

# Under-Reporting of R&D in Small Firms: The Impact on International R&D Comparisons

Stephen Roper

**ABSTRACT.** There is a widely recognised tendency for conventional measures of R&D activity to under-estimate the R&D investments of small companies. This arises due to small firms' emphasis on developmental rather than fundamental research, and because this activity is often informally organised. International survey evidence suggests a greater degree of formality in the organisation of R&D in German small firms. This reduces the likely degree of under-estimation of German small firms' R&D activity relative to that in the U.K. As a result, aggregate R&D figures may be under-estimating the true level by 13.9 per cent in the U.K. and 2.4 per cent in Germany. This is equivalent to around half of the historical difference between aggregate levels of business R&D in the U.K. and Germany.

## 1. Introduction

A major strength of recent international work in the areas of R&D and technological innovation has been the harmonisation of statistical definitions (OECD, 1981; 1992). There is a tendency, however, for the conventional indicators, which typically relate to either R&D expenditure or employment, to underestimate the level of R&D activity in small firms.<sup>1</sup> Studies, based on national surveys, have demonstrated that this under-estimation can be significant in size and important in understanding the relationship between organisational form, R&D investments and innovation outputs (e.g. Santarelli and Sterlacchini, 1990). This note extends the argument to suggest that, because of differences in the internal organisation

of enterprises (Roper, 1998), the extent of any underestimation of small firms' R&D can vary between countries. This may in turn distort international comparisons of business investment in R&D.

Underestimation of R&D activity in small firms is usually attributed to either the type of R&D being undertaken or the way it is organised. R&D in small firms tends to be concerned with the developmental rather than the research-based phases of the innovation process (Segal Quince Wicksteed, 1985; Santarelli and Sterlacchini, 1990). That is, it concerns the translation of known research into new products or processes rather than the creation of new knowledge (OECD, 1981).<sup>2</sup> As a result, a larger proportion of small firms' R&D activity is likely to be distributed between operational areas than would be expected in larger enterprises, and a smaller proportion of small firms are likely to have formal R&D departments (Rothwell, 1989). Where R&D activity is distributed between operational areas rather than concentrated in a specialist unit, costs are significantly more difficult to identify. This, and the limited managerial resources of small firms, mean that in many cases small firms' R&D investments are either unidentified or underestimated.

The dispersion of R&D activity in small firms is also likely to lead to its exclusion from official definitions. In the OECD definition of formal R&D, for example, only R&D performed inside an R&D department and involving at least one full-time researcher is counted (ENSR, 1994, p. 162). Both this, and the difficulty for small firms of keeping track of R&D expenditure incurred in different operational areas, mean that the under-estimation of R&D activity is likely to be greatest

---

Final version accepted on July 5, 1998

*Northern Ireland Economic Research Centre  
Queen's University of Belfast  
46-48 University Road  
Belfast, BT7 1NJ  
U.K.*

where it is less formally organised. Where a firm has a formal R&D department, costs and staff-time allocations are likely to be more easily and reliably identified. In this paper survey evidence is reported which indicates that substantial differences exist between the organisation of R&D in small firms in different countries, and particularly between the U.K. and Germany. German small firms are much more likely to have a formal R&D department making R&D spending more easily identifiable and less liable to under-estimation. This is shown to have potentially important effects on aggregate R&D comparisons.

Information on the organisation of R&D in plants in the U.K. and Germany is taken from the Product Development Survey, described in Section 2. Subsequent sections outline national differences in the organisation of small firms' R&D and assess the implications for international comparisons of R&D investment.

## 2. The product development survey

The Product Development Survey (PDS) was a postal survey covering over 13,500 manufacturing enterprises in the U.K. and Germany and was conducted between November 1994 and April 1995 (see Roper et al., 1996). In each country the sample was structured to allow size-band, regional and inter-industry comparisons. Overall response rates were 25.1 per cent in Germany (1374 responses) and 20.6 per cent in the U.K. (1722 responses). Prior to the analysis, survey responses were weighted to allow for sample structuring and differential response. Weights for each industry/size-band cell were constructed by comparing sample responses and the 1993 target population of manufacturing firms in each country.

