportionally with size slightly outnumbered those with the opposite pattern (Scherer and Ross, 1990).

But, small firms are much more innovative than large firms when an output measure of innovation is used (direct innovation counts). Acs and Audretsch demonstrated that small firms are much more efficient at innovation than their larger counterparts. Small firms produced 43% more innovations per employee for all manufacturing industries. Their advantage is paramount in highly innovative industries, where they produced 6.6 times more innovations per employee (Acs and Audretsch, 1988). Hence, small firms (< 500 employees) need much less R&D per innovation than their larger counterparts.

Bob van Dijk et al. contribute to the ongoing debate on relative innovative advantage and firm size in their august 1997 contribution to this journal. They summarize a number of the Acs and Audretsch results in a neat table, in which they note some inconsistencies. Subsequently they present their own results based on Dutch data on R&D intensity and firm size. I want to add to the discussion by commenting on these alleged inconsistencies. A second objective is to discuss their research findings.

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The summary table by Van Dijk et al. attaches signs (+, – or 0's) to the Acs and Audretsch regression results for the relative innovative advantage of large versus small firms. The results can so be compared in one glance, which clarifies the discussion. Some different (0 and + or –) or opposite signs (+ or –) in the regression results can be observed.

Capital intensity, product differentiation, unionization and concentration favour large firm innovation rates in highly innovative industries (+, 1987a). These variables are not significant for all innovative industries (0, 1987a). This difference can be attributed to the much higher efficiency differential found by Acs and Audretsch in highly innovative industries. Capital intensity, product differentiation and unionization hamper innovation (Acs and Audretsch, 1988). Hence, large firms seem to have the innovative advantage in the less innovative industries within the group of highly innovative industries.

One of the interesting results from Acs and Audretsch 1987a involves their finding that a relatively small employment share of small firms boosts their relative innovation rate and there with efficiency in R&D (Acs and Audretsch, 1987a). This seems plausible, considering that a low small firm share will put small firms at a large profit disadvantage. This can only be remedied by greater efficiency in R&D and/or rapid (expected) growth boosting (expected) profits of small firms. Greater small firm efficiency in R&D seems therefore, required to (partly) compensate this disadvantage.

Van Dijk et al. state that the 1987a (+) results for capital intensity; concentration and unionization are not reproduced in Acs and Audretsch (1987b/1988), in which they are insignificant (0). However, the dependent variable in these studies is specified as the number of innovations in large and small firms or as the large/small firm innovation share and not as the innovation rate (number of innovations per employee). The large/small firm innovation shares differ from innovation rates. Small firms are more efficient than large firms, but have a lower employment share. Small firms produced 43% of all innovations, which is the result of a lower employment share (33%) and higher efficiency. The (number of innovations) variable used in the 1987b and 1988 publications seems, therefore, less capable

of capturing the large/small firm innovative efficiency differential. This applies most forcefully to all variables jointly. However, Acs and Audretsch found a significant large firm advantage for company R&D and concentration and a small firm advantage for skilled labour (1988). The product differentiation variable was found insignificant. The large/small firm differential was not explicitly tested in the 1987b publication.

The signs of the technological opportunity variable are opposites in the 1987a and 1987b publications. Small firms have the innovative advantage in 1987a and large firms in 1987b. But, the van Dijk's et al. technological opportunity variable refers to innovativeness in the 1987a (+) and to R&D intensity in 1987b (–). These results are not contradictory, when we realize that the small firm employment share varies negatively with R&D intensity, whereas small firm R&D efficiency is higher in more innovative industries. Van Dijk's et al. summary, therefore raises some interesting questions with regard to the determinants of large and small firm innovation. Their research draws renewed attention to the intriguing phenomenon of high small firm R&D efficiency.

Van Dijk's et al. research into the determinants of innovation in large and small Dutch firms produces results, which differ somewhat from Acs and Audretsch's results. An important difference involves the relative advantage they found of large Dutch innovative firms (> 100 employees) in rapidly growing markets (Acs and Audretsch got insignificant results for this variable). Another difference involves the influence of concentration. Van Dijk et al. found, that concentration stimulates R&D in both large and small firms and does not affect the relative large/small firm innovative advantage. This contrasts with Acs and Audretsch, who found that concentration hampers innovation and favours large firms. The non-significant result van Dijk et al. obtained for skilled labour where Acs and Audretsch found a small firm advantage constitutes a third difference. The latter difference can be explained by the use of their variable; labour intensity, whereas Acs and Audretsch use the skilled labour share.

However, a more important difference between the Acs and Audretsch and van Dijk et al. studies is that R&D intensity is used as the dependent variable in the Dutch study.

Their results are, therefore – in my view – incomparable with Acs and Audretsch. R&D can be expected to produce totally different results than direct innovation counts due to varying efficiency in R&D.

Moreover, their results are incomparable with most other studies using R&D intensities due to the R&D variable used. Their data are derived from innovation surveys, which include both formal and informal R&D. Informal R&D encompasses activities undertaken by people in other than R&D departments (e.g. sales and production) and to external R&D undertaken by universities, government institutes and other enterprises. The inclusion of informal R&D boosts total R&D by a large margin. The number of firms conducting R&D is 3.6 times larger than when only formal R&D is taken into account (Kleinknecht, 1991).

More importantly; informal R&D is largely the province of small firms (Kleinknecht, 1989, 1991). Small firms (< 50 employees) are considerably more R&D intensive than larger firms (50–500 employees), which conduct any R&D. R&D intensity increases somewhat for the largest firms (> 500 employees), but does not attain the intensity of the smallest size group by a wide margin (Kleinknecht, 1989). Hence a totally different picture emerges when both formal and informal R&D data are used. Instead of equal R&D intensities for firms of varying sizes, we now find a trimmed U-shaped relationship between R&D intensity and size.

These differences raise some doubts concerning the validity of the informal R&D data. Kleinknecht pointed to the large similarity between the estimated number of firms reporting some R&D (either formal and informal) and estimates based on R&D subsidy records (Kleinknecht, 1991). (Small) firms might have inflated their R&D in order to obtain (small firm) R&D subsidies. We might also conjecture that Dutch small firms are of more prolific innovators than their U.S. counterparts. Higher relative R&D intensity of small Dutch firms seems to imply this. Small Dutch innovative firms should be either much more profitable than large firms or of living largely on promise (future profits). The latter situation is plausible, when Dutch (venture) capital especially would favour small firms and start-ups. However, this contrasts sharply with the conclu-

sion from a recent McKinsey report, which found the Dutch climate for high tech firms less attractive than in the U.S. A lack of venture capital for these firms was stated as the main reason (McKinsey, 1997). This relative lack of early stage Dutch venture capital was also found in Brouwer and Hendrix. It can, therefore, be doubted whether informal R&D can be treated on the same footing as formal R&D.

Summing up, the differences van Dijk et al. found between various Acs and Audretsch studies can be largely attributed to specification and sample differences. The same applies to the differences found between Acs and Audretsch and van Dijk et al.

Note

¹ Van Dijk et al., 1997, 'Some New Evidence on the Determinants of Large- and Small-Firm Innovation', *Small Business Economics* 9(4), 335–343.

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