

The finance of Innovation in Late Victorian and Edwardian Britain: Possibilities and Constraints

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"... of all the potential ways of improving the performance of modern economies, technological change is probably the most important. Without invention and innovation it is highly likely that improvement in living standards would occur at a much reduced rate."

J.E.S. Parker, *The Economics of Innovation* (London 1978) p. 3

"It is commonly held that the slow development of new industries in the United Kingdom in the decades preceding World War I was an important source of the decline in the rate of growth compared with earlier in the nineteenth century and represented the chief shortcoming compared with other countries, especially Germany"

R.C.O. Matthews, C.H. Feinstein & J.C. Odling-Smee,
British Economic Growth 1856-1973 (Oxford 1982) p. 256

Innovation is the means by which a new product, method, system or device is transformed into a commercial possibility.¹ As the quotation from Parker suggests, this is a process of major importance for it is by constant re-appraisal and change that the modern economy not only grows but also develops. However, as the other quotation from Matthews, Feinstein & Odling-

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¹ J.E.S. PARKER, *The Economics of Innovation* (London, 1978) p. 50; C. Freeman, *The Economics of Industrial Innovation* (London, 1974) p. 22.

Smee indicates, it was in this very area that the British economy is considered deficient in the 1870-1914 period. The historical judgement, concerning the success or failure of the British economy during the later nineteenth century, increasingly centres upon the opinion that there was a growing unwillingness to innovate. Rolt, for example, noted in 1970, in his history of Victorian engineering, that,

“... the story of Victorian engineering in the period after 1860 is very different from that of the heroic years that went before. Increasingly we find British engineers adopting and developing new inventions initiated in other countries. Sometimes they grasped the technical leadership but failed to exploit it for lack of financial support from a country that had lost faith in their powers.”²

The engineers themselves are largely absolved from blame which is placed with those whose responsibility it was to introduce and finance the new technology, and now were less willing to do so than before. This viewpoint, however, fails to acknowledge the fact that it was never easy to persuade investors to finance unproven methods, machines, or products, even during the Industrial Revolution itself.³

More explicitly, the slow growth and difficulties of the late Victorian and Edwardian economy have been blamed generally upon the investor and/or the financial system, for either failing to perceive the new opportunities available or ignoring them in favour of more secure alternatives, especially abroad.⁴ This

² L.T.C. ROLT, *Victorian Engineering* (London, 1970) pp. 176-7.

³ H.I. DUTTON, *The Patent System and Inventive Activity during the Industrial Revolution, 1750-1852* (Manchester, 1984) p. 169; T.K. DERRY & T.I. WILLIAMS, *A Short History of Technology* (London, 1960) p. 607; S. Lilley, “Technological Progress and the Industrial Revolution, 1700-1914” in C.M. CIPOLLA (ed.), *the Fontana Economic History of Europe* Vol. 3 (London, 1973) p. 221; C. Wilson, “Technology and Industrial Organization” in C. SINGER ET AL (ed.) *A History of Technology* (Oxford, 1958) Vol. 5, pp. 800, 807.

⁴ R.C.O. MATTHEWS, C.H. FEINSTEIN & J.C. ODLING-SMEE, *British Economic Growth, 1856-1973* (Oxford, 1982) pp. 256, 451, 536, 539 P. MATHIAS, *The First Industrial Nation* (London, 1969) p. 419; F. CROUZET, *The Victorian Economy* (London, 1982) pp. 371, 382; D.S. LANDES, *The Unbound Prometheus* (London, 1968) pp. 348-9, 339; P.L. COTTRELL, *Industrial Finance, 1830-1914* (London, 1980) p. 258.

argument has been taken furthest by W.P. Kennedy who attributes almost all of Britain's economic problems between 1870 and 1914 to a cumulative failure to fully exploit the technological advances of that period.

"If Britain, by the standard of the late nineteenth century, had been as aggressive and successful in exploiting the uses of electricity, the internal combustion engine, scientific chemistry, rapid communications and other technical advances of the time as she had been in first exploiting, by the standards of the late eighteenth century, the steam engine, textile machinery and the metallurgical improvements of that period, a per capita British income in 1913 at least 50 per cent greater than that actually achieved appears to have been eminently feasible."⁵

The failure to exploit such opportunities is seen to lie entirely with the functioning of the capital market. This transmitted the wrong signals to investors and so encouraged them to ignore domestic openings in such fields as electricity supply, electrical engineering, motor vehicle manufacture and chemicals. Instead, the way the capital market functioned directed funds into safe but foreign securities which lacked a long-term growth potential.⁶

The aim of this article is both to evaluate the finance of innovation, and to suggest that the weaknesses, becoming evident in the British economy during this period, were not due to any mal-function in the capital market but to the effects of government legislation at both the national and local level. An accidental by-product of government controls and measures was that the wrong signals were transmitted to investors. Though this was true in only a small number of instances, which were probably of limited significance to the overall performance of the economy in the years before 1914, this did have serious long-term repercussions. Rather than government direction of investment being a remedy for contemporary economic ills, it

⁵ W.P. KENNEDY, *Industrial Structure, Capital Markets and the Origins of British Economic Decline* (Cambridge, 1987) p. 19. Cf pp. 6, 8, 17, 24.

⁶ KENNEDY, *Industrial Structure*, pp. 56, 110, 120, 139-141, 148-9, 160.

was government itself that was largely responsible for those ills. Kennedy has rightly identified the backwardness of a number of strategic industries as being responsible for weakness in the manufacturing sector before 1914, but he has failed to put forward a convincing common denominator that explains it.

I

“There are countless inventions every year, but not one in a thousand ever gets beyond being an invention and becomes something of practical use to humanity. It is therefore as much a question of the commercial man’s ability as of the inventors as to whether or not any developments shall become useful to the public”.

Morning Post, 19 Nov. 1909

By its very nature the initial finance of major innovations is not the steady re-investment of current income, but the movement of funds from one established sector of the economy into another of unknown potential. This involves a risk of intangible dimensions for the investor. As both the costs and returns are uncertain, it is virtually impossible to predict with accuracy the eventual yield of the investment. Thus the finance of innovation does not lend itself easily to either modelling, measurement or categorisation. In addition, where there is no clear view of the eventual outcome of the investment, it cannot be very responsive to minor alterations in interest rates or short-run changes in the capital market.⁷

It is important to observe that different innovations require different amounts of capital, necessitate varying means of financing, and involve a considerable spread of risk. At one extreme are developments in the realm of social overhead capital. There the initial capital is both largely indivisible and substantial, requiring the commitment of a large amount of funds for a

⁷ N. ROSENBERG (ed.), *The Economics of Technological Change* (London, 1971) p. 36; N. ROSENBERG, *Perspectives on Technology* (Cambridge, 1976) p. 83; J. JEWKES et al, *The Sources of Investment* (London, 1969) p. 76; FREEMAN, *Industrial Innovation* pp. 168, 222, 227; PARKER, *Economics of Innovation* p. 37; DUTTON, *The Patent System* p. 155.

long period. Once the enterprise is established, however, competition is limited and a guaranteed yield over a long life is created, barring unforeseen changes. Railways and electric utilities typify this type of investment. At the other extreme are those activities in which the initial capital requirement is both small and divisible, with further expansion being financed by credit, re-investment or an appeal to the secondary market once assets had been created and performance established. With the cost of entry low, actual or potential competition was always great in this sphere and returns never guaranteed for long, unless protected by such artificial barriers as patent rights. Most areas of industrial and commercial life fall into this category, such as locomotive engineering or the manufacture of electrical goods. This situation was especially true during the early period of the life of an innovation in manufacturing or distribution.⁸

As a result of these differing capital requirements the means used to finance each were radically different, and largely remained so up to 1914. Almost all new railway developments, for example, were beyond the capability of any single person or small group to finance for the length of time necessary. Consequently, railway construction was dependent upon the willingness of passive investors to risk their funds, and this fluctuated with the prosperity of the economy and the availability of funds. Traditionally, railways were of limited appeal to the investor, before they were well established, and were only financed when more attractive alternatives had been satisfied. Thus, this kind of investment was most at the mercy of any changes in the capital market.⁹ In contrast, developments in in-

⁸ ROSENBERG, *Technological Change* p. 104; ROSENBERG, *Perspectives* p. 66; C.F. CARTER & B.R. WILLIAMS, *Investment in Innovation* (London, 1958) p. 31; S.A. COURTARELLI, *Venture Capital in Europe* (New York, 1977) p. 86; Cottrell, *Industrial Finance* p. 189; FREEMAN, *Industrial Innovation* p. 209, 213; PARKER, *Economics of Innovation* p. 13; DUTTON, *Patent System* pp. 155, 169.

⁹ T.R. GOURVISH, "Railway Enterprise" in R.A. Church (ed.), *The Dynamics of Victorian Business: Problems and Perspectives to the 1870s* (London, 1980) p. 132; R.J. Irving, "British Railway Investment and Innovation, 1900-1914", *Business History* 13

dustry and commerce were financed in a variety of other ways and were more dependent upon the non-institutional capital market, such as individual or corporate savings and the funds of partners, relatives, friends, neighbours or business associates. While railway construction, for example, was dependent upon the rate of interest and the sentiment of the market, the growth of a locomotive engineering industry was funded from a miscellany of sources. Established firms producing iron or in the engineering trade began to manufacture railway locomotives as an ancillary product in response to demand, with some giving up the business while others concentrated upon it. Essentially, the profits from one area of activity financed entry into another. Alternatively interested individuals from varied backgrounds teamed together in small firms to provide both the expertise and the finance to set up production, each drawing on all the funds they could muster. Here, finance from other areas of the economy were channelled into the new development through individuals and their contacts.¹⁰ With the growing wealth of Britain, and its unequal distribution, it was not impossible for individuals to collect sufficient sums to finance entry into even the most capital intensive of manufacturing activities. In shipbuilding, for example, the industry was transformed in the mid-nineteenth century, with the coming of iron steamships instead of wooden sailing ships. Nevertheless, single entrepreneurs were able to afford the £ 5-25,000 required to set up in the shipbuilding business, and the industry never appears to have suf-

(1971) pp. 39, 47; W. Vamplew, *Railways and the Transformation of the Scottish Economy (Edinburgh Ph.D. 1969)* pp. 41, 436; R.C. Michie, *The Scottish Stock Exchanges in the Nineteenth Century (Aberdeen, Ph.D. 1979)* pp. 107-8, 128, 143-162; T.C. Barker & M. Robbins, *A History of London Transport* (London, 1963 and 1974), Vol. I, p. 113.