As part of the Product Development Survey enterprises were asked to indicate their level of R&D employment in 1993. Comparing these figures to official survey results provides an indication of the representativeness of the Product Development Survey. In the U.K., 1993 R&D employment estimated from the Product Development Survey was 117,000 (3.1 per cent of the workforce) compared to official estimates of 119,000 (2.8 per cent of the workforce). In Germany, the Product Development Survey estimate of R&D employment was 248,000 (3.4

per cent) compared to the official figure of 278,000 (3.7 per cent). The suggestion is that the Product Development Survey is broadly representative, and can therefore provide a useful indication of the likely impact on aggregate R&D measures of the underestimation of R&D investments in small firms.

## 3. Measuring R&D activity

Following earlier studies the Product Development Survey sought information on whether individual plants were undertaking in-house R&D and whether this was within a formal R&D department. Table I gives the proportion of plants in each category in the U.K. and Germany by plant sizeband. For comparison, earlier survey results for the Netherlands and Italy are also included. In each case the proportion of plants undertaking in-house R&D and having a formal R&D department increased with plant size. More striking, however, was the difference between Germany and the U.K. (and the Netherlands and Italy) in the proportion of small and medium-sized plants with a formal R&D department. In the U.K., 17.3 per cent of those plants with 20–49 employees undertaking R&D had a formal R&D department, in Germany the same figure was 67.3 per cent.<sup>4</sup>

Any estimate of formal R&D activity (i.e. only measuring activity in R&D departments) is therefore likely to embody a significantly greater degree of underestimation in the U.K. than in Germany. The same may also be true of more general expenditure measures intended to include all of plants' R&D activity. To illustrate the potential scale of this underestimation it is useful to start with baseline R&D expenditure figures broken down by plant sizeband (Table II).<sup>5</sup> The simplest assumption would then be that any underestimation of expenditure would be (inversely) proportional to the ratios of the number of plants with R&D departments to that undertaking some in-house R&D (Table I). Assuming no underestimation of expenditure in plants with 500 or more employees, and normalising any underestimation in smaller plants accordingly, suggests the extent of potential underestimation for each country (Table II). For example, 67.4 per cent of plants in the 20–49 employee sizeband in Germany had an R&D department. The ratio of this proportion to

TABLE I  
Proportions of plants undertaking R&D and having an R&D department

|                         | Plant employment sizeband |       |         |         |          | All plants |
|-------------------------|---------------------------|-------|---------|---------|----------|------------|
|                         | 20–49                     | 50–99 | 100–199 | 200–499 | 500 plus |            |
| Netherlands (1983)      |                           |       |         |         |          |            |
| Undertaking R&D (%)     | 50.2                      | 72.3  | 79.4    | 87.4    | 97.5     | 70.1       |
| With R&D department (%) | 9.8                       | 19.5  | 41.1    | 45.1    | 67.2     | 27.2       |
| Ratio                   | 0.195                     | 0.270 | 0.518   | 0.516   | 0.689    | 0.388      |
| Italy (1985)            |                           |       |         |         |          |            |
| Undertaking R&D (%)     | 15.9                      | 32.5  | 41.6    | 58.5    | 75.2     | 30.9       |
| With R&D department (%) | 4.4                       | 10.8  | 17.1    | 32.0    | 56.8     | 13.4       |
| Ratio                   | 0.277                     | 0.332 | 0.411   | 0.547   | 0.755    | 0.434      |
| Germany (1993)          |                           |       |         |         |          |            |
| Undertaking R&D (%)     | 31.9                      | 54.1  | 57.5    | 78.9    | 91.7     | 52.6       |
| With R&D department (%) | 21.5                      | 31.2  | 46.0    | 61.0    | 77.2     | 41.2       |
| Ratio                   | 0.674                     | 0.577 | 0.800   | 0.773   | 0.842    | 0.783      |
| U.K. (1993)             |                           |       |         |         |          |            |
| Undertaking R&D (%)     | 45.5                      | 56.7  | 72.7    | 72.9    | 77.6     | 56.0       |
| With R&D department (%) | 7.9                       | 20.5  | 33.7    | 47.8    | 63.5     | 20.8       |
| Ratio                   | 0.174                     | 0.362 | 0.464   | 0.656   | 0.818    | 0.371      |

