January 2004

Transport

Simon Ville
University of Wollongong, sville@uow.edu.au

Transport

Abstract

This chapter describes the process of transport growth and development in eighteenth- and nineteenth-century Britain, including its political, organisational and developmental impact. Transport systems (including communications) move people, goods and information. The large size and capital-intensive nature of transport operations caused unprecedented organisational challenges for companies. The identification of transport as a form of social overhead capital, supporting production across the economy, helps account for its broad-ranging impact on economic development. In this role transport contributed to the efficient allocation of resources over space, thereby promoting competition between producers, and providing information about alternative consumption possibilities to consumers.

Keywords

transport history, Britain, economic history, market integration, social savings

Disciplines

Business | Social and Behavioral Sciences

Publication Details

This chapter was originally published as: Ville, S, Transport, in R. Floud and P. Johnson (eds) The Cambridge Economic History of Modern Britain, 2004, 3rd edition, 295-331.

11 Transport

SIMON VILLE

Contents

INTRODUCTION

Transport has long been viewed as of central importance to modern British economic history.[1] More than forty years ago, Rostow (1960: 302) viewed the railway as the 'leading sector' of the British economy of the mid-nineteenth century, driving broader economic modernisation through its strong intersectoral linkages. This early interest in the developmental role of transport has given way more recently to a closer

[1] This chapter has benefited from feedback provided by Joel Mokyr, Paul Johnson, Martin Daunton, Peter Wardley and other participants at the 2001 London conference that discussed chapter drafts. Paola Crinnion provided valuable research assistance.

understanding and recognition of its pioneering contribution to behavioural and structural elements of economic change, particularly in terms of government intervention and corporate innovation.

This chapter will describe the process of transport growth in the eighteenth and nineteenth centuries, and then focus more closely on its political, organisational and developmental impact. Transport systems (including communications) move people, goods and information. This chapter will look at each of these functions in order to reveal the pervasive role of the transport industry in modern British history. The tendencies for transport infrastructure to take the form of a public good, open to all users, and for some transport services to operate in a manner similar to a monopoly explain the interest shown in the industry by governments seeking to assess the private and public costs and benefits involved. The large size and capital-intensive nature of many operating units caused unprecedented organisational challenges for transport companies. The identification of transport as a form of social overhead capital, supporting production across the economy, helps account for its broad-ranging impact on economic development that has been the focus of much of the historiography. In this role transport contributed to the efficient allocation of resources over space, thereby promoting competition between producers, and providing information about alternative consumption possibilities to consumers.

PATTERNS OF TRANSPORT DEVELOPMENT

Roads

Concerted efforts were made to improve the quality of the road system in the eighteenth century. Levels of maintenance had not been commensurate with actual or potential demand from road users. Parishes previously provided road maintenance in their vicinity but the neglect of such duties led to the transfer of responsibility to 'turnpike trusts', beginning in the mid-seventeenth century. Access to these roads was through a turnpike, and users had to pay a toll towards the upkeep of the road. The trusts consisted largely of local entrepreneurs with a strong private interest in road maintenance. The first turnpike trust was established by act of parliament in 1663. After a slow start, the number of turnpikes increased rapidly with the economic expansion of the 1750s and 1760s. Further booms occurred in the early 1790s, 1809–12 and the mid-1820s. In the first of these booms turnpike trusts were established across many areas of Britain; in the second and third phases expansion was particularly linked with the port and dock activities of wartime; and in the final period the industrial expansion of Lancashire and Yorkshire provided a strong incentive. By the mid-1830s around 22,000 miles of roads

had been turnpiked or entrusted to Improvement Commissioners, representing about one-fifth of all roads (Barker and Gerhold 1993: 37–8). In a similar fashion, bridge trusts often bore responsibility for the maintenance of bridges and the rapid growth in their construction from the late eighteenth century through to 1830 (Ginarlis and Pollard 1988: 208–12; Harrison 1992: 246, 259–60).

Accompanying these improved institutional arrangements were important developments in road building and haulage technology. John Metcalfe, Thomas Telford and John McAdam have been given much of the credit for the improved quality of roads from the later eighteenth century. Roads were strengthened by packing broken stones into them, and drainage was improved by developing convex surfaces. By 1829 concrete was also being used in roads. Many more tunnels and bridges were constructed in order to avoid steep gradients and long contours, which helped roads to handle heavier traffic and to be passable in inclement conditions. Gerhold (1996) has recently argued that road haulage technology, not road systems, was the key explanation of the growth of road transport services. Improved breeds of sturdier horses ate less and worked harder, and some improvements in wagon design predated the turnpike trusts. Of course, better roads and vehicles went hand in hand: better roads facilitated the shift to lighter more capacious wagons by providing harder, smoother, dryer surfaces with less steep inclines. The consequence of these combined improvements was larger loads, higher speeds, and longer continuous periods of travel, including more overnight movements.

How rapidly did road transport grow? Road transport took many forms, most obviously passenger conveyance and goods shipment including the mail, but a distinction is also drawn between London, provincial, local and private carriers of goods (Barker and Gerhold 1993: 19–33). Several estimates have been made of the growth of the London cargo carriers travelling to the provinces, for whom a variety of evidence survives from directories, advertisements, legal proceedings and business records. Estimates of the growth of capacity (number of weekly services) and output (ton-miles) both show a substantial annual compound growth rate: 0.7 to 1.8 per cent in the former and 1.0 to 2.8 per cent in the latter for 1681–1840 (Table 11.1). For passenger services from London to the provinces, growth rates of weekly services and passenger miles come to 1.9 per cent and 2.8 per cent respectively for 1715–1840 (Table 11.2). It is more difficult to estimate the growth of local and private carriers, for whom little evidence survives. Services were often irregular and undertaken by small carriers, who sometimes combined this with cartage work on farms at harvest and other busy seasons. Distances covered were mostly as little as 25 or 30 miles, and carriers rarely required specialist premises because of the smallness of their operations (normally one or two carts) and their ability to complete most tasks on the same day.