¹⁰ ROLT, *Victorian Engineering* pp. 75-6, 132-3; COTTRELL, *Industrial Finance* p. 124; A.E. Musson, "The Engineering Industry" in Church (ed.), *Dynamics of Victorian Business* pp. 94, 103; DUTTON, *Patent System* p. 168, c.f. the development of electro-metallurgy in the 1840s. G.F. Williams, *The Origins of Industrial Electro-Metallurgy and its Development to 1855 (London, Ph.D 1976)* pp. 208, 231-51, 329, 338.

ferred a shortage of capital, though remaining dominated by family firms until World War One.¹¹

In the late nineteenth/early twentieth century projects with a high initial capital cost continued to be dependent upon the capital market, as in the case of electricity generation, hydraulic power supply, underground railways, electric traction, cinemas or the telephone system.¹² Though numerous industrial and commercial firms did approach the market for funds by this period, they were mainly established firms being converted from private to public concerns, with much of the capital raised being used to pay vendors rather than finance expansion into a new area of activity. Harry Lucas, for example, used most of the money he realised from the public flotation of Joseph Lucas and Son in 1897 to build himself a substantial house. In general, issues by these established firms were readily absorbed by the capital market.¹³ Even by 1914 it remained rare for completely new concerns to raise their initial finance by a public flotation.¹⁴

Some writers have felt that a continued reliance upon informal means was unsatisfactory, considering the novelty of the various enterprises, and their heavy capital requirements, by the early twentieth century.¹⁵ However, developments at the end of the century were no more novel to their contemporaries than those at the beginning while their capital requirements were, re-

¹¹ A. Slaven, "The Shipbuilding Industry" in Church (ed.), *Dynamics of Victorian Business* p. 123; S. POLLARD & P. ROBERTSON, *The British Shipbuilding Industry, 1870-1914* (Cambridge, Mass., 1979) p. 82.

¹² BARKER & ROBBINS, *London Transport* vol. II, p. 113.

¹³ H. NOCKOLDS, *Lucas: The First Hundred Years* (Newton Abbot 1976) p. 95; KENNEDY, *Industrial Structure* p. 167.

¹⁴ COTTRELL, *Industrial Finance* p. 189; J.H. LENFANT, *British Capital Export, 1900-1913* (London, Ph.D. 1949) p. 104; G.L. AYRES, *Fluctuations in New Capital Issues on the London Money Market, 1899 to 1913* (London, M.Sc. 1934) pp. 188-9, 202, 209; A.E. HARRISON, *Growth Entrepreneurship and Capital Formation in the United Kingdom's Cycle and Related Industries, 1870-1914* (York Ph.D. 1977) p. 373, 382.

¹⁵ K.S. LOMAX, "Growth and Productivity in the U.K.," *Productivity Measurement Review*, 37 (1964) p. 15.

latively, no greater, considering the growing wealth of the community. Consequently, there remained nothing unusual in the continued finance of numerous areas of innovation by informal means. Established companies, for example, continued to use profits generated in one activity to finance new products or processes, such as in the soap company, Crosfields, or the glass company, Pilkingtons. Not all were successful. The Hull engineering firm of Priestman Brothers spent £ 44,027, between 1883 and 1894, developing a marketable oil engine. Though sales were achieved, improvements by other manufacturers rendered their engine quickly obsolete, and the project was eventually abandoned. The firm returned to its main business of manufacturing dredging equipment but now lagging technologically and financially crippled, because of the unsuccessful diversion into the new field. For other firms the diversification was both substantial and successful, as in the case of the silk and crape manufacturers, Courtaulds. Between 1904 and 1908 that company spent £ 190,000 in acquiring the patents for, developing, and commercially producing, artificial silk. Of this sum roughly half came from a public issue, when the established firm of Samuel Courtauld & Co. was converted into a public company, and the rest from the realisation of investments and the profits from the existing silk and crape operations. After 1908 the profits in the artificial silk business could generate the finance for further expansion. Generally, the profits being generated by established firms provided the principal source of finance for investment.¹⁶

Though most established firms were perfectly content with the line of business they were in, and had little desire to change, there were always others tempted by new opportunities and fac-

¹⁶ T.C. BARKER, *Pilkington Brothers and the Glass Industry* (London 1960) p. 166; A.E. MUSSON, *Enterprise in Soap and Chemicals* (Manchester 1965) pp. 157-8; D.C. COLEMAN, *Courtaulds: An Economic and Social History* (Oxford 1969) Vol. II, pp. 29-30, 57-9; J.M. Bellamy, *Some Aspects of the Economy of Hull in the Nineteenth Century with special reference to business history* (*Hull Ph.D.* 1966) Part II, Appendix III B pp. 13-18; Matthews, Feinstein, Odling-Smee, *British Economic Growth* p. 347.

ing difficult conditions in their existing operations. H. J. Tetley, the managing director of Samuel Courtauld & Co., for example, concluded in April 1904 that:

“For some time it has been apparent to me that the crape trade proper is unmistakeably declining — the loss of profits from it for the last two years has been balanced by a continued increase in the yield of the colours; special considerations have somewhat helped up — and the expansion of our colour business has been remarkable — but we cannot hope to maintain the profits of the last 2 or 3 years — unless we can find some new source of profit¹⁷”.

As well as diversification by existing enterprises, individuals either singly or in small groups continued to be important pioneers in the development and finance of innovations. It was quite common for a small syndicate to finance the testing and evaluation of a new product or process, before approaching the public for money on the basis of an established business, though frequently the project came to nought. In the cycle manufacturing industry a small entrepreneur, with good connections, could raise £ 10,000 for the establishment of his own firm, in the period 1870-1914. With some widening of those involved in providing the funds, up to £ 30,000 could be raised.¹⁹ During the 1890s the manufacture of viscose in Britain was pioneered by a small group connected by education, vicinity, family or business, while Lanchester's motor car experiments were backed by two brothers who had been successful in the cycle industry. The manufacture of aircraft and office equipment and the production of films were also areas of economic activity in which finance was obtained from individual savings supplemented by loans from friends and relations. Sir William Bass, the brewer,

¹⁷ Quoted in Coleman, *Courtaulds II* pp. 27-8.

¹⁸ Cf. the sections on electrical products and motor cars.

¹⁹ E.T. POWELL, *The Mechanism of the City* (London 1910) p. 31; HARRISON, *Cycle and Related Industries* pp. 367, 441, 467; D.H. MacGregor, “Joint-Stock Companies and the Risk Factor”, *Economic Journal*, 39 (1929) pp. 493, 500; “Present Investment Opportunities”, *Financial Review of Reviews* June 1906. Cf. R.C. Michie, “Options, Concessions, Syndicates and the Provision of Venture Capital, 1880-1913”, *Business History*, 23 (1981).

for example, became heavily involved in film finance.²⁰ Similarly, Lever's foray into the manufacture and mass marketing of soap, at a cost of £ 27,000, was financed by withdrawals from the family grocery business and loans from other members of his family.²¹ In most areas of commercial life the initial capital costs were so small that almost anyone could enter. These included a penniless Jewish immigrant by the name of Marks who, through re-investment and the assistance of trade and later bank credit, and the £ 300 put in by his partner Tom Spencer, created a retail drapery business producing profits of £ 30,000 p.a. by 1914²². Finally, backed by £ 7,000 provided by his father, an Admiral, and the connections that his family background gave him, Cuthbert Heath became the foremost innovator in the insurance world, pioneering from the 1880s, such novel policies as burglary, loss of profits due to fire, accidental loss, loss of goods in transit, and, particularly, cover against hurricane and earthquake damage. Such was his success that the Lloyds Syndicate he represented was producing a premium, income of c. £ 100,000 p.a. by 1894²³.

It is quite clear that throughout the nineteenth century, and up to 1914, there were two main components to the finance of innovation in the range of capital requirements and the ways it was provided. Firstly, in terms of the initial capital required there continued to be innovations covering the whole range of the spectrum, from the minimal needs of retail trade to the substantial requirements of electricity generation and distribution.

²⁰ COLEMAN, *Courtaulds* II p. 10; P.W. KINGSFORD, *F.W. Lanchester* (London 1960) pp. 33-4, 36; W. Fraser Ryder, *The Economic History of the British Aircraft Industry, 1903-1953* (*Southampton M.Sc. 1958*) p. 419; J.S. DORLAY, *The Roneo Story* (London 1978) pp. 6-7; R. Low, *Developments in the British Film Industry before 1918* (*London Ph.D. 1949*) Section III, p. 153; R. Low, *The History of the British Film, 1906-14* (London 1948) p. 129.

²¹ C. WILSON, *The History of Unilever* (London 1954) Vol. I, pp. 30-2.

²² G. REES, *St. Michael: A History of Marks and Spencer* (London 1969) pp. 6-8, 12, 26, 19-20; P. MATHIAS, *Retailing Revolution* (London 1967) p. 40

²³ A. BROWN, *Cuthbert Heath: Maker of the Modern Lloyds of London* (Newton Abbot 1980) p. 62, 69-73, 85-7, 93.

Secondly, though the public capital market grew in importance, it was not the sole means of finance, and its significance diminished as the level of capital needed declined. Even by 1914 the informal capital market continued to play a vital role in the finance of innovation. Institutions had by no means replaced the individual in the direct provision of finance for new enterprise. What evidence there is suggests an abundance of both funds and channels through which finance could be provided for all types of ventures before 1914.

Generally, in British industry the capital/output ratio was rising throughout the period suggesting that it was not any lack of funding that hampered the introduction of new technology at least in established sectors.²⁴

II

"...as practical invention ever follows in the wake of discovery, so do the promoters and the capitalists pursue the inventor, multiplying his models and extending his achievements over land and sea in a thousand profitable projects".