*Note:* Sample sizes were as follows (in sizeband order): Netherlands, 550, 451, 326, 213, 119, totalling 1659 plants; Italy, 3939, 1789, 1210, 815, 467 totalling 8220 plants; Germany, 299, 286, 242, 228, 129, totalling 1184; U.K., 393, 235, 234, 160, 109, totalling 1131.

*Sources:* Kleinknecht, 1989, Table 2, p 218; Santarelli and Sterlacchini, 1990, Table 3, p. 225; the Product Development Survey.

TABLE II  
Illustrative calculations correcting for underestimation of R&D activity in small firms

|                                            | Employment sizeband |         |          | Total |
|--------------------------------------------|---------------------|---------|----------|-------|
|                                            | 20–100              | 100–499 | 500 plus |       |
| 1. German R&D Spending (Dm, million, 1989) | 2363                | 3256    | 39935    | 45554 |
| 2. Correction factors                      |                     |         |          |       |
| Germany                                    | 1.35                | 1.07    | 1.00     |       |
| U.K.                                       | 3.06                | 1.42    | 1.00     |       |
| 3. Implied R&D spending                    |                     |         |          |       |
| Applying German correction factor          | 3190                | 3483    | 39935    | 46608 |
| Applying U.K. correction factor            | 7230                | 4624    | 39935    | 51789 |

*Note:* Correction factors derived from Table I are averaged to match the company sizebands of the R&D expenditure figures. Weights are used to reflect the level of employment in each plant sizeband in Table I. These were (in sizeband order): 0.506, 0.494, 0.420, 0.580.

*Sources:* Report of the Federal Government on Research, 1993, Figure II/11, p. 90; Table 1.

the proportion of plants with more than 500 employees with an R&D department (0.842) suggests the extent to which R&D spending might be underestimated (i.e.  $0.674/0.842 = 0.800$ ). The reciprocal of this ratio provides a simple scaling or correction factor for any underestimation.

In Germany, the relatively high proportion of

small and medium-sized plants undertaking R&D within a formal R&D department means that the multipliers are relatively small. In the U.K., the less formal organisation of R&D in small firms suggests larger multipliers. Applying the correction factors suggests that aggregate figures would underestimate the true level of R&D in Germany

by 2.3 per cent and that in the U.K. by 13.7 per cent. The difference between these percentages represents the bias that would be introduced into international R&D comparisons as the result of differences in small firms' internal organisation.

#### 4. Conclusions

Previous studies have highlighted the tendency for conventional R&D indicators to underestimate the size of R&D investments in small firms. This is usually attributed to the developmental rather than research emphasis of small firms' R&D, and the less formal organisation of R&D in small enterprises. Significant differences exist, however, in the organisation of R&D in small firms in the U.K. and Germany. German small firms are much more likely than their U.K. counterparts to have a formal R&D department. This is likely to make R&D investments easier to identify and lead to a lower degree of underestimation.

Assuming that the degree of underestimation is proportional to differences in firms' internal organisation (i.e. differences in the proportion of R&D performing firms with R&D departments) it is possible to estimate the likely impact on aggregate R&D comparisons. Taking into account the share of national R&D undertaken in small firms suggests that aggregate U.K. figures might underestimate the true level of R&D activity by 13.7 per cent, with German figures underestimated by 2.4 per cent. This means that official figures are likely to be overstating the gap between industry investments in R&D in Germany and the U.K. For example, in 1992 business expenditure on R&D in the U.K. was measured as 2.0 per cent of GDP compared to 2.5 per cent in Germany. Correcting for the underestimation of R&D in small and medium-sized firms suggests figures of 2.27 per cent and 2.56 per cent respectively.

