Both approaches encounter difficulties when faced with a substantial body of evidence which indicates that until the late 1960s British firms invested substantial and growing sums of their own funds in R&D. This assessment was recognised by some economists in the late 1950s and has underpinned a limited number of historical accounts [10, 11, 12]. This essay draws on evidence from a range of sources, including contemporary surveys, archives and publications of individual firms, business and technical organisations, as well as recent research in business history, to support this view and to provide an examination in quantitative and qualitative terms of the nature of the British industrial R&D effort. Such an assessment, it is argued, is an important prerequisite for an effective analysis of the innovative performance of British industry and should inform attempts to assess the role of R&D in economic growth. This is a relationship which, as Stoneman has recently observed, is complex and indirect, so that, 'investment in technology does not automatically lead to improvements in firm performance' [1].

The scale of the postwar R & D commitment

Starting during the final years of World War 11, and continuing thereafter, government ministers, leaders of industrial organisations and representatives of individual firms were vocal in their support of research and active in initiating institutional developments to promote its benefits. British wartime successes were attributed to a successful collaboration between science and industry, a partnership which could now be harnessed to win the battle of the peace. The incoming Labour administration pledged its commitment to expanding R&D and incorporating its findings into industrial practice. This was echoed by industrial organisations and reflected in the expansion plans drawn up by firms for their R&D activities. For at least 20 years after the end of the hostilities, this committed enthusiasm persisted and British industry was characterised by a passion for R&D and a belief in its power to modernise industry found in few other countries [9, 12].

Surveys of industrial research undertaken in the 1940s and 1950s by the Federation of British Industries Industrial Research Committee (FBI IRC) and the Department of Scientific and Industrial Research (DSIR) indicate how far this enthusiasm was translated into practice: expenditure on R&D rose much faster than prices and the employment of qualified R&D staff increased significantly [See Table 1].
Financing R&D: the significance of private industrial funding

The figures in Table I cover the extent of R&D expenditure in the research establishments of private industry. What they do not take into account is the extent to which industry itself was the source of funds for this work. This is an important distinction in case of Britain: considerable government funds, mainly for defence projects, were spent on research carried out by private industry, especially during the 1950s. Identifying the extent of R&D expenditure provided by industry itself, Business Expenditure on R&D (BERD) is important because it allows us to separate that R&D which firms regarded as commercially important enough to fund from their own resources from that which they undertook on behalf of the state (although it is worth noting that government funded R&D was often an integral part of corporate research strategies and did bring commercial benefits in some cases). As well as providing a better indication of the importance which British firms attached to R&D, it also offers a more appropriate measure to use when comparing their efforts with those of overseas competitors.

Table 2 demonstrates clearly the growth of BERD, but also indicates its significant increase as a proportion of total R&D expenditure between the mid-1950s and the late 1960s. It is also worth noting that while the proportion of R&D funded by private industry increased significantly, the share of R&D which was spent in industry remained remarkably constant at around 60 per cent. Here the most significant shifts were in government spending away from defence projects towards those with a civilian orientation.

While the suggestion R&D ‘crowded out’ spending by private industry (R&D) is not supported by the evidence presented above, defence R&D nonetheless had an important impact on the way in which R&D in British industry developed. This is a feature of British industrial R&D that has only recently begun to be explored by historians and one where the limited availability of sources can make it difficult to draw conclusions [12]. Some aspects of defence were clearly detrimental to the development of R&D for strictly commercial purposes while others were regarded as beneficial by firms themselves. During the expansion of R&D in the years immediately following World War II, resources for building were strictly limited and those firms able to demonstrate their potential to contribute to defence R&D projects received priority. Government R&D contracts provided firms with the resources to expand their R&D facilities and provided them with opportunities to train new staff who subsequently worked on projects more central to commercial operations [9].