R.W. Hirst, *The Six Panics and Other Essays*, (London 1913) p. 227

Inventive genius and the demands of the economy certainly provided a stream of opportunities for the adventurous investor during the nineteenth century.²⁵ During the first three-quarters of the century these were largely connected with the application of steam power to a widening range of activities in manufacturing, mining, agriculture, transport and urban services. At the same time there were many related areas of progress, such as the

²⁴ B. Elbaum & W. Lazonick, "An Institutional Perspective on British Decline" in B. Elbaum & W. Lazonick (eds.), *The Decline of the British Economy* (Oxford, 1968) pp. 3-4 (cf. Chap. on Cotton Textiles by Lazonick p. 31); Matthew, Feinstein & Odling-Smee, *British Economic Growth* pp. 354, 381-2; R.C. Floud "Britain 1860-1914: A Survey" in R. Floud & D. McCloskey (eds.), *The Economic History of Britain since 1700* (Cambridge 1981) Vol. 2 p. 16; C.H. Lee, *The British Economy since 1700: A Macroeconomic Perspective* (Cambridge 1986) pp. 53, 105.

²⁵ J.G. CROWTHER, *British Scientists of the Nineteenth Century* (London 1935) p.X; Lilley, "Technological Progress" p. 211.

widespread introduction of a public gas supply from 1812 or the electric telegraph from 1837.²⁶ In contrast, the last quarter of the century, and even the years before 1914, are often seen as something of a hiatus in technological innovation. Though new developments were taking place, especially in electric lighting and power and the motor vehicle, they were felt to be of insufficient weight to influence the general pattern of events. However, their absence reflects more the tardiness of Britain's exploitation of these advances than any interruption to technological potential on a world scale.²⁸ Even in Britain, by the early twentieth century capital investment in electrical plant and machinery was averaging over 10 per cent of fixed capital formation, while the engineering industry was being transformed by the needs of the motor car and electrical utilities.²⁹ It is also not clear whether the supposed 'climacteric' in British economic growth due to a temporary dearth of technological advances — ever occurred at all, let alone in which particular decade.³⁰

Innovation depends not only on invention but also upon the prior existence of an appropriate effective demand. There was often a considerable lag between invention and full-scale utilisation. The possibility and means of transmitting visual pictures by wire was under consideration and experimentation as early as

²⁶ R.A. CHURCH, "Problems and Perspectives" in Church (ed.) *Dynamics of Victorian Business* p. 11; ROLT, *Victorian Engineering* pp. 210, 215; DERRY & WILLIAMS, *History of Technology* p. 510; Slaven, "Shipbuilding" in Church (ed.), *Dynamics of Victorian Business* pp. 106, 112.

²⁷ LANDES, *Unbound Prometheus* pp. 235-7, 277; E.H. Phelps Brown & B. Weber, "Accumulation, Productivity and Distribution in the British Economy, 1870-1938", *Economic Journal* 63 (1953) p. 270; D.H. Aldcroft & H.W. Richardson, *The British Economy, 1870-1939* (London 1969) pp. 116-7, 147.

²⁸ DERRY & WILLIAMS, *History of Technology* pp. 277, 305; G.T. JONES *Increasing Return* (Cambridge 1933) p. 15; Lilley; "Technological Progress" pp. 240-1.

²⁹ A.E. MUSSON, *The Growth of British Industry* (London 1978), pp. 188, 196; S.B. Saul. "The Engineering Industry" in D.H. ALDCROFT (ED.), *The Development of British Industry and Foreign Competition, 1875-1914* (London 1968) pp. 209-210.

³⁰ D. Greasley "British Economic Growth: The Paradox of the 1880s and the Timing of the Climacteric" *Explorations in Economic History* 23 (1968) pp. 418, 431, 438-9.

1880, using selenium as a non-metallic conductor, but there was no demand for such a service at that time and the projected 'photophone' was dropped.³¹ Britain's very success in pioneering the technological advances of the early and mid-nineteenth century are often thought to have reduced the incentive to take up later developments. Excellent rail, telegraph and gas networks and the wide-spread use of steampower, burning cheap coal, implied that the openings for the motor car, telephone and electricity were more limited than in an economy that had been less dynamic and less innovative earlier.³² However, it was only an advanced industrial economy that both wanted and could afford the next stage of innovations, most of which were not close substitutes for the old. The motor car, for example, offered a form of personal transport that, initially, was a far greater threat to the horse than the railway. With average money incomes normally substantially higher, and hours of work less, in Britain than in other European countries, and the cost of living lower, especially with cheap foodstuffs, Britain offered a market second only to that of the United States by 1914.³³

The number of people in Britain with an income of £ 160 or over rose from 280,000 in 1860 to 1,190,000 in 1913, and they represented an excellent potential market for such new products as the motor car and electricity supply, which depended upon a sizeable but fairly affluent clientele. Reflecting this position was the fact that Britain did possess the largest market for motor vehicles in Europe. In 1913 there were 106,000 private cars in

³¹ LANDES, *Unbound Prometheus* pp. 329, 339 C.A. Hempstead, Semiconductors, 1833-1919: An Historical Study of selenium and some related materials (*Durham Ph.D. 1977*) pp. 106, 109-10; Rosenberg, *Perspectives* p. 68; Derry & Williams, *History of Technology* p. 608.

³² LANDES, *Unbound Prometheus* p. 336; ROLT, *Victorian Engineering* p. 271.

³³ E.H. PHELPS BROWN, *A Century of Pay* (London 1968) p. 185; P. MATHIAS, *Retailing Revolution* (London 1967) p. 13; P. O'BRIEN & C. KEYDER, *Economic Growth in Britain and France, 1780-1914* (London 1978) pp. 38, 67, 74, 164; T.R. Nicholson, *The Origins of the Motor Car in Britain, 1769-1881* (*Leicester Ph.D. 1979*) p. 639.

use in Britain compared to 91,000 in France and 60,900 in Germany, while British demand for commercial vehicles far outstripped that of European rivals, with 103,000 in use compared to 9,700 in, for example, Germany.³⁴ Late Victorian and Edwardian Britain offered all the market opportunities of a growing urban/industrial community in receipt of rising real incomes and increasing leisure. Undoubtedly, certain countries improved their own market for specific products by tariffs, subsidies, or government purchasing. The French aircraft industry, for instance, was far larger than the British because, by 1911, the French government had purchased 200 military aeroplanes compared to the 16 acquired by the British government.³⁵ However, despite these exceptions the general case that the British market was the best in Europe, remained true.

Increasingly, developments in new technology in the nineteenth century required an intimate knowledge of science in order to understand and cope with its growing complexity, and Britain's technical education was poor in comparison to that prevailing on the continent. Musson is of the opinion that

"The voluntary education agencies of earlier years no longer sufficed in an increasingly scientific-technological age, but a state system of education, especially of technical education, was slow in developing... this lag certainly seems to have contributed to the relatively slow development in Britain of new industries such as organic chemicals, electrical engineering, internal-combustion engines and motor vehicles, as well as new scientific-technical processes in old industries."³⁶

³⁴ LENFANT, *Capital Export* p. 106; L. HANNAH, *Electricity before Nationalisation* (London 1979) p. 9; B.R. MITCHELL, *European Historical Statistics, 1750-1970* (London 1975) pp. 640-2; T.C. Barker, *The Spread of Motor Vehicles before 1914* (circulated typescript 1981) p. 4; W. HAMISH FRASER, *The Coming of the Mass Market 1850-1914* (London 1981) p. 23.

³⁵ RYDER, *British Aircraft Industry* pp. 40, 45, 56.

³⁶ MUSSON, *British Industry* p. 157; cf. LANDES, *Unbound Prometheus* pp. 339, 344; ALDCROFT & RICHARDSON, *British Economy* pp. 147-150; CARTER & WILLIAMS, *Investment in Innovation* p. 12; D.N. McCloskey & L.S. Sandberg, "From Damnation To Redemption", *Explorations in Economic History* 9 (1971) p. 107.

By the first World War Germany was training three times as many technical and university students as Britain while the German government was spending four times as much upon its universities.³⁷ It does seem probable that Britain's growing backwardness in the chemical industry, at least, was substantially due to a shortage of well-trained chemists.³⁸ Central government and local authority spending on education did rise from £ 8.9m p.a. in the 1880s to £ 55.1m p.a. in 1910/13, but the system did not meet all the needs of an advanced industrial economy.³⁹ However, the degree of scientific or even technical knowledge required in the development of the new technology was not considerable. Until well into the twentieth century technological change remained predominantly the product of the skilled and knowledgeable practical man, and these abounded in British industry, with the early progress in steam, locomotive and textile engineering.⁴⁰ In the commercial sphere all that was required was a sound general education. Cuthbert Heath's venture into hurricane and earthquake insurance, for instance, was based on no more than simple arithmetic and rudimentary geography, but that was sufficient for him to pioneer a completely new field.⁴¹ To a large extent Britain's deficiency in education arose because of her lag in developing the new technology rather than being a cause of it. Even in areas

³⁷ J.P. Brown, *Some Aspects of the early development of the Electric Lighting Industry, 1882-1919* (*Sheffield M.A.* 1964) pp. 205, 228-9, 265, 322-4.

³⁸ J.J. BEER, *The Emergence of the German Dye Industry* (Urbana 1959) pp. 42-4; H.W. Richardson, "The Development of the British Dyestuffs Industry before 1939"; *Scottish Journal of Political Economy* 9, p. 113; Musson, *British Industry* p. 219.

³⁹ B.R. MITCHELL & P. DEANE, *Abstract of British Historical Statistics* (Cambridge 1962) pp. 396-9, 416-21, 423-5; W.H.B. COURT, *British Economic History, 1870-1914* (Cambridge 1965) p. 167; W. Ashworth, "The Late Victorian Economy", *Economica* 33 (1966) pp. 28-9.

⁴⁰ H.J. HABAKKUK, *American and British Technology in the Nineteenth Century* (Cambridge 1967) pp. 195, 202; C.K. Harley, "Skilled Labour and the Choice of technique in Edwardian Industry", *Explorations in Economic History* 11 (1974) p. 413; Pollard & Robertson, *British Shipbuilding* pp. 130-145; Lee, *British Economy* p. 79.