Table 11.1 Growth of the London carrying trade, 1681–1840

	Services per week		Index of ton-miles (1765 = 100)		per week Ton-miles
	Chartres and Turnbull	Gerhold	Chartres and Turnbull	Gerhold	Gerhold
1681	372	346			
1690		348		31	74,700
1705		453			
1715	611		17		
1738		422			
1765	990	493	100	100	243,500
1796–8	1,662	565	169	111	269,800
1808		608		113	274,300
1816–18	3,246	823	344	140	340,700
1826		1,025		152	369,800
1838–40	6,113	1,093	571	149	362,200
Annual compound growth (%)	1.8	0.7	2.8	1.0	1.1

Notes: Figures from Chartres (1977), Chartres and Turnbull (1983), and Gerhold (1988). Chartres and Turnbull's index of services per week, 1715–1840, has been converted to actual services on the basis of Chartres's figure for 1715. Gerhold's figures exclude services covering less than 20 miles to London.

Source: Barker and Gerhold 1993: 22, Table 2.

Table 11.2 Growth in passenger services to selected provincial centres, 1715–1840

Year	Service quotient	Index (1796 = 100)	Passenger miles (000)	Index (1796 = 100)
1715	158	10	67	7
1765	279	18	123	12
1773	376	24	183	18
1796	1,596	100	1,040	100
1816	2,060	129	2,043	197
1840	1,765	111	2,369	228
Annual compound growth (%)		1.9		2.8

Note: Service quotient refers to a quantum of the weekly frequency of coach departures from London to thirty-eight major provincial cities.

Source: Chartres and Turnbull 1983: 69.

Better roads and road transport substantially improved the operation of services: average travel times declined by 20 to 30 per cent over the period 1750–1830 (Jackman 1916: 335–6) and carriers could offer a greater range of service types, from slow coaches to flying wagons (faster but higher price), depending upon whether speed or cost was more important. Regularity was enhanced by less seasonal laying up, as only the most severe winter weather made the new roads impassable. These changes undoubtedly reduced the input costs of transport, and the increased competition associated with the extension of services led to these lower costs

being passed on in the form of lower freight rates (Pawson 1977: 297; Barker and Gerhold 1993: 40–3). Contemporaries noted that road transport charges were falling, perhaps by as much as a third (Albert 1983: 55–6). None the less, road carriage remained more expensive than by inland waterway or coastal shipping, particularly for long hauls of bulky materials.

Inland waterways

In the half century or so before 1750, navigational improvements had been made to a number of rivers in response to expanding internal trade. Channels had been cut across winding bends and shallow areas deepened. However, from the second half of the eighteenth century there was heightened interest in the construction of canals, which are defined as deadwater navigations, built as directly as possible, avoiding obstructions such as weirs, and incorporating an adjacent towpath for haulage and locks to adjust to altitude changes. The Sankey Brook Navigation, which was partly opened in 1757, connected the coal mines of St Helens with the river Mersey. The Bridgewater Canal, which was opened in 1761, joined the coal mines of the duke of Bridgewater at Worsley with Manchester. Although the change from river improvement to canal was gradual, these two waterways are often viewed as symbolising the beginning of a period of intensive canal construction that lasted until at least the end of the French Wars in 1815. The demand for transporting bulky raw materials that lay behind their construction reflected the type of service to which canals were best suited. Although the Bridgewater was a short local canal it was soon followed by longer trunk canals connecting different regions, including the Forth and Clyde Canal in 1790, which gave Edinburgh access to the commercial waterway of the Clyde, and the Leeds and Liverpool Canal in 1816, which crossed the Pennines.

In a similar fashion to the turnpike trusts, canal construction required the authority of a private Act of Parliament, and these acts provide a proxy for the intensity of waterway expansion. Table 11.3 shows that in the decade and a half from 1760 canal construction proceeded rapidly. This was then followed by a slowdown for about a decade until expansion rose to a peak in the first half of the 1790s. High levels of construction continued through the first three decades of the nineteenth century, by which time the British canal network was all but completed, with the major exception of the Manchester Ship Canal, which was finished in 1894. The mileage of all inland waterways in England and Wales grew from 1399 in 1760 to 3876 in 1830, a growth rate of 1.4 per cent per annum, with most of this growth attributable to canal construction (Duckham 1983: 109).

Although we lack reliable data on the growth of waterway traffic, expansion was heavily orientated towards freight traffic, especially in bulky goods, such as coal and other minerals, and where only a low rate of

Table 11.3 Growth of inland waterways, 1760–1830

Years	Mileage	New acts	All acts total
1760	1,399		–
1760–4	–	6	6
1765–9	–	23	29
1770–4	–	23	52
1775–9	–	13	65
1780–4	–	11	76
1785–9	–	11	87
1790–4	–	82	169
1795–9	–	44	213
1800–4	–	47	260
1805–9	–	44	304
1810–14	–	37	341
1815–19	–	30	371
1820–4	–	21	392
1825–9	–	35	427
1830	3,876		–
Annual compound growth (%)	1.4		

Note: In most of these years the vast majority of acts were for extending the powers of existing companies or navigation undertakers.