#### Acknowledgements

This research was supported by the Department of Economic Development, Northern Ireland as part a research programme on *Innovation and Industrial Change*. Natalie Campbell provided valuable research assistance.

#### Notes

<sup>1</sup> Evidence from the Netherlands can be found in Kleinknecht, 1987; Kleinknecht, 1989; Kleinknecht et al., 1991. On Italy see Santarelli and Sterlacchini, 1990 and on the U.S. see Scherer, 1991.

<sup>2</sup> The alternative, normally called basic or applied R&D, involves an element of original scientific analysis, is a scale intensive activity and is predominantly located in larger firms or in centralised facilities (Howells, 1984).

<sup>3</sup> Sources are U.K., R&D in U.K. Businesses, 6th Edition, Table 10. Size Analysis of U.K. Businesses, 1993, Table 10. Germany: Statistik Bundesbericht Forschung, 1993, Tables VII/30a and VII/30b and ifo-Institut.

<sup>4</sup> See Roper (1996) for a detailed discussion of the reasons for this organisational difference and other related issues.

<sup>5</sup> Ideally, U.K. and German R&D figures for different plant sizebands would both have been examined. Official U.K. figures, however, provide very little detail by sizeband (see, for example, R&D in U.K. Businesses, 6th Edn., Table 20, p. 45).

#### References

- ENSR, 1994, 'European Observatory for SMEs – 2nd Annual Report', European Network for SME Research, EIM, Zoetermeer, Netherlands.
- Howells, J. R. L., 1984, 'The Location of R&D: Some Observations and Evidence from Britain', *Regional Studies* **18**, 13–29.
- Kleinknecht, A., 1987, 'Measuring R&D in Small Firms: How Much are We Missing?', *Journal of Industrial Economics* **36**, 253–256.
- Kleinknecht, A., 1989, 'Firm Size and Innovation: Observations in Dutch Manufacturing Industries', *Small Business Economics*, 215–222.
- Kleinknecht, A., T. P. Poot and O. N. Reijnen, 1991, 'Formal and Informal R&D and Firm Size: Survey Results from the Netherlands', in Z. J. Acs and D. B. Audretsch (eds.), *Innovation and Technical Change*, Hemel Hempstead: Harvester Wheatsheaf.
- OECD, 1981, *The Measurement of Scientific and Technical Activities: Proposed Standard Practice for Surveys of Research and Experimental Development (Frascati Manual)*, Paris.
- OECD, 1992, *Innovation Manual: Proposed Guidelines for Collecting and Interpreting Innovation Data (Oslo Manual)*, Paris: Directorate for Science, Technology and Industry.
- Roper, S., 1998, 'Product Innovation and Small Business Growth: A Comparison of the Strategies of German, U.K. and Irish Companies', *Small Business Economics* **11**(1), 11–24.
- Roper, S. and H. Hofmann, 1993, *Skills, Training and Company Competitiveness*, Belfast: Northern Ireland Economic Research Centre.
- Roper, S., J. H. Love, S. Dunlop, B. Ashcroft, H. Hofmann H and K. Vogler-Ludwig, 1996, 'Product Innovation and

- Development in U.K., German and Irish Manufacturing', NIERC/FAI, Queen's University of Belfast.
- Rothwell, R., 1989, 'Small Firms, Innovation and Industrial Change', *Small Business Economics* **1**, 51–64.
- Santarelli, E. and A. Sterlacchini, 1990, 'Innovation, Formal vs. Informal R&D, and Firm Size: Some Evidence from Italian Manufacturing Firms', *Small Business Economics* **2**, 223–228.
- Scherer, W. K., 1991, 'Firm Size and Innovation: A Comment', *Small Business Economics* **3**, 155–156.
- Segal Quince Wicksteed Ltd., 1985, *The Cambridge Phenomenon*, Cambridge, U.K.

Copyright of Small Business Economics is the property of Springer Science & Business Media B.V.. The copyright in an individual article may be maintained by the author in certain cases. Content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.