⁴¹ BROWN, *Cuthbert Heath*, pp. 62, 69-73, 85-7, 93.

such as electricity and motor vehicle engineering, skills were learnt in a trial and error fashion as the industry grew, thus a lag at any stage created a need for training in order to catch up.⁴² If Britain had continued to pioneer or even maintained an equal position, the weaknesses of the educational system would hardly have been apparent within an industrial system where the tradition was to train their own.

It is thus clear that there continued to be numerous and sizeable opportunities for investors in the finance of innovation in the late Victorian/Edwardian economy, stemming from the realm of both supply and demand, while the level of technical skill required did not form an insuperable barrier to entry. Within the important established industries, such as cotton textiles, iron and steel, and shipbuilding, though opportunities were missed they were of only marginal significance, and were readily explained within each sector's internal economies. They were not, in any general sense, due to any shortage of finance.⁴³ It would be unrealistic to expect Britain to monopolise all advances in all sectors in the more competitive environment of the late nineteenth century onwards. She did not do that even in early or mid-century. Nevertheless, even when all allowances are made there remain two key areas of the economy in which Britain experienced a significant lag behind progress in other industrial nations, notably electricity and motor vehicles.

It is these two sectors which are usually referred to when any examples are sought regarding Britain's technological back-

⁴² H.C. PASSER, *The Electrical Manufacturers, 1875-1900* (Cambridge, Mass. 1953) pp. 360-1; G. Maxcy, "The Motor Industry" in P.L. COOK & R. COHEN (eds.), *Effects of Mergers* (London 1958) p. 355.

⁴³ HABAKKUK, *American and British Technology* p. 220; L.G. SANBERG, *Lancashire in Decline* (Columbus 1974) p. 54; D.N. McCLOSKEY, *Economic Maturity and Entrepreneurial Decline: British Iron and Steel, 1870-1913* (Cambridge, Mass. 1973) pp. 15, 126-7; POLLARD & ROBERTSON, *British Shipbuilding* pp. 29, 73, 82, 86, 129; MATHIAS *Industrial Nation* p. 420; A.J. Taylor, "The Economy" in S. Nowell-Smith, *Edwardian England* (London 1964) p. 137; Cottrell, *Industrial Finance* p. 180; Matthews, Feinstein & Odling-Smees, *British Economic Growth* p. 449; Lee, *British Economy* pp. 84, 88.

wardness compared to other advanced industrial economies in the 1870-1914 period.⁴⁴ As Weiner put it in 1981, when trying to explain Britain's industrial decline.

"Insufficient long-term investment hobbled productivity growth, which in turn made such investment ever less attractive and so on in a downward spiral. Particularly hurt were the new electrical equipment and automobile industries, two of the industries of the second industrial revolution".⁴⁵

Shorn of the complaint about insufficient capital deepening in manufacturing industry by the statistical evidence of Matthews, Feinstein & Odling-Smee, the argument rests heavily on the backwardness of the two industries of electricity and motor vehicle manufacture. This makes it imperative to try and understand why these two areas were slower to advance in Britain than elsewhere, in order to discover whether they were both symptoms of a general malaise or the products of peculiar and individual circumstances. Certainly their backwardness cannot be easily explained by reference to market conditions, skills shortage, or other easily identifiable conditions. Whether it was due to capital market imperfections and/or investor reluctance remains to be ascertained.

One cannot believe that investors were unaware of the opportunities existing in such fields as motor vehicles and electricity, for contemporary comment foresaw a great future for both at an early stage. Henderson, writing in 1878/9 noted that

"Besides the new countries that are being opened up as a field for the employment of capital, there are also signs of the multiplication of new and vast scientific forces, such as the electric light, for instance, which will probably lead to an immense development of enterprise".⁴⁶

⁴⁴ MATTHEWS, FEINSTEIN & ODLING-SMEE, *British Economic Growth* pp. 400, 451, 536, 539; ORCUZET, *Victorian Economy* p. 382; L.G. Sandberg "The Entrepreneur and Technological Change" in Flad & McCloskey (eds.) *Economic History of Britain* in p. 110; LEE, *British Economy* pp. 90-91; KENNEDY, *Industrial Structure* p. 139-141.

⁴⁵ J.S. HENDERSON, "Commercial and Financial England", in T.H.S. Escott, *England: Its People, Polity, and Pursuits* (London 1879) Vol. I, p. 216.

⁴⁶ A.R. HALL, *The London Capital Market and Australia, 1870-1914* (Canberra 1963) pp. 13, 16; A.K. Cairncross, *Home and Foreign Investment, 1870-1913* (Cam-

Amidst the general euphoria it is unlikely that the investor would have remained in ignorance. Again, it cannot be claimed that the finance for such projects was lacking in Britain. High per capita incomes, and their unequal distribution, encouraged savings and this was reflected, for example, in the amount invested overseas which rose from c. £ 1.3b in 1875 to c. £ 3.8b in 1913.⁴⁷ Consequently, the finance for innovation was available and there was a general acknowledgement of both the existence and the potential of opportunities in major innovations. Also, though many innovations brought little financial reward to their pioneers, there was always the example of those individuals or firms who had become wealthy through the introduction of some novel technique, product or process. Perkin in dyestuffs and Armstrong in hydraulic power, were both able to retire early and in luxury, while Courtauld's profits rose from 3 per cent p.a. in 1907 to 50 per cent p.a. in 1912 due to rayon production.⁴⁸ With examples such as these, innovations in motor cars and electricity should have held great attractions for investors. As Powell observed in 1910,

"The investor cannot be prevented from taking risks. In a very real sense the progress of the world depends, as human society is at present organised, upon his willingness to take them."⁴⁹

However, in the case of both electricity and motor vehicles most British investors were either unwilling to take the risk or

bridge 1953) pp. 87, 231; L. Soltow, "Long-run Changes in British Income Inequality", *Economic History Review* 21 (1968) p. 21; J.A. HOBSON, *The Economic Interpretation of Investment* (London 1911) pp. 37, 39; C.K. HOBSON *The Export of Capital* (London 1914) p. 25; M.G. MULHALL, *Industries and Wealth of Nations* (London 1896) p. 100.

⁴⁷ A.R. HALL, *The London Capital Market and Australia, 1870-1914* (Canberra 1963), pp. 13, 16; A.K. CAIRNCROSS, *Home and Foreign Investment, 1870-1913* (Cambridge 1953), pp. 87, 231; L. SOLTOW, "Long-Run Changes in British Income Inequality", *Economic History Review* (1968) p. 21; J.A. HOBSON, *The Economic Interpretation of Investment* (London 1911), pp. 37, 39; C.K. HOBSON, *The Export of Capital* (London 1914), p. 25; M.G. MULHALL, *Industries and Wealth of Nations* (London 1896), p. 100.

⁴⁸ DERRY & WILLIAMS, *History of Technology* pp. 543-4; ROLT, *Victorian Engineering* p. 126; COLEMAN, *Courtaulds II* p. 60.

⁴⁹ POWER, *Mechanism of the City* p. 155.

something prevented them from doing so. In the next two sections the circumstances surrounding the finance of these two innovations will be investigated in the hope of finding out the reasons for the reluctance.

III

"The worried manufacturers blame the capitalists for not finding money, the men of science declaim against the manufacturers for not doing pioneer work,..., and the educationists scold everybody for not building more technical schools. On the other hand, capitalists are blamed for over capitalising because dividends are small, and the men of science are told that they do not know anything except theory, and are of no real use in the workshops. The truth is all are placed in unfavourable conditions. At every stage promoters are thwarted by Parliament, by municipalities, by chaotic survivals from legislation passed before electric power was heard of, and by an equally chaotic overlapping of different jurisdictions."

Times, 20 Oct. 1906

In financial terms there were two distinct components within the electrical industry. The production and distribution of electricity involved very large initial capital requirements in order to provide the generating plant, transmission lines, transformer stations and basic installation. As early as 1901/2, £ 27.9m had been expended on electricity supply alone and this had risen to £ 66.5, by 1913/14. In contrast, the manufacture of electrical equipment did not require substantial amounts of initial capital, while expansion could be financed through re-investment and credit, once profits were being generated. However, the success of the manufacturing branch was very dependent upon the growth and performance of the supply industry, as the market for electrical equipment before 1914 was not a mass consumer one but derived from the use of electricity in public lighting and transport or in industry and mining. If the supply industry grew slowly so would the business of the equipment manufacturers.⁵⁰

⁵⁰ S. Judek, *The Development of the Electricity Supply Industry in Great Britain* (*Edin. Ph.D. 1947*) Vol. II, p. 127, Vol. I, pp. 269, 295; E.C.R. BYATT, *The British*

Thus, within this one field is encapsulated the two extremes involved in financing technological innovations and, in international terms, Britain lagged in both. Britain's electricity supply was inferior to Germany by World War One while its electrical manufacturing industry was only half the size, by value of output.⁵¹ Clearly something was wrong.

The possibilities of using electricity had long existed in the nineteenth century, though its utility had been severely curtailed when the battery was the only source of current. With the incorporation of electro-magnets in the generator in the mid-1860s, which occurred simultaneously in Britain, Germany and the United States, it became feasible to provide electric current on a large scale and at a competitive price. The rapid expansion of arc and then incandescent lighting resulted from this development. At this stage Britain was well up with her competitors. The incandescent lamp, for example, was invented almost simultaneously by Swan in Britain and Edison in the United States.⁵² In addition, the investing public appeared eager and able to supply all the finance that might be required. During the early 1880s there was a sustained burst of speculative activity in electrical undertakings, with numerous companies being formed to develop both arc and incandescent lighting systems and to provide a public supply of electricity. Between 1880 and 1882, a total of 142 electrical companies were established with an estimated paid-up capital of £ 23m. In electricity supply alone £ 16m was provided by 1883. Most of this capital was obtained

Electrical Industry, 1875-1914 (Oxford 1979) p. 5; H.H. BALLIN, *The Organisation of Electricity Supply in Great Britain* (London 1946) p. 15; E.C.R. Byatt, "Electrical Products" in Aldcroft (ed.), *British Industry and Foreign Competition* p. 240; J.D. SCOTT, *Siemens Brothers, 1858-1958* (London 1958) pp. 76-7, 169.

⁵¹ LANDES, *Unbound Prometheus* p. 290; HANNAH, *Electricity before Nationalisation* p. 37; JUDEK, *Electricity Supply Industry II* p. 74, I p. 347; BALLIN, *Organisation of Electricity* p. 37.