Source: Duckham 1983: 106.

dispersion in their delivery was required. Many of the earliest canals were promoted and financed by individual entrepreneurs for the benefit of their firms. They were mostly connected with the industrialising regions of Lancashire, the West Midlands and South Wales. The Trent and Mersey ('Grand Trunk') Canal, which formed a link between the west and east coasts of England, was completed in 1777. Its promoter, Josiah Wedgwood, used the canal to ship his pottery to the ports of Hull and Liverpool and receive the raw materials of coal and clay. By the 1790s, canal construction had become more widely spread in terms of geographical location, goods carried and numbers of investors, the latter often as part of joint-stock companies. As such, the canals played their part in weaning investors away from government bonds towards a capital market in industrial finance.

The leading canal engineers, men such as Thomas Telford, John Smeaton, the Whitworths and the Rennies, faced enormous natural obstacles, which required the construction of tunnels, cuttings, embankments, bridges and aqueducts. Such works took many years, as can be seen from the long lag in completing the trunk canals: the Forth and Clyde was completed in 1790, twenty-two years after its act was passed, while the construction of the Leeds and Liverpool took from 1770 to 1816. Waterway transport was largely undertaken in narrow boats pulled by horses from

the towpath. There was little use of steam on canals before the middle of the nineteenth century, and even then its use and effectiveness was limited by the narrowness of many canals. Fly boats became common during the early nineteenth century. Like the flying coaches on the roads, they used relays of horses, ran to regular timetables, and often worked all night.

Thus, there were only limited improvements to speed from the canal era. Even the progress of relays of horses was constrained by the time taken to pass through locks. Nor was regularity much improved, since narrow canals could easily flood or freeze over in winter. However, the canal era did create significant additional transport networks, both to make connections between existing river systems and to bring water transport into new areas. Canals reduced transport costs, particularly of bulk cargoes such as minerals on longer distances (see chapter 15 below). Duckham (1983: 131) has estimated a saving of 50 to 70 per cent in the bulk trades, though this figure fluctuated substantially according to the distance carried and the extent to which road transport was still needed at the beginning and/or end of the journey: canals rarely delivered door to door, thus involving expensive transhipment costs compared with journeying entirely by road.

Shipping

The shipping industry faced huge increases in demand in both the coastal and overseas trades in the eighteenth and nineteenth centuries in response to industrialisation, international specialisation of production, and colonialism. Increased household and factory demand for coal 'fuelled' the growth of its interregional trade, particularly that sourced from South Wales and the north-east of England. Rapidly growing volumes of grain, livestock and building materials were all being shipped around the coast of Britain in response to population growth and industrial expansion. In the nineteenth century, European industrialisation and the emergence of the steamship stimulated a major expansion of coal exports. Coastal passenger services covered most British ports by the early nineteenth century, particularly serving business travel and leisure excursions. Their comfort and convenience prevented their immediate extinction by the railway in the mid-nineteenth century. Coasters continued to provide a larger share of domestic transport output (ton-miles) than railways throughout the nineteenth century (Armstrong 1987: 176). Most foreign deployment of the British fleet had been found in Europe at the start of the eighteenth century, particularly in the Mediterranean, the North Sea and the Baltic. Over the next century and a half, growing numbers of vessels entered longer-haul intercontinental foreign trades, particularly as a result of British influence over, and settlement of, distant lands in the Americas, Africa, Australasia and Asia. These trades required

large amounts of tonnage because of their long distance; additionally, this involved the carriage of some bulky cargoes such as timber, wool, raw cotton, slaves and migrants. Major technological and organisational advances were essential to enable British shipping to respond to this huge increase in demand.

Steamboat experiments took place on the Clyde in the first decade of the nineteenth century and they were shortly in use as river craft. By the 1820s and 1830s larger engines and more efficient paddles brought steam into coasting. In the 1840s paddles were replaced by more efficient screw propellers and in the following decade the compound engine was patented. Further improvements in engine efficiency with the triple and quadruple expansion engines and the turbine, together with the use of high-pressure boilers, made the steamship efficient on most of the ocean trade-routes (Fletcher 1958: 557; Henning and Trace 1975: 365–8). Steam in shipping brought higher speeds, shorter distances since vessels no longer had to pursue circuitous courses in search of trade winds, and greater regularity through not being reliant upon the vagaries of changing wind directions. Iron and then steel provided greater strength, safety and space in vessel construction. Specific vessel types suited to particular trades were developed, including 'reefers' (refrigerated ships), tankers and ore vessels. Sailing vessels remained an important part of the shipping fleet through the nineteenth century (see Table 11.4), benefiting from some of these innovations, such as iron construction, and improvements in sailing and design efficiency. However, the number of sailing vessels was in absolute decline from the 1860s, and the tonnage of steamships overtook that of sail in the mid-1880s.

Infrastructural developments resulted from the new technologies, including a network of bunkering stations, improved port facilities to accelerate the turnaround of expensive steamers, and the reorganisation of shipyards to adapt to the new construction technologies. Improvements in port facilities, navigational aids (for example the chronometer, the quadrant and lighthouses) and stowage methods additionally enhanced the productivity of a ton of shipping (North 1958; Walton 1967; Ville 1986; Harley 1988; Menard 1996). The laying of the first transoceanic cable in 1866 by Brunel's *Great Eastern* steamship, with connections to Japan and Australia by the early 1870s, vastly accelerated international communication, to the great benefit of shipping companies and other international business organisations.