In other words, investment in state defence R&D generated a positive externality for the firms concerned. In some cases this reliance on public contracts meant that painful adjustment to be made when this source of funding began to fill during the 1960s. In contrast to the United States, where military funding for defence R&D and the subsequent procurement of innovative products is regarded as having played a crucial role in stimulating the electronics industry, in the UK the far smaller market which the military represented meant that this stimulus was largely absent [18]. In addition, the commercial advantages which could be derived from ‘spin off’ were limited by the system of awarding contracts, which was supposed to preclude firms from benefiting from government work in the spirit of the ‘gentlemanly military industrial complex’ which characterised relations between defence contractors and manufacturers. It also seems likely that the national security provision in British patent law, which meant that the Patent Office could prevent the disclosure of any patent deemed to have implications for national security, had a detrimental effect on the flow of technical information between British firms, preventing them from exploiting fully the fruits of their R&D operations in licensing negotiations. This provision was by no means restricted to research funded by defence departments and was a particular problem for the electronics sector.
British R&D in international context

If we compare the R&D efforts of British firms with those overseas, whether the measure adopted is R&D expenditure, employment of qualified staff, patenting activity, or the dates and origins of significant innovations, the most striking feature of such comparisons is the overwhelming domination of the United States. On all these criteria, US efforts exceeded those of all Western European enterprises combined (see Table 3 for illustrative figures). It is clear therefore that the R&D efforts of British firms were not alone in lagging behind that of the US in absolute terms: the same was true of all Western European nations.

However, Britain was only one of a small number of nations outside the US that contributed significantly to world patenting activity and to the pool of significant innovations. Although Britain enjoyed only a small positive balance of payments in technological royalties, other than the United States, they were alone in this within the international community. British spending on R&D could only be judged difficult when compared with US R&D expenditure: set against other Western European nations and Japan, British investment in R&D was very high indeed [10, 11, 12].

These conclusions, which emerge from a range of sources, challenge those accounts that attribute poor economic performance to an absolute lack of investment by commercial enterprises in R&D and suggest that explanations should be sought elsewhere.

The distribution of British industrial R&D by sector and firm

Having established the extent of the British industrial R&D effort, its key features during the period 1945-1970 will now be outlined. The high degree of sectoral concentration which had been a feature of industrial R&D during the interwar years persisted after 1945. The vast majority of R&D spending in industry was concentrated in the aerospace, electronics, and chemicals industries. Other significant contributors were electrical engineering, machinery, and vehicles. The distribution of privately funded R&D was somewhat different, with the chemical industry dominating. Firms in the food, drink, and tobacco industries spent more of their money on R&D than did those in the aerospace. These were the same industries, wine some variation in proportions, which dominated the research efforts of private industry in other leading industrial nations [11].

As in other countries, expenditure oil development work far exceeded the resources devoted to research. Although there were some differences between sectors, the overall ratio of spending within Britain was around 7.5 per cent for development, 20 per cent for applied research and less than 5 per cent for basic research.

R&D was also concentrated on just a few large firms. This was the case before World War II and persisted with remarkable continuity as to the firms involved thereafter. In 1945 the largest twenty spenders accounted for more than two thirds of total industrial R&D expenditure [13]. By 1955 this concentration had fallen, but still remained high with 58 companies responsible for about one third of expenditure. The concentration of R&D workers reflected this: in 1955 72 per cent of R&D workers were employed in manufacturing establishments where the R&D staff exceeded 100, but these represented only 6.7 per cent of all establishments employing at least one R&D worker. Ten establishments employing over 1000 R&D staff each accounted for 17 per cent of R&D workers. These patterns of concentration persisted throughout the period under review, although later surveys made little effort to document them in detail. This means that the history of much of British industrial R&D can be traced by examining the activities of just a few firms [14]. In principle, this should make it relatively easy to identify which enterprises were the largest spenders, although, in practice, this identification is made more difficult by the reluctance of many firms to divulge what they regarded as commercially sensitive information. It is only recently that company reports have consistently contained details of this activity. The largest British enterprise engaged in R&D was Imperial Chemical Industries (ICI), accounting for around 16 per cent of the total reported to the FBI for 1945/6, and falling to just over five per cent of the total of industrially funded R&D in 1961-2.

The distribution of British industrial R&D by region

In addition to its concentration by sector and firm British industrial R&D remained highly concentrated by region, despite an active policy of industrial dispersion, particularly during the period 1945-51. The dominant cluster of establishments was in London and the South with lesser groupings in the Midlands and the North West. The North, Scotland, Wales and Northern Ireland were host to very few R&D establishments, either industrial or government. Concentration by number of establishments was high and that of R&D workers even more pronounced.

This pattern contributed to the growing ‘spatial division of labour’ in Britain which saw regions specialising by function rather than by industry. R&D and management functions became concentrated around London while standardised assembly work was located in areas with a cheap and adaptable labour supply, initially in Britain but later abroad as well [4]. A number of factors account for these locational preferences. Many research intensive industries had initially developed in these regions and, having established R&D facilities close to manufacturing, were reluctant to move them. In other cases the need for close liaison between head office and research activities was a factor. Accessibility to national and international transport networks and to formal and informal information sources were also important. Finally they required a supply of skilled technicians. Indeed, the reluctance of this group to relocate ensured that research establishments quickly became entrenched.