⁵² PASSER, *Electrical Manufacturers* p. 12; JUDEK, *Electricity Supply Industry I* p. 40; Lilley, "Technological Progress" p. 242; BROWN, *Electric Lighting Industry* pp. 3-5; A.G. WHYTE, *The Electrical Industry: Lighting, Traction and Power* (London 1904) p. 23.

from local shareholders who could expect to benefit directly from the service, and was raised in the normal way of a publicly or privately circulated 'prospectus' and the operations of stock-brokers, bankers, and other intermediaries.⁵³ Undoubtedly, investors were well aware of the potential of electricity, as well as the considerable risks involved in proving the commercial worth of the technology. This early exuberance among investors was, in fact, harshly punished as much of the capital invested was lost — half in the case of the electricity supply companies.⁵⁴

It was after this flourish of financial enthusiasm that the British electricity supply industry began to fall behind its main rivals, especially the United States and Germany. After the numerous failures it was only to be expected that investors would avoid the industry for some time, but this was only a temporary reaction common to other activities at various times, such as domestic railways or overseas investment. By the late 1880s confidence was returning with a few new concerns appearing in 1887/8, and there were occasional flourishes of enthusiasm for electricity right up to 1914. However, there was never again the degree of investor participation as experienced in the early 1880s, though the varied individuals and institutions of the capital market were closely involved in the financing of the industry.⁵⁵ For example, in 1907 a group of Edinburgh solicitors and accountants, backed by their individual and institutional

⁵³ HANNAH, *Electricity before Nationalisation* pp. 5-6, 43; BALLIN *Organisation of Electricity* p. 6; BYATT, *British Electrical Industry* pp. 7, 188; JUDEK, *Electricity Supply Industry I* pp. 37-8; AYRES, *New Capital Issues* p. 44; W.J. READER, *A House in the City* (London 1979) pp. 98-100; A. Essex-Crosby, *Joint Stock Companies in Great Britain, 1890-1930* (London *M.Com.* 1938) pp. 23, 220-3.

⁵⁴ *Investor's Monthly Manual* (I.M.M.) 27 May 1882, 29 July 1882; *Philips' Investors' Manual* (London 1887) p. 199; H.O. O'HAGAN, *Leaves from my Life* (London 1929) I, p. 118; HANNAH, *Electricity before Nationalisation* p. 6; JUDEK, *Electricity Supply Industry I* pp. 37-8, 165.

⁵⁵ *I.M.M.*, 30 Nov. 1897; LADY WANTAGE, *Lord Wantage: A Memoir* (London 1907) pp. 304-5; AYRES, *New Capital Issues* p. 44; ROLT, *Victorian Engineering* pp. 225, 228; HANNAH, *Electricity before Nationalisation* pp. 11, 43; BYATT, *British Electrical Industry* p. 101; BROWN, *Electric Lighting Industry* p. 91; JUDEK, *Electrical Supply Industry* p. 165; READER, *House in the City* pp. 98-100.

clients, provided a total of £ 140,000 to invest in a small number of new electric traction and power companies. A number of the purchases turned out to be disastrous and the debenture-holders had to wait until 1918 before getting their money back, while the shareholders lost all of their capital.⁵⁶

The problem was that after 1882, the legislative conditions under which the British electricity supply industry operated actively discouraged investment. With the object of controlling the random proliferation of electrical undertakings, and their need for rights of way for their transmission lines, the government legislated for the industry in 1882. The Act that was passed not only provided for maximum prices but also allowed the purchase of private undertakings by local authorities at written-down value after 21 years. This threat was a real one with the extensive municipalisation of other urban services, and was a serious impediment to an industry that looked to repay its high initial capital requirements over a long life. However, the threat of municipal take-over, with little compensation, was largely removed in 1888, when the time period was extended to 42 years. Nevertheless, a major restriction of growing magnitude remained, namely the limitation of each company's operations to the area under the control of a single local authority.⁵⁷

This legislation was of little consequence when the low pressure d.c. system prevailed, for its high cost of transmission confined it to small areas. Even by the late 1880s, thought, the a.c. system was operational and this needed, for efficient running, large central power stations serving extensive areas through high pressure transmission lines. The introduction of this system, and the cheap electricity it offered, was delayed and impeded by the ex-

⁵⁶ Electrical Securities Trust: *Annual Report* 23 Sept. 1907, 14 Nov. 1918; *Circulars* 3 May 1909, 12 May 1910; *Minutes* 8 July 1907-25 Sept. 1907.

⁵⁷ HANNAH, *Electricity before Nationalisation* pp. 5-6; BALLIN, *Organisation of Electricity* p. 12; BROWN, *Electric Lighting Industry* pp. 23-8; JUDEK, *Electricity Supply Industry* p. 78; E. GARCKE, *The Progress of Electrical Enterprise* (London 1907) pp. 13-17; WHYTE, *Electrical Industry*, p. 22.

isting legislation and the obstruction of local authorities. In London, for example, a company with strong financial backing was formed with the object of supplying the city's electricity from three large generating stations, but this plan was blocked by the various London local authorities. London continued to be supplied with electricity from 66 generating stations, with an average size of only 3,000 h.p., controlled by 72 authorities. Comparable cities in Europe or the United States had single generating stations of up to 70,000 h.p. Legislation was passed enabling power companies to be formed which could operate over a wide area, but this was circumscribed by local authorities' ability to exclude themselves, thus tending to leave the companies with the less remunerative rural areas.⁵⁸

Essentially, the legislation gave control of electricity supply to the very people who had a vested interest in slowing down and limiting development, namely the local or municipal authorities. By the 1880s these authorities already owned much of the country's gas supply and had no wish to see a competitor destroy their investment. Thus, they either restricted the expansion of privately financed electric utilities or sought to provide their own facility. However, whereas gas could be economically supplied over a limited geographic area, electricity increasingly could not, and most authorities were unwilling to submerge their interests and accept a large central power station serving many districts. Where this did take place, such as the North-East of England, the cost of electricity by 1914 was less than a quarter than that of London, where extreme fragmentation prevailed.⁵⁹ Generally, with regard to the relationship between

⁵⁸ PASSER, *Electrical Manufacturers* p. 336; HANNAH, *Electricity before Nationalisation* pp. 31-2, 44-6, 51; BALLIN, *Organisation of Electricity* pp. 11, 21, 32, 71, 94; BROWN, *Electric Lighting Industry* p. 152; JUDEK, *Electricity Supply Industry I*, pp. 42, 75, 79, 116; ROLI, *Victorian Engineering* p. 230.

⁵⁹ HANNAH, *Electricity before Nationalisation* pp. 32, 39, 48; BALLIN, *Organisation of Electricity* p. 32, 94; BYATT, *British Electrical Industry* p. 209; JUDEK, *Electricity Supply Industry* pp. 47, 54-5, 75. For a somewhat contrary view see L. Hannah, "Public Policy and the Advent of large-scale Technology: the case of electricity supp-

electricity supply and the attitude of local government Falkus concluded in 1977 that,

“... the fact remains that the municipalities were on the whole a conservative force, reluctant to embark on large-scale investments in electricity, yet jealous of private enterprise in the field.”⁶⁰

The result of this intervention was that Britain failed to make full use of electric light and power either because it was not quickly and readily available or because it remained costly in terms of alternatives such as coal and gas. In international terms Britain slowly lost the advantage of being a country where energy was cheap. At the same time the changes in industrial practices and the productivity gains that came from the use of electricity were both delayed and dampened. The limited mechanisation in British coalmines, the weakness in electro-chemicals and electrolytic production, the limited introduction of electric motors in manufacturing, and the restricted use of electricity in transportation can all be blamed, to a varying degree, on the obstacles placed on electrical generation, distribution and pricing by local authorities, with detrimental consequences for the economy as a whole in the long run.⁶¹

Despite the legislative barriers erected against private entry into electricity supply there were investors who continued to try. The London Electricity Supply Corporation, for example, was formed in 1887 with a capital of £ 535,000, subscribed privately by a close group of 28 people, with the aim of supplying

ly in the U.S.A., Germany and Britain” in N. Horn & J. Kocka (eds.), *Formation of the Big Enterprises in the 19th and early 20th centuries* (Göttingen 1979) pp. 579-80, 584-6.

⁶⁰ M. FALKUS, “The Development of Municipal Trading in the Nineteenth Century” *Business History* 19 (1977) p. 158.

⁶¹ M.S. COTTERILL, *The Scottish Gas Industry up to 1914 (Strathclyde Ph.D. 1976)* pp. 1, 304; JUDEK, *Electricity Supply Industry* I p. 347; BALLIN, *Organisation of Electricity* p. 38; HABAKKUK, *American and British Technology* p. 200; Lilley, “Technological Progress” p. 239; Derry & Williams, *History of Technology* p. 551; ALDCROFT & RICHARDSON, *British Economy*, p. 165; H.W. RICHARDSON, “Chemicals” in Aldcroft (ed.), *British Industry and Foreign Competition* p. 279; WHYTE, *Electrical Industry* pp. 29, 140-4.

all London's electricity from one huge power station located on the Thames and close to the supply of coal. A London merchant banker, R.H. Benson, who was loosely connected with the company, reminisced in 1907 that "Extravagant estimates were formed of the profits that lay before the company, and to many of the shareholders it seemed that an El Dorado had opened at their feet."⁶² However, there were technical difficulties with the turbine generators installed by Ferranti while the legislation, maintaining local electricity supply monopolies, destroyed the Company's prospect of a wide distribution network served by a central plant and achieving substantial economies of scale. By 1898 the managing director, R.S. Bain, was bemoaning the position of the company.

"This company being the pioneer of all the other companies in London, had to take upon its shoulders the whole of the experimental cost of developing the industry, with the result that the company's experience has cost it a large part of its paid-up capital, and our shareholders have up to the present never received any dividend."⁶³

No dividend was paid until 1905, 18 years after the company was formed. Nevertheless, the company was kept afloat by its shareholders, especially Lord Wantage, in the hope that it would become successful once the technical problems were overcome and a large supply business had been built up. Wantage, for instance, became the largest shareholder and provided a further £ 170,000 by way of loans.⁶⁴ These were hardly the actions of a reluctant or risk-averse investor.