The organisation of ship owning experienced important changes associated with several phases of increased specialisation: the emergence of specialist ship owning firms in the first half of the nineteenth century and the gradual division of the industry into liner companies and tramp owners in the second half. The initial specialisation involved the emergence of a separate occupation of ship owning, decoupled from the mercantile or shipbuilding functions. It was facilitated by the growth of

Table 11.4 Shipping registered in the United Kingdom, 1790–1900

	Sailing ships		Steamships		All ships		Annual compound growth (%) all ships (tons)	Avg ship size (tons)	Carrying capacity (000 tons)	Annual compound growth (%) (carrying capacity)
	Number	000 tons	Number	000 tons	Number	000 tons				
1790					13,557	1,383		102.0	1,383	
1800					15,734	1,699	1.9	108.0	1,699	1.9
1810					20,253	2,211	2.4	109.2	2,211	2.4
1820	21,935	2,436	34	3	21,969	2,439	0.9	111.0	2,448	0.9
1830	18,876	2,168	298	30	19,174	2,202	−0.9	114.8	2,288	−0.6
1840	21,883	2,680	771	88	22,654	2,768	2.1	122.2	3,032	2.6
1850	24,797	3,397	1,187	168	25,984	3,565	2.3	137.2	4,069	2.7
1860	25,663	4,204	2,000	454	27,663	4,659	2.5	168.4	6,020	3.6
1870	23,189	4,578	3,178	1,113	26,367	5,691	1.8	215.8	9,030	3.8
1880	19,938	3,851	5,247	2,724	25,185	6,575	1.3	261.1	14,747	4.6
1890	14,181	2,936	7,410	5,043	21,591	7,979	1.8	369.6	23,108	4.2
1900	10,773	2,096	9,209	7,208	19,982	9,304	1.4	465.6	30,928	2.7
Annual compound growth (%)	−0.9	−0.2	7.2	10.1	0.4	1.7			2.8	

Notes:
1. Tonnage figures are net.
2. The Isle of Man and the Channel Islands are included in this table.
3. Carrying capacity reflects the growth rate of steam shipping; thus steamship tonnage is multiplied by 4.

Sources: Mitchell and Deane 1962: 217–19.

marine insurance, which reduced the risks of focusing on a single occupation, while agency and brokerage services provided necessary ancillary support. Lloyds List, from the 1730s, and a growing plethora of publications, provided information to ship owners on shipping movements, navigation and stowage (Craig 1982). Helped by these support services, and drawing upon their evolving expertise, these pioneer owners proved adept at keeping their vessels actively deployed across a wide range of trades (Ville 1993). The later subdivision of ship owners into tramp and liners operators was largely the product of the coming of steam and the ocean cable. The liners provided a fast, regular, timetabled service of mixed consignments on particular routes at fixed freight rates. The slower conveyance of a specific cargo on almost any route at a negotiated rate was undertaken by the older tramp vessels. These differences in shipping operations brought a greater choice of service types for shippers, and more focused expertise.

The ability of the shipping industry to respond to rapid increases in demand was further aided by the growing amount of foreign-owned shipping carrying British trade, a process helped by the repeal of the Navigation Laws in 1848 which had limited the rights of third-party nations to carry British trade (see chapter 7 above). Jackson has estimated that by the middle of the nineteenth century about 40 per cent of tonnage entering and clearing ports in Britain's overseas trade was foreign owned, leading him to conclude: 'the myth of the permanent superiority of the British merchant marine cannot be sustained' (1988: 260).

The UK shipping industry, as measured by vessels registered, grew at an average rate of 1.7 per cent between 1790 and 1900 (Table 11.4). If one takes account of the greater productivity of steamships, growth rates were around 2.8 per cent. How was this rapid technical change and growth financed? For centuries the industry had relied upon a system of tenants-in-common ownership of most vessels, which came to be known as the 64th system, owing to its numerical divisibility. Helped by the statutory requirement of vessel registration from 1788, which revealed details of the ship and its owners, the system endured in the nineteenth century in spite of modern company law and the introduction of limited liability by the mid-nineteenth century. However, an increasing number of steamship enterprises opted for joint-stock company status from mid-century (Palmer 1973: 46).

In the light of these streams of organisational and technical change, it is clear that the speed, regularity and coverage of shipping services all increased substantially during our period. Freight rates were highly susceptible to short-term fluctuations in the eighteenth century as a result of intermittent warfare, which increased the demand for shipping in the form of transport vessels and longer journey times in convoys. The steep rise in freight rates during the French Wars was particularly noticeable. However, there appears to have been a large and sustained fall in freight

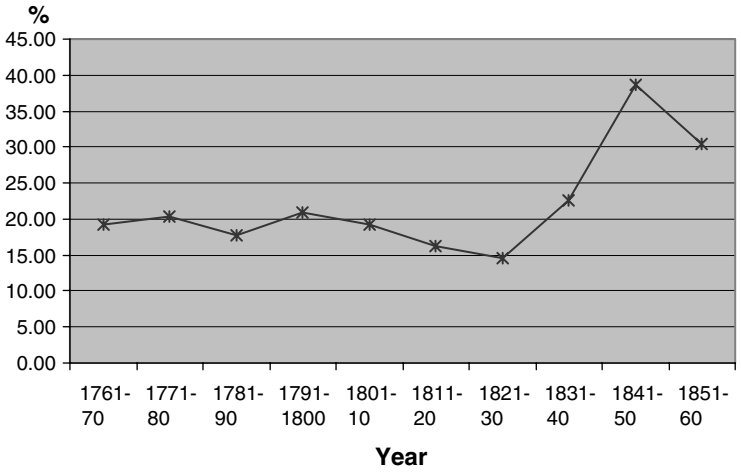

Figure 11.1
Transport's share of gross domestic fixed capital formation in Great Britain, 1761–1860

Source: Feinstein 1981: 133–4.

rates through the nineteenth century under the impact of the increased efficiencies. North's (1958: 549) freight rate index for a variety of North Atlantic cargoes, including timber and grain, shows a fall from an average of 186 in 1816–20 to 77 in 1861–5 (1830 = 100), with the downward trend continuing through the remainder of the century. An alternative index by Harley (1988: fig. 11.1) shows a similar downward trend in real freight rates from about the middle of the nineteenth century (O'Rourke and Williamson 2000: 36). Finally, an index of coal freight rates shows a strong secular decline throughout the nineteenth century (Hausman 1993: 611).

Railways

Land transport along a pair of raised rails was used by collieries to ship coal between pithead and riverside quay in the eighteenth century. Here gravity transported the cargo the relatively short distance over wooden rails to the quayside and the wagons were returned uphill by the use of horses or stationary engines. However, the 'railway age' begins in the early nineteenth century, and particularly from 1830. The construction of the Liverpool to Manchester railway in that year provided the main features of a modern railway: a reserved track, public traffic facilities, provision for passengers, and mechanical power (Gourvish 1988: 57). The line adopted George Stephenson's new steam locomotive technology embodied in the 'Rocket', which had tested successfully in locomotive trials at Rainhill in 1829. The line's success initiated a period of intense railway construction in Britain, with peaks of building activity in 1837–40, 1846–50 and 1860–6, during which a series of main trunk lines were completed and then complemented by secondary and branch routes. By 1871 about two-thirds of the network was completed (see Table 11.5). The resulting pattern was a series of main lines radiating from London to connect with

Table 11.5 Construction of the rail network, 1830–1900

	km	Annual compound growth (%)
1830	157	
1840	2,390	28.1
1850	9,797	13.7
1860	14,603	3.7
1871	21,558	3.6
1880	25,060	1.4
1890	27,827	1.0
1900	30,079	0.7
Annual compound growth (%)	7.7	

Source: Mitchell 1975: 316–18.

the main cities of the British mainland, with the latter acting as satellites for regional and local lines. An amalgamation movement among the railway companies and the establishment of the Railway Clearing House (1842) helped to address problems of service duplication and the lack of connectedness between lines and across schedules.

The Liverpool to Manchester was successful as a passenger carrier as well as for its original use in the cotton trade, an experience repeated by many subsequent lines. Passenger travel did not incur the heavy intercompany transhipment costs and delays of early freight movements. Moreover, it soon became clear that the railway could offer long-distance transport to a wider portion of the population than the stage coach because of the lower marginal costs of adding additional carriages, or just open trucks for third-class travel. The railway also became an important mode of information conveyance. Mail was carried from the time of the Liverpool to Manchester and played a central role in the success of the Penny Post from 1840 by absorbing much of the rapid increase in demand as the number of letters delivered by the Post Office grew from 76 million in 1839 to 863 million in 1870 (Daunton 1985: 80, 122–32). In addition, the railway companies played an important role in the evolution of the telegraph network from the 1830s to state ownership in 1870, operating services alongside five specialist telegraph companies (Perry 1997: 416–17).

Construction of the rail network, as with other transport modes, encountered formidable technical problems. The Liverpool to Manchester was built across the inhospitable wetlands of Chat Moss. Major construction works such as the Severn Tunnel (1886) and the Forth Bridge (1890), which survive today, are testimony to the engineering achievements associated with the railway era. Railway companies sought to emphasise the quality and reputation of their services through the erection of architecturally grandiose stations such as those at London St Pancras and Bristol Temple Mead. In contrast to the shipping industry with its centuries-old institutions, railway companies were quick to embrace the new corporate investment opportunities of the Victorian era to pay for these engineering works and extravagant buildings. Indeed, railway stock was the main form of traded instrument on the London Stock Exchange, representing 26 per cent of the nominal value of securities quoted in 1863, and rising further to 49 per cent by 1893 (Michie 1999: 89). Included in these figures are the sale of stock in foreign railway companies, particularly those of the United States, reflecting the sector's role in the growth of British

overseas investment. Railways played an initiating and facilitating role in many capital market developments. These particularly included broadening the geographical and occupational base of the investing community through the spread of regional stock exchanges, such as at Liverpool and Manchester (1836) and at Leeds, Glasgow and Edinburgh (1844–5), together with the sale of much lower denominated shares, and the increased use of fixed-interest industrial securities to sustain investment when many companies were yielding very low dividends (Michie 1999: 60–9, 116–17). The railway companies themselves were the largest private business organisations of the mid-Victorian period and the pioneers of many advances in the corporate form, as we shall see below.

Table 11.6 Growth of railway services, 1842–1900 (millions)

	Passengers (numbers)	Freight (tons)
1842	24.7	5–6
1850	72.9	38
1860	153.5	88
1870	322.2	167[a]
1880	596.6	232
1890	796.3	299
1900	1,114.6	420
Annual compound growth (%)	6.7	7.6

Note:
[a] 1871 figure.
Source: Gourvish 1988: 74; Mitchell and Deane 1962: 225–6.

Table 11.6 testifies to the very rapid growth of railway traffic, 6.7 per cent per annum for passenger numbers and 7.6 per cent for freight tons. The rapid growth in passenger numbers is noteworthy in spite of the freight motivation for most early railways. Output measured in terms of numbers of passengers and tons of freight doubled in both the 1850s and the 1860s.