The internationalisation of R&D

Foreign investment in British R&D

Another significant feature of industrial R&D in Britain after 1945 was the contribution made of overseas enterprises. The establishment of R&D facilities in Britain by overseas enterprises started before World War I and accelerated during the interwar years, expanding rapidly after World War II when existing laboratories were expanded and new ones opened. By 1970 well over 200 foreign-owned firms undertook R&D in Britain. US-owned enterprises dominated and it has been estimated that they were responsible for at least ten per cent of privately funded R&D expenditure in Britain. In general, expenditure by these enterprises was lower than that of the largest British-owned R&D performers, but compared favourably with the average. A number of foreign-owned firms were ranked highly amongst the largest spenders into the 1950s and 1960s. In some cases, notably Ford and Kodak, firms were spending more than their indigenous competitors. This was most frequent in those sectors where such firms dominated production, or were responsible for a significant fraction of total output. Elsewhere, notably in pharmaceuticals, the absence of firms with small UK R&D operations, but with access to the much more extensive resources of overseas parent companies stimulated British-owned enterprises to increase their own efforts [16].

R&D overseas by British-owned firms

These activities were paralleled, though on a much smaller scale, by the development by British firms of their own overseas R&D laboratories. Cadbury’s, for example, had an international network of laboratories before

| Table 3: Index of Absolute Industrial Funded R&D (USA (1963) =100) |
|------------------|----------|
| U.S.A. (1963)    | 100.0    |
| U.K. (1964)      | 15.6     |
| Germany (1964)   | 14.5     |
| Japan (1963)     | 10.7     |
| France (1966)    | 10.3     |
| Italy (1963)     | 3.3      |

Source: [11], p. 62
World War II. One of the few studies to discuss any aspect of the overseas R&D activities of British firms was that undertaken by Reddaway and his collaborators as part of a broader investigation, using data from 1964, into the effects of UK direct investment overseas. This revealed that despite the often large sums of money spent on overseas R&D, only a small proportion yielded any results which could be applied outside the country in which they originated, so that the majority of R&D by overseas subsidiaries was linked directly to local markets. Knowledge which could be used more widely was most likely to emerge from R&D activities in the more technologically advanced countries. The US was the outstanding source of informal know-how, but high costs deterred most British firms from establishing an R&D presence there. The value of overseas research also varied considerably between sectors, with the chemical industry accounting for half of the total.

The internationalisation of R&D of which these developments were a part, suggest that purely nationalistic assessments of industrial R&D should be treated with considerable caution. British firms and firms operating in Britain had access to technology developed elsewhere through cross-border R&D organisations and also licensing agreements, patent pools and the formal and informal exchange of ideas which took place in a variety of contexts. It would be very difficult indeed to argue convincingly that the innovative performance of British industry rested only on its own internal ability to generate new products and processes.

Conclusions

The evidence presented above indicates clearly that explanations for innovative failure and poor economic growth which rest either on the lack of spending by firms themselves or on the 'crowding out' of corporate R&D by state funded projects are difficult to sustain. This article has sought to move beyond this basic debate by exploring some of the features of the British industrial R&D in more detail. Understanding the nature of the R&D effort provides an important starting point from which to begin an assessment of what it actually achieved and in what ways R&D was linked to economic performance.

There are plenty of areas for further investigation by historians, as recent work in the economics of innovation has indicated. In particular it appears that the analysis of the factors within firms which linked investment in R&D to innovation and economic performance require consideration [1]. Although historians have as yet provided few detailed case studies of this process for individual British firms, there is strong evidence from contemporary sources that it was a matter of considerable concern. Leading industrialist Sir Charles Horrocks argued in the 1950s that what British industry needed was "more science and more research but more effective management of existing capabilities. Evidence from the published histories of individual enterprises lends some credence to these views and to Carter and Williams' observation that good practice coexisted alongside extremes of 'short-sighted parochialism'. A better understanding of these issues appears to offer a way to move beyond the debates and unsupported assumptions which have dominated many discussions of British R&D during the period 1945-1970 and to contribute to an improved understanding of just what the extensive investments in this activity achieved.

References


Bibliographical Note