Thus, under the most trying of circumstances the finance was available from public and private sources for technological innovation involving considerable risk and real losses. The prob-

⁶² R.H. BENSON, "Episodes of business and finance" in Lady Wantage, *Lord Wantage: A Memoir* (London 1907) pp. 304-5.

⁶³ *Finance*, 25 June 1898.

⁶⁴ Benson, "Episodes of business" pp. 304-12; Hannah, *Electricity before Nationalisation* p. 11; BYATT, *British Electrical Industry* p. 101; BROWN, *Electric Lighting Industry* pp. 91, 98; ROLT, *Victorian Engineering* p. 223.

lem was, as Benson so aptly noted "The Electric Lighting Act of 1882 had driven too hard a bargain with private enterprise, and few... had been willing to risk capital under those conditions."⁶⁵ The British Electric Traction Company, for example, had been formed in 1896 to invest in and promote electric tramway and allied undertakings in Britain. By 1902 its paid-up capital, provided by c. 2,000 investors, totalled £ 2.8m, of which at least £ 100,000 was invested in government securities as a reserve. However, both its areas of main operation in Britain, electric traction and electric power, were so hindered by local and central government legislation that it began investing its surplus funds overseas, especially in New Zealand and India where it had placed £ 490,000 in two tramway subsidiaries by 1907.⁶⁶ Rivers Wilson, the Chairman, made the company's position clear to the shareholders at the Annual General Meeting in 1911.

"... It is not easy to find in this country investments for capital to yield an industrial return, and we have great difficulty at the present time in profitably employing our surplus cash resources, because we are determined not to extend the business of electrical enterprise in this country unless and until we can secure better treatment and better prospects of making an industrial profit than is the case at present."⁶⁷

The Company possessed both the resources and the inclination to invest in British electrical utilities but was disinclined to do so solely because of the existing legislation.

A related piece of legislation, the Tramway Act of 1870, slowed down considerably the electrification of Britain's tramway systems, and thus delayed the appearance of a major domestic market both for electrical power and electrical equipment. By this Act, local authorities leased the right to run tramways, along the public highway, to private companies, but they

⁶⁵ Benson, "Episodes of business" p. 305.

⁶⁶ British Electric Traction Co.: *Annual Report*, 14 Dec. 1896, 18 June 1900, 16 June 1902; 27 June 1907; Derry & Williams, *History of Technology* p. 387.

⁶⁷ B.E.T. *Annual Report*, 15 June 1911. Cf B.E.T. *Report of the Directors*, 31 March 1911.

retained the right to purchase these undertakings after 21 years at scrap valuation, with no payment for goodwill or earning capacity. Consequently, as the end of these leases approached, the tramway companies ran down their capital expenditure, in case their franchises were not renewed. Unfortunately, the period when most of these leases were nearing termination was also the time when electrical power was being applied to the tramway system in place of horses or steam traction. With electrification involving at least a doubling of expenditure per mile, tramway companies were neither willing nor able to raise the large sums of capital required, until they had a security of tenure sufficient to justify the cost. Even 21 years was considered possibly too short a time in which to obtain the full return for the capital invested and the risks taken. Thus, while tramway electrification was proceeding apace in the United States, and later Continental Europe, in the 1880s and 1890s, it was largely delayed in Britain until after 1900, when either the leases had been renewed or the local authorities had taken over the network. By that time American and continental manufacturers were well placed to satisfy equipment needs.⁶⁸

The manufacture of electrical equipment presented few entry difficulties to any person or firm with an engineering background and a moderate amount of capital. Ferranti, for example, began in 1883 by making electric meters in a small workshop, Crompton by producing dynamos, while Royce and a partner started in 1884, with a capital of £ 75, by manufacturing electric bell sets, lampholders, switches, fuses and registering instruments. Success and profitability, plus the assistance of friends and relatives, financed further growth. A number of established engineering firms also added electrical goods to their product

⁶⁸ J.P. MCKAY, *Tramways and Trolleys: The Rise of Urban Mass Transport in Europe* (Princeton 1976) pp. 40, 61, 63, 67, 71, 73, 168-170, 178, 184, 243; Barker & Robbins, *London Transport I*, pp. 268, 297-9, II, pp. 27, 35; Hannah, *Public Policy*", p. 580; GARCKE, *Electrical Enterprise* pp. 8, 12, 51; WHYTE, *Electrical Industry* pp. 69-70, 93.

range, such as the textile machinery concern of Mather & Platt, who produced dynamos from 1883 onwards, and the Birmingham hydraulic engineering enterprise, Tangyes, who began making a range of electrical equipment in the 1890s.⁶⁹ However the prospects of all these concerns was blighted by the difficulties of the electricity supply industry and major users such as electric traction, upon which they were dependent. The profits, for example, of publicly quoted electrical manufacturing concerns fell by over half between 1899 and 1907 before beginning a slow recovery up to 1913. Nevertheless, despite the difficulties, electrical manufacturers continued to make successful appeals to the capital market.⁷⁰ It is thus evident that the backwardness of Britain's electrical supply and manufacturing industry dates from the legislation of 1882 onwards, though, according to Garcke, blame was soon placed elsewhere.

“As the public sees only the effect of this delay, and does not appreciate the underlying causes, it continues to attribute to lack of enterprise a situation which is created and dominated by antiquated legislation, framed, not to encourage, but to restrict in various ways the natural advance of electrical distribution in the direction of cheapness, efficiency, and general adoption.”⁷¹

IV

“No further explanation or excuse is required to show why Great Britain failed for many years to take a foremost place in what is, beyond question, one of the greatest engineering movements in modern history. The ground which was lost to this country in the early days of the development of the modern motor car has been hard to regain, and it is only within the last two or three years that England can claim to have taken a

⁶⁹ I. LLOYD, *Rolls-Royce: The Growth of a firm* (London 1978) pp. 3-4; R.E. WATERHOUSE, *A Hundred Years of Engineering Craftsmanship: Tangyes Ltd., 1857-1957* (Birmingham 1957) p. 52; ROLT, *Victorian Engineering* p. 222, 227; BROWN, *Electric Lighting Industry* p. 453.

⁷⁰ AYRES, *New Capital Issues* p. 36, 44; Byatt, “Electrical Products” in Aldcroft (ed.), *British Industry and Foreign Competition* p. 261; Scott, *Siemens* pp. 76-7; BYATT *British Electrical Industry* p. 7; ALDCROFT & RICHARDSON, *British Economy* p. 165.

⁷¹ GARCKE, *Electrical Enterprise* p. 32.

foremost place in motor car design and construction, and to have become a great central mart for the trade in motor vehicles."

W.E. Hooper, *The Motor Car in the first decade of the Twentieth Century* (London, 1908) p. 40.

Though the motor car industry came to require vast inputs of capital its initial needs were fairly limited, and certainly within the means of the affluent in late Victorian and Edwardian society. Consequently, the industry provides an excellent case a study of an innovation that was not dependent upon the public capital market for venture finance, but relied on the savings of its pioneers and their contacts, assisted by trade and bank credit and the generation of profits for re-investment. Only when the enterprise was well-established need there have been an approach to the market for further funds, and by then a track-record had been created. Here again, though, Britain lagged behind major competitors in Europe and North America.⁷² This backwardness is somewhat surprising as Britain was a pioneer of mechanical road vehicles in the mid-nineteenth century, in the form of steam traction engines. However, legislation passed in the 1860s effectively stopped all developments. The Locomotive Acts of 1861 and 1865 restricted all mechanical vehicles, using the public highway, to a speed of 4 m.p.h. and required each vehicle to carry a crew of two, plus a third, who had to walk twenty yards in front giving warning by means of a red flag. In 1878 the red flag provision was made optional but the speed restrictions remained. These regulations were largely in force until 1896 and were rigorously policed, with the consequence that road vehicle experimentation in Britain almost ceased completely. Weight restriction, which were not amended until 1904, further restricted progress in commercial vehicles. Tangyes, for example, abandoned their attempts to develop a viable road

⁷² HABAKKUK, *American and British Technology* p. 202; MATHIAS, *Industrial Nation* p. 424; Maxcy, 'Motor Industry' pp. 355-6; J. Foreman-Peck, 'The effect of market failure on the British Motor Car Industry before 1939', *Explorations in Economic History* 18 (1981) pp. 284, 286-7.

transport vehicle, while F.W. Lanchester, a pioneer of the modern British motor industry, was forced to give his engine its trials in a motor launch on the Thames in 1893. Prohibitive legislation of this description was sufficient to discourage all but the bravest of endeavours. Demand from India, and use restricted to private estates, provided an outlet and so there was some experimentation, and production did continue. In contrast, France was relatively free from restrictive legislation on motor vehicles and it was that country that became the largest manufacturer of automobiles in Europe.⁷³

Sufficient scope for the growth of a British motor vehicle manufacturing industry did not come until the repeal of the 'Red Flag' legislation in 1896, and the substitution of a speed limit of 12 m.p.h.. Unfortunately, by that time considerable advances had been made in both Europe and the United States, where there had not been similar restrictions, so the the British industry was in the position of having to catch up on its rivals. Despite these developments elsewhere, there remained considerable uncertainty over the type of motor vehicle that would prevail with, in power alone, steam, electric batteries, oil and petrol, all being considered possibilities until at least 1902.⁷⁴ Nevertheless, the years after 1896 saw a flurry of hopeful entrants into the industry. Numerous established engineering firms producing

⁷³ ROLT, *Victorian Engineering* p. 107; DERRY & WILLIAMS, *History of Technology* p. 388, Maxcy, 'Motor Industry' p. 355; T.R. NICHOLSON, *The Birth of the British Motor Car, 1769-1897* (London 1982) Vol. 2 pp. 291, 304, 313; A. DU CROSS, *Wheels of Fortune: A Salute to Pioneers* (London 1938) pp. 11, 188; P.W. KINGSFORD, *F.W. Lanchester* (London 1960) pp. 33, 35, 63; WATERHOUSE, *Tangyes Ltd* p. 28; W. PLOWDEN, *The Motor Car and Politics, 1896-1970* (London 1971) p. 22; Barker & Robbins, *London Transport II*, pp. 119, 126; G.L. TURNBULL, *Traffic and Transport: An Economic History of Pickfords* (London 1979) p. 149; J.S. MOORE, *The Engineering History of the Motor Industry in Northern Ireland (Belfast M.Sc. 1978)* pp. 8-9, 18; W.E. HOOPER, *The Motor Car in the First Decade of the Twentieth Century* (London 1908) pp. 27-8, 35-6; NICHOLSON, *Origins of the Motor Car* pp. 63, 69, 167, 176, 214, 222, 228, 248, 360, 397, 470, 474, 488, 491, 509, 511, 513, 544, 563, 618, 636-7.

⁷⁴ COURT, *British Economic History* pp. 151-2; Maxcy, "Motor Industry" p. 356; MOORE, *Engineering History* p. 100.

anything from traction engines, textile machinery and cake-mixing machines to sheep-shearing equipment and bicycles started manufacturing either whole vehicles or components. Once the Boer War ended armament firms faced spare capacity and many saw the production of motor vehicles as a suitable alternative for their plant, capital and labour force. Firms such as Vickers, Kynoch, Armstrong, Palmers, Hotchiss and Beardmore all entered the industry about that time. When M. S. Napier, for example, inherited the ailing engineering business of D. Napier & Son in 1895, he cast around for new but related openings and, after experimenting with the production of machine tools for the cycle industry, he eventually concentrated upon motor car manufacture in 1898-9. The prior experience of many firms in general engineering ensured that there was little novelty attached to the manufacture of motor vehicles, except the end product itself.⁷⁵

These established engineering firms financed motor vehicle developments by funds taken from other branches of their activities. Armstrong Whitworth, for instance, invested over £ 80,000 in their motor car subsidiary between 1902 and 1913, as well as underwriting its cumulative losses of £ 65,000. The pattern of events was similar at Vickers, where they attempted to develop both the Wolseley and Siddeley cars. Illustrative of the effect this diversion of funds could have on the firm's main business was Joseph Lucas & Son, whose profits declined from

⁷⁵ MUSSON, *British Industry* p. 190; COTTRELL, *Industry Finance* p. 176; Maxcy, 'Motor Industry' p. 355; ROLT, *Victorian Engineering* p. 113; WELLWORTHY, *The First Fifty Years* (Lymington 1969) p. 16; C. Trebilcock, "Spin-off in British Economic History: Armaments and Industry, 1760-1914", *Economic History Review* 22 (1969) p. 486; HARRISON, *Cycle and Related Industries* p. 352; MOORE, *Engineering History* pp. 65-7, 215; R.G.A. CHESTERMAN, *Local Taxation and the Motor Car in Cheshire, 1888-1978* (Chester 1978) pp. 9-10; R. CHURCH, *Herbert Austin: The British Motor Car Industry to 1941* (London 1979) pp. 5, 10-11; T.J. Byres, *The Scottish Economy during the 'Great Depression', 1873-1896* (*Glasgow B. Litt.* 1963) p. 631; H. NOCKOLDS, *Lucas: The First Hundred Years* (Newton Abbot 1976) pp. 105, 113, 115; C. WILSON & W. READER, *Men and Machines: A History of D. Napier & Son, Engineers, Ltd., 1808-1958* (London 1958) pp. 59, 67.

£ 27,129 in 1898 to £ 11,09 in 1902, due to heavy spending on the development of motor accessory manufacture in order to supplement their existing bicycle trade.⁷⁶

An example of the whole process, the capital involved, the risks taken, and the perseverance needed, is the British Electric Traction Company's involvement in the manufacture and running of road vehicles. As early as 1904 they wrote off £ 10,607, with Rivers Wilson explaining why.

"It arises mainly out of the experiments which we have thought it advisable to make in connection with the new motor haulage industry. It is necessary, having regard to our large interest in traction undertakings, that we should watch carefully all new developments, and be prepared to adopt any methods of traction which offer advantages over those at present employed, both for conveyance of passengers and of goods, and for these reasons we have made sundry investments and experiments in connection with motor haulage vehicles and motor omnibuses, and the whole of the expenses incurred have been written off.⁷⁷

This was not the end of the matter, for B.E.T. formed a subsidiary, in conjunction with its associate company, the Brush Electrical Engineering Co., to manufacture and run motor omnibuses. By 1914, B.E.T., along with Brush, had provided c. £ 200,000 from their own internal resources to provide omnibus services outside London, while another associated enterprise, the London General Omnibus Co., did likewise within the metropolis. In addition, a further £ 100,000 had been invested by B.E.T. and Brush in the development of suitable motor vehicles. Despite the early failure of their involvement, B.E.T. continued to finance innovation as they had a firm belief in the eventual success of motor vehicles, and had the financial

⁷⁶ Some Investment Decisions of Sir W.G. Armstrong, Whitworth & Co. Ltd., 1900-1914", *Business History* 17 (1975) pp. 150-168; C. TREBILCOCK, *The Vickers Brothers: Armaments and Enterprise, 1854-1914* (London 1977) pp. 39-40; A. RICHARDSON, *Vickers Sons & Maxim Ltd.* (London 1902) pp. 178-9; Church, "Problems and Perspectives" pp. 11, 13; NOCKOLDS, *Lucas* pp. 117-8, 120.

⁷⁷ B.E.T. *Annual Report*, 11 July 1904.

strength, from their established traction enterprises, to back that belief.⁷⁸

Much of the pioneer work, however, took place outside these established firms and was financed through the personal contacts of the mainly middle-class personnel involved. Napier, for example, was aided by his mother while his partner, S.F. Edge, was supported by his immediate employer in the Dunlop Tyre Company, Harvey Du Cross, who had made a fortune from the conversion of that firm into a public concern. By 1906, £ 32,600 had been spent on Napier's Acton car-engine plant and the firm's profits had risen to £ 13,206 p.a.. F.W. Lanchester's attempts to develop a new motor car during the 1890s were financed from his own savings and by the financial support of a few people who had already been successful in the bicycle industry. Numerous other concerns, such as Rolls-Royce and Austins were also indebted to individual contacts for the finance needed to begin production, being, in their case, respectively A.H. Briggs, a wealthy Bradford woollen manufacturer, and Frank Keyser, a Sheffield steel producer. There appeared to be no shortage of wealthy backers willing to provide all or part of the venture capital needed to begin motor vehicle production.⁷⁹ Once begun, the growth of profits supplemented by credit and mortgage loans, was sufficient to finance steady expansion. Even

⁷⁸ B.E.T. *Annual Report*, 24 July 1905, 27 June 1907, 20 June 1912, 10 June 1913, 18 June 1914; *Report of Directors and Statement of Accounts*, 31 March 1904; 31 March 1906, 31 March 1907, 31 March 1908; 31 March 1912, 31 March 1913, 31 March 1914.

⁷⁹ WILSON & READER, *Men and Machines* pp. 67, 71, 79-80, 83; LLOYD, *Rolls-Royce* pp. 8, 11-14, 18; Church, "Problems and Perspective" pp. 17-18; KINGSFORD, *Lanchester* pp. 33-45; DU CROSS, *Wheels of Fortune* pp. 81-2, 123; R.J. OVERY, *William Morris, Viscount Nuffield* (London 1976) p. 11; P.W.S. ANDREWS & G.E. BRUNNER, *The Life of Lord Nuffield* (Oxford 1955) p. 67; W.J. READER, *The Weir Group: A Centenary History* (London 1971) pp. 48-57; J.M. LAUX, *In First Gear: The French Automobile Industry to 1914* (Liverpool 1976) p. 102; S.B. SAUL, "THE MOTOR INDUSTRY IN BRITAIN TO 1914", *Business History* 4 (1962) pp. 27-8; MOORE, *Engineering History* p. 185; TURNBULL, *Pickfords* p. 157; HARRISON, *Cycle and Related Industries* pp. 367-8, 467.

when additional funds were required for a major investment programme, there appeared to be no difficulty in making a public issue on the capital market, as long as a suitable time was chosen, such as 1902, 1905-7, or 1911-13. For example, motor car manufacturers raised £ 2.7m by public flotation between 1905 and 1907 and a further £ 1.3m in the period 1911-13. This was in spite of the considerable mortality of motor car firms, with over half the British makes of car having disappeared by 1913.⁸⁰

The small scale of most British motor manufacturing firms by 1914 thus reflected not so much any shortage of capital but more the constant flux in the style and technology of the industry, which rendered long product lines uneconomic and made heavy capitalisation positively dangerous, especially in the face of periodic over-capacity. The Argyll Motor Co., for example, was floated in 1905 with an issue of £ 232,000, which was three times over-subscribed. It raised a further £ 365,000 between December 1905 and August 1907, by which time its production of 1,200 vehicles per annum was the highest of any European car company. However, the company collapsed in 1908 with debts of c. £ 750,000. In many ways the numerous models reflected the eagerness of individual investors to back potential entrants into the industry in the expectation that their preference would become the popular choice. Out of the 281 motor cars registered in Cheshire in 1904 there were 87 different makes with the most popular manufactures, such as Darracq and Humber, only commanding a market share of 9 per cent each.⁸¹ The

⁸⁰ Saul "Motor Industry in Britain" p. 40; AYRES, *New Capital Issues* p. 44; LLOYD, *Rolls-Royce* pp. 15, 26, 35; Maxcy, "Motor Industry" pp. 361-2; COTTRELL, *Industrial Finance* p. 176; Church, "Problems and Perspectives" pp. 17-18, 30; WILSON & READER, *Men and Machines* p. 84; HARRISON, *Cycle and Related Industries* pp. 354, 357-9; MOORE, *Engineering History* pp. 28-9.

⁸¹ Maxcy, "Motor Industry" p. 360; LLOYD, *Rolls-Royce* pp. 15, 17, 19-20, 26, 35, 150; ALDCROFT & RICHARDSON, *British Economy*, p. 152; MOORE, *Engineering History* pp. 30, 102; Harrison, *Cycle and Related Industries* pp. 439, 459; Saul "Motor Industry in Britain" p. 38; Chesterman, *Local Taxation* pp. 54-6.

British motor vehicle industry was late in starting because of very restrictive legislation, but apart from minor speed and weight restrictions, which continued to curtail progress in some branches, after 1896 it was free to compete with European rivals on an equal footing. Consequently, the early twentieth century witnessed a rapid development of the industry in Britain with particular success in such fields as commercial vehicles, agricultural tractors, and light cars of moderate power. Apart from what would be expected in an experimental activity prone to cyclical fluctuations, there was no obvious deficiency of finance, and the major legislative impediments had been removed sufficiently early as the industry was still in its pioneer stage.⁸²

By 1908 the industry had grown sufficiently in size and stature to warrant both an objective financial analysis and a positive recommendation for investment by, for instance, the *Investor's Monthly Manual*.

"The industry is a new one - it has grown with remarkable rapidity; but it requires to be placed on a broader and sounder basis. The sudden and large demand for cars induced manufacturers to erect large factories equipped with the most modern machinery for the rapid construction of motors, and the result has been that there is no longer a large demand and a limited supply. The position, owing to the enormous output, has been reversed; supply has overtaken demand, and, indeed, passed it, with the result that makers have been left with large stocks of cars on their hands, and the further disadvantage of the discharge of a large number of work people.

Up to the present time there has been a good demand for a fairly costly pleasure car, but, in our opinion, it is not in that direction that the motor industry will expand. The market for a car costing anything from £ 500 to £ 1,000 is of necessity limited. Whether we shall see anything like such a cutting of prices as nearly ruined the cycle industry years ago it is impossible to say, but we sincerely hope that nothing of the kind

⁸² K. RICHARDSON, *The British Motor Industry, 1896-1939* (London 1977) p. 17; MUSSON, *British Industry* p. 190; S.B. Saul, "The Engineering Industry" in Aldcroft (ed.), *British Industry and Foreign Competition* p. 223; HOOPER, *The Motor Car* pp. 40, 57, 69; TURNBULL, *Pickfords* pp. 149, 157; BARKER & ROBBINS, *London Transport II*, pp. 118, 126-7, 167; PLOWDEN, *Motor Car and Politics* pp. 34, 62, 454; G. DE HOLLAND-STONE, *The Automobile Industry* (London 1904) pp. 5-6, 32.

will take place. But we advise those who think of investing in motor company shares, either now or later on, to pay particular attention to those companies which are willing to cater for that public which wishes a reliable car costing from £ 150 to 300, and, more importantly still, to those companies which are paying attention to the manufacture of the commercial motor, for we are strongly of the opinion that there is practically unlimited field of enterprise before the manufacturer of these two classes of motors. Manufacturers of commercial motors have hitherto touched only the fringe of the industry.

Whatever may be the immediate future of the industry we are not at all despondent as to its ultimate position, and the man who does not mind taking some risk would do well to watch the motor share market closely."⁸³

V

"Whatever may be said for or against these social and legislative movements, the fact remains that they have seriously limited the opportunities of electrical enterprises."

E. Garcke, *The Progress of Electrical Enterprise* (London 1907)

The two case studies of electricity and motor vehicles have shown that, given suitable conditions, shortage of finance was not a problem afflicting the development of the new technology in Britain. Through both the personal and impersonal capital market finance was easily channelled to where it was required in new departures, even if a considerable risk was attached to the investment. Indeed, there seemed an eagerness among investors to become involved, as in the electricity industry in the early 1880s or the motor-car industry after 1896. In the innovations requiring little initial capital, it appears to have been readily available in either individual savings or through personal contacts. Once the new business had been proven the investing public were always willing to be tapped for funds, as in the case of the pioneers of volume sales, notably Lever Brothers, Liptons, and Home & Colonial.⁸⁴ Arthur Wheeler and Arthur

⁸³ I.M.M. JAN, 1908; cf. K. RICHARDSON, *British Motor Industry* p. 179.

⁸⁴ MATHIAS, *Retailing Revolution* pp. 111, 127.

Blake, for instance, specialised in the raising of capital for small Midland-based industrial and commercial concerns from 1899, and by 1910 they had a large clientele of potential investors.⁸⁵ Where the innovations necessitated a large initial capital, the availability of finance was much more responsive to the general state of the market. However, throughout the late nineteenth/early twentieth century there were periods when it was relatively easy to raise large sums from the capital market for the most novel and risky enterprise. In the 1908-11 period, for example, there was investment mania in cinemas with the result that some £ 11m had been raised for cinema construction by the end of 1913.⁸⁶ The opportunities were there, the finance was available, investors were willing to take risks, and the market — formal and informal — provided the means.

The problem was that many of the developments in these fields, which the capital market appeared ready to finance, had their prospects so blighted by government restrictions, that British developments lagged behind those elsewhere in western Europe or North America. Bell's efforts in telephonic communication, for example, initially met a ready response in Britain with the formation of a spate of locally backed telephone companies in 1878-1880. However, this enthusiasm was short-lived for the Post Office was granted, in 1880, a monopoly over the telephone service, by virtue of their acquisition of the Telegraph Companies in 1868. A compromise was agreed whereby the Post Office licensed the operations of the companies, who also had to pay substantial royalties for their privileges. The Post Office used this power to restrict the growth of an inter-urban telephone system as this most threatened their heavy in-

⁸⁵ L. DENNETT, *The Charterhouse Group, 1925-1979* (London 1979) p. 16. BARKER & ROBBINS, *London Transport I*, p. 246; cf. R.C. Michie, "The Social Web of Investment in the Nineteenth Century", *Revue Internationale d'Histoire de la Banque* 18 (1979).

vestment in the telegraph network. The Post Office was supported in this obstruction by the refusal of both Parliament and local authorities to grant the necessary way-leaves for telephone lines.

Eventually, the Post Office took over trunk telephone lines in 1896 and the total system in December 1911. Though progress continued it was slow and incomplete as the Post Office was ever mindful of trying to minimise the effects on its established telegraph system.⁸⁷ Consequently, investment was limited and this was reflected in the service provided, with one American being of the opinion in 1913, that nowhere was there "... a telephone service so dreadful and so exasperating" as that of London.⁸⁸

Where and when the new innovations were unfettered with restrictions, appropriate finance was readily available, whether it came via the personal or impersonal capital markets. Where restrictions were imposed, and they were of significance, the finance of innovation was circumscribed and rendered insufficient. It was the reinforcing of natural conservatism by powerful legislative and administrative controls, that, as a by-product, thwarted the provision of finance in late Victorian and Edwardian Britain. As Garcke so rightly observed

"... capital is shy as well as bold, and is at once withheld when threatened with expropriation on confiscatory terms, with state or rate-aided competition, or with labour troubles; and without capital inventiveness and commercial enterprise count for nothing in a new industry."⁸⁹

⁸⁷ DERRY & WILLIAMS, *History of Technology* p. 628; J. KIEVE, *The Electric Telegraph: A Social and Economic History* (Newton Abbot 1973) pp. 118, 195, 200-6, 211, 213-4, 243-4, 243-4; J.W. GROVE, *Government and Industry in Britain* (London 1962) pp. 16-7; C.R. PERRY, "The British Experience, 1876-1912: The Impact of the Telephone during the years of delay" in I; de S Pool (ed.), *The Social Impact of the Telephone* (Cam. Mass. 1977), pp. 71-2, 75-6, 80-2, 84, 88-90; MUSSON, *British Industry* p. 192.

⁸⁸ W.C. VAN ANTWERP, *The Stock Exchange from Within* (New York 1913) p. 341.

⁸⁹ GARCKE, *Electrical Enterprise* p. 84.

Both the investor and his institutions were willing to take risks, but in certain spheres the opportunities were either not available to them, because of central or local government ownership, or rendered unattractive by legislation and its implementation. The areas of the economy most affected by these conditions were almost inevitably, being new, among the most potentially dynamic, ranging from the manufacture of motor vehicles, electrical goods and telephone equipment to the provision of an electricity supply, a telephone service, and an improved urban transport system. Though the cumulative consequences of specific failings such as these had made little impact on the economy as a whole, before the First World War, they had begun to undermine its growth possibilities.⁹⁰ Consequently, when any overall assessment is made concerning the performance of the British economy in the late Victorian and Edwardian eras, the part played by government at all levels should figure prominently as a major impediment to growth.⁹¹ As Whyte so aptly put the point in 1904,

“Playing second fiddle in the orchestra of progress is not a very glorious proceeding; and it is as well to understand that the reasons we did not play first fiddle or lead the whole orchestra are to be sought among the Blue Books and Acts of Parliament, and not in the supposed degeneracy of our engineers and capitalists.”⁹²

If one examines the reasons behind the reluctance of the investor to finance innovation or capital market imperfections which hindered the process, as perceived both at the time and since, it becomes clear that both the investor and the system were responding to the conditions created by a growing body of parliamentary legislation and central/local government intervention. The common denominator behind the failure to innovate

⁹⁰ Cf. the motor car industry. Foreman-Peck, “British Motor Car Industry” pp. 184, 286-7.

⁹¹ Cf. Viscount Goschen, *Essays and Addresses on Economic Questions* (London 1905) pp. 233-293.

⁹² WHYTE, *Electrical Industry* p. 72.

was not irrational biases in the market but the role played by government. Certainly governments before World War I were not powerful enough to manage the economy or even intervene in a general way. Nevertheless, they had a growing presence at all levels and in numerous areas, and this has to be considered when any evaluation is made of British economic performance before 1914. It is too easy to make the assumption that this was an era of laissez faire and that the contribution of the state was so marginal as to be ignored. This was not the case as the examples of electricity and motor vehicles illustrate. For good or ill the state was already important between 1870 and 1914 and its actions need to be examined before the judgement can be made that the capital market failed to support the introduction of the new technology because of inherent biases.⁹³ The biases were there but they were symptoms not causes of the problem.

⁹³ For the role of the state, see S. Checkland, *British Public Policy, 1776-1939: An Economic, Social and Political Perspective* (Cambridge 1983) pp. 125, 169, 202; A.J. TAYLOR, *Laissez-faire and State intervention in Nineteenth Century Britain* (London 1972) pp. 55, 60; G.C. PEDEN, *British Economic and Social Policy: Lloyd George to Margaret Thatcher* (London 1985) pp. 2-6; Falks, "Municipal Trading" p. 134. None of these captures the more general economic consequences of government legislation.