Railways in Britain did little to extend the transport network already long established by road, canal and coast. However, their substantial improvements in speed and reductions in cost, particularly for long-distance bulk carriage were impressive. All writers, contemporary and modern, agree that railway freight rates considerably undercut road and canal, and that rail rates fell further between 1830 and 1870. Second-class rail passenger fares of 2 to 2.5d per mile were well below road rates of similar comfort of 3.5 to 4.5d. Ton-mile canal charges of about 3d were easily beaten by rail rates of 1.67d. By 1870, passenger rail rates had fallen 40 per cent from these figures and freight about 30 per cent (Gourvish 1988: 76–7). The cost of conveying mail by rail fell by two-thirds between 1862 and 1882 (Daunton 1985: 133). While rail transport was much faster than its competitors, the resultant benefits were limited by the relatively short average journey length of about 20–30 miles (Hawke 1970: 64).

Urban transport

Transport, by its nature, has always been a spatially diverse activity, connecting localities, regions and nations. However, the locus of many transport services lies in a condensed urban environment. The termini of most transport services have been located in the larger towns and cities of

Britain, reflecting the agglomeration of population and industry, and therefore transport demand, in these places. Many transport companies have located their head offices in towns and cities, to be close to their major customers. Some towns and cities are themselves intimately connected with the economic activity created by transport, such as Liverpool and Bristol (shipping) or Crewe and Swindon (railways). Urban expansion in the eighteenth and nineteenth centuries additionally created a demand for localised transport *within* individual cities and towns. Such transport was particularly associated with the daily commuting of the workforce and the distribution of consumer goods from local factories, wharfs or warehouses to retailers and in some cases direct delivery to the home.

As Barker has pointed out, urban transport in mid-nineteenth-century Britain predominantly drew upon human and animal power (1988: 134). Costers, porters, hawkers and general dock labour all provided substantial amounts of freight carriage. The number of horses pulling freight vehicles grew rapidly in the nineteenth century and much of this was urban activity (Thompson 1976: 80). Cartage agents like Pickfords found plenty of work transporting goods to and from the new urban rail termini. Passenger transport took many forms, from hackney coaches for the wealthy to cabriolets (cabs) for hire and short-distance stage coaches, the latter being replaced by the more practical omnibus from the 1830s. In spite of some improvements to the efficiency of the omnibus through better design, horse tramways began to spread in the 1870s, the reduced friction of their metal rail yielding a significant saving on horse costs. They were particularly popular in provincial cities such as Glasgow, Edinburgh, Birmingham and Liverpool, whose urban spread was insufficient to justify the heavier investments in underground railways begun in London in 1863 with the building of the Metropolitan Railway. Inanimate forms of urban road transport developed towards the end of the nineteenth century: steam trams from about the 1890s and electric from around 1900.

COMPETITION AND INDUSTRY POLICY

The transport sector has always attracted considerable government attention, and there was no exception to this rule in the period under study in spite of a generally limited role for government in the economy. Thus, for example, road, waterway and railway projects required parliamentary approval. Shipping was subject to a series of statutes, dealing with such issues as ports, registration, safety, manning and trading rights. Doubtless, much of this attention reflected the strategic and defence role of transport, especially shipping. Transport investment reverberated widely through the economy, with the result that governments also sought to

influence its domestic impact. Several economic concepts help to clarify these political and legal dimensions, most notably natural monopoly and public goods.

Under natural monopoly it is always cheaper for a single firm to produce the relevant output than two or more firms. This applies to transport because large economies of scale and high minimum levels of operation exist in most transport service industries. Public goods are those which are open to all users, and in which one person's consumption does not prevent another's. To a degree, this is true of transport services; rail, road and waterway may be used by many consumers simultaneously as long as there remains some unused capacity.

The existence of monopoly and public-good features in transport commonly attracts government intervention to address the injustices of anti-competitive behaviour and the market failure represented by the underprovision of services. Monopolists have the power to raise prices and restrict output, both of which are likely to limit the economic benefits of a transport system to a small group of operators. On the other hand, public goods risk being underprovided for the opposite reason: the benefits are too widely dispersed (that is, social utility exceeds private utility), so that the private costs exceed the benefits to the transport company. In practice, as we shall see, transport is not a pure form of natural monopoly or public good, but rather a complex hybrid of both features. Finally, issues of co-ordination and standardisation, critical for a complex network industry, are often not easily handled without some form of intervention.

Therefore, governments must decide how the costs and benefits of improved transport systems are to be distributed among different interest groups. Three direct interests are the providers of infrastructure, transport service operators (carriers) and service users (passengers, merchandise owners). Vertical integration, for example the ownership by oil companies of tanker fleets, helps to reconcile these groups but also extends market power. Indirect benefits from transport investment (known to economists as positive externalities) flow more widely through society, and thus reinforce official interest in the industry.

Road maintenance before the turnpike trusts illustrates an undersupplied public good, since the costs were borne locally and collectively within the parish but the beneficiaries were largely private, including through-travellers from beyond the locality. The introduction of turnpike trusts privatised road use and transferred much of its cost to the user. By mitigating the risks of underinvestment associated with public goods, this change provided a firm basis for higher optimal standards of road maintenance and held out the prospect of the construction of new highways through the support of an income stream from toll charges. The trusts themselves were non-profit bodies in contrast to the for-profit joint-stock companies adopted by canal builders and, later, railway companies. They were initially viewed as supplementing local labour services

in road maintenance and thus a more limited role was envisaged than the major new capital expenditures of canal and railway construction.

While providing a solution to underinvestment in roads, the new policy adversely affected local groups who were accustomed to traditional free right of access. They perceived the change, sometimes negatively, as the replacement of a communal institution based on custom and tradition with a cash payment based on a private market transaction (Albert 1983: 36). Popular unrest occurred among colliers and industrial workers in the West Country, Wales and the West Riding of Yorks, sometimes ending in the destruction or avoidance of tollgates and assaults on collectors (Albert 1983: 35; O'Brien 1994: 219). Opposition gradually subsided when the beneficial impact was more clearly understood and concessions were obtained for local users.

A system of tolls existed on many inland waterways before 1750, charged by empowered local trustees or commissioners, sometimes as part of a tradition of river conservancy and often under the influence of town corporations. Such groups did not always serve the best interests of users, continuing levies after improvement costs had been paid and mixing waterway finances with other local services (Duckham 1983: 113–14). In the canal era the joint-stock company was the main instrument of progress, with its more clearly defined rights and responsibilities to serve only an individual waterway, and its ability to raise sufficient funds for the high cost of building new waterways. This lack of a challenge to customary public usage of rivers, and the fact that canals extended transport into new areas, minimised the opposition to their development, although of course there were still some losers from trade diversion.

Distributional questions largely centred on the vertical integration of canal owner and barge operator. As noted above, several of the earliest canals were built by individual entrepreneurs for their own use. Parliament used its control over the passage of the Canal Acts to insist, in most cases, upon a separation of ownership of the canal from the carriage of goods upon it until an act of 1845 reversed this policy. Bridgewater was one of a few permitted exceptions to this policy; others included the Forth and Clyde and the Thames and Severn (Hawke 1970: 232; Duckham 1983: 124). Given the growing investor interest in canal building by the late eighteenth century, the separation of owners from operators did not extinguish the growth of the canal system. Integration of operator and user was not uncommon, for example coal merchants and flour millers who owned their own barges. The largest operators were non-integrated specialists, although they gained alternative market power by operating across several transport modes, the most famous being Pickfords, with a very strong presence on both British roads and waterways (Turnbull 1979).

While the separation of functions enhanced competition, transport infrastructure remained a monopoly that governments sought to control

in ways that balanced the private incentive to extend the network with the broader social welfare gain from lower transport costs. The canal's enabling act included a schedule of maximum tolls. In some cases, legal restrictions on canal company dividends were imposed but such a policy was at best intermittent and piecemeal (Duckham 1983: 114). Competition was also aided by the growing variety of investors in canal companies, particularly merchants, bankers and landowners, whose interests might favour lower transport costs or improved land values in the vicinity. Thus, they had an incentive for improved transport services rather than solely seeking to maximise the private returns to the canal company. The average return on capital in canal companies in 1825 has been estimated as 5.75 per cent, suggesting that a competitive equilibrium perhaps existed (Duckham 1983: 123).

Navigational aids for shipping such as buoys and the dredging of deep-water entrance channels were public goods, paid for by a levy on shipping entering and clearing the port. Some infrastructure such as lighthouses was also erected in the interests of passing shipping; this was handled by a national system of shipping dues to avoid non-payment (free-riding) by some ship owners. National ports policy by the sixteenth century had begun to divide all of the coastline into the jurisdiction of a series of legally defined ports, each covering its locality in order to strengthen revenue-raising capabilities (customs duties, shipping and port dues) and to eliminate free-riding by trading at small inlets. By mitigating the risks of an undersupply of public goods, official policy ensured the increased safety and productivity of shipping.

Port infrastructure was becoming far more capital intensive by the early nineteenth century, initially to handle the rising volume of traffic and to safeguard valuable cargoes being warehoused, but by mid-century to serve the needs of large steamships for deep-water berths and rapid turnaround. By 1840, Liverpool boasted nearly 70 acres of dock estate, stretching $2^1/_2$ miles along the Mersey, and receiving 2.5 million tons of shipping (Hyde 1971: 247). These new investments required modern forms of capital raising and organisation, focused on a dock's particular needs rather than taking the general form of a public good. The resulting private dock companies charged dock fees to shipping firms using their facilities. In some ports, such as Hull, this produced monopolists who devoted resources to protecting their dominance at the expense of investing in new facilities (Jackson 1988: 228). Contrariwise, in a large port like London, their very high fixed and low marginal costs created destructive price competition among numerous dock companies. Amalgamations were the initial solution, such as that of the London, St Katherine's and Victoria Dock companies on the Thames in 1864. New investments and price wars continued until a Royal Commission led to the establishment of the Port of London Authority in 1909 to take over the private dock companies and operate again in the public interest (Jackson 1988: 228, 241).

Shipping operated in an increasingly competitive market, which helps explain the ability of the industry to respond effectively to steep increases in demand. The monopoly charters of the overseas trading companies (East India Company, Hudson's Bay Company and others) had been revoked by the early nineteenth century. Under the influence of the changing political economy, British governments believed that national economic and strategic interests were better served by encouraging a general proliferation of ship owners and merchants rather than placing their faith in a few vertically integrated monopolies. The costs of setting up political and economic connections to many parts of the world had now been absorbed by these original companies in return for their monopoly rents. The other remnants of mercantilism, which had included the exclusion of third-country shipping from British trade, were relaxed in the 1820s and finally abolished in 1848 (see chapter 7). Coasting, however, continued to be reserved for British shipping for reasons of defence and because navigating treacherous coastal waters and handling bulk cargoes bred sturdy seaman: a policy known as the 'nursery of seamen'. Low entry and exit costs in shipping and a fragmented ownership structure enhanced competition. Michael Henley and Son, one of the largest ship owning firms operating out of London at the beginning of the nineteenth century, entered the industry through the purchase of cheap second-hand sailing vessels. Their fleet of up to twenty vessels represented only a tiny share of London registered shipping (Ville 1987).

By the middle of the nineteenth century, however, the structure of the industry began to change owing to the new technologies of steam and steel. This generated vessels that were more expensive by dint of their steam power and that could be built much larger, because of the use of steel, to produce scale economies. Thus increased capital indivisibility (larger ships) and intensity (capital substituted for labour) raised entry costs to the industry. The regularity of steam, and improved international communications from the development of the oceanic cable, meant that for the first time regular timetabled shipping services could be offered, but this required a fleet of vessels to operate. As a result of these changed operating conditions, a few large companies emerged as leaders of the British shipping industry. However, speed and regularity are more important sources of competitive advantage for some commodities than others. In the carriage of bulk raw materials such as coal and metallic ores, staples of the demand for shipping, cost is a more important factor. With rapid technical change in shipbuilding and consequentially equally high rates of obsolescence, some ship owners concentrated on the purchase and operation on demand of second-hand steamers at lower cost. The effect was to divide much of the shipping industry into liner (fast, regular, high-quality) and tramp (slow, irregular, low-cost) shipping services. This segmentation encouraged relatively high degrees of competition, to the extent that groups of liner companies began to form collusive shipping rings from the 1870s in an attempt to exclude the price-cutting tramps

from particular trades. It was not until the beginning of the twentieth century, however, that British governments addressed seriously this restraint on competition.

The broad social benefits from railways and the strong monopoly features of the network have been compelling reasons for relatively high levels of government interest. High entry costs were associated with the construction challenges discussed earlier. In addition, acquiring privately owned land could be an obstacle. Therefore, a private act of parliament provided for the legal devices of compulsory land purchase (eminent domain) and the security of limited liability in order to attract a broader range of investors (see chapter 8 above). From the outset, many of the largest investors were business owners who stood to gain directly from improved transport services. This helped to mitigate the risk that the benefits would largely be secured by the railway company rather than service users and the broader community. Competition among railway companies and the initial separation of infrastructure owners from service operators also lessened the threat to competition.

From about the 1840s the competitive structure of the industry began to change. Amalgamations produced larger railway companies with fewer rivals. The acquisition of competing canal companies had a similar effect. Competition from new entrants was lessened by the rising scale economies that were being recognised and acted upon. It soon became apparent that the turnpike model of separate infrastructure owners and freight carriers was unworkable, both technically, because of safety considerations, and economically because of the monopoly power of the former. Governments unwittingly contributed to the trend by deciding in 1840 to prohibit private operators on a line, thus fostering vertical integration in the industry. A 'railway interest' emerged in parliament, initially to support the passage of railway acts against opposition from landlords who feared their land values would be affected and road operators who anticipated a loss of business. Increasingly, though, the interest became vociferous in support of powerful economic rights for the railways (Alderman 1973). Similarly, the growth of managerial capitalism among the railway companies created an executive class that performed to the best interests of the company, rather than the business interests of some of its shareholders (Gourvish 1973). Thus, by 1850 the top fifteen railway companies controlled 61 per cent of total paid-up capital in the industry, rising to 80 per cent two decades later (Gourvish 1988: 83).

Governments took seriously the threat to competition posed by these developments and were pressured by traders organised in chambers of commerce and also well-represented in parliament to oppose the railway interest. However, the idea that politics is dominated by distributional coalitions of producer group interests is not the only explanation of government regulation of the railways. A strong sense of public interest motivated Gladstone at the Board of Trade during the passage of the 1844 Railway Act. Among contemporaries, he showed a close understanding

of the operation of natural monopolies and the collusive tendencies of oligopolists. The act was an important piece of legislation that has been neglected by many economic historians in the belief that it became watered down during parliamentary debates. It established a pattern of price and quantity regulation that survived until 1960, and its safety provisions remain today. It has been viewed as shaping the pattern for regulation of natural monopolies in the United States through the 1887 Interstate Commerce Act, which itself was the basis for subsequent legislation (McLean and Foster 1992: 315). The act included an option for nationalisation of the rail system, which was to come into effect after twenty-one years. In practice, these purchase powers were not taken up. However, McLean and Foster (1992: 322) have argued for a behavioural impact: that the *threat* of appropriation influenced investors and managers to keep rates of return below 10 per cent by investing in less productive branch and secondary lines. Thus, the experience of Britain's railways over the next eighty years might be viewed as evidence of the hypothesis that regulated industries produce overcapitalisation (Averch and Johnson 1962).

More effective, though, was the scope for intervention in the amalgamation movement. To commence working together, companies had to seek parliamentary approval. This gave parliament the right to investigate their practices, and the Board of Trade in particular negotiated with the railways the final terms of the amending act. By the 1850s, parliament was looking sceptically at many of the proposed amalgamations. The division of interests between users and railway companies was made clear by mid-century with the debates over discriminatory pricing. Under the terms of the Railway and Canal Traffic Act of 1854, companies were only permitted to price discriminate on the basis of cost, whereas their major motive would have been the degree of competition, charging less where competition from shipping was significant. It is conceivable that some of this anti-monopoly stance was overzealous; several proposed amalgamations of the 1870s that sought to cut costs during a downturn were rejected. Significantly, Irving has attributed the declining performance of railway companies in the late nineteenth century in part to service extensions and improvements required by parliament (Irving 1978). Assessing government policy towards the railway as a whole, Dobbin (1994) has concluded that it had a formative influence on the shift of British industry policy away from the idealised free markets of *laissez-faire* to a form of interventionism designed to mitigate an excessive concentration of economic power.

NEW ORGANISATIONAL CHALLENGES

We have seen in the previous sections that in order to be competitive transport firms often have to operate at a high level of output, employing

large amounts of geographically dispersed capital and labour. Firm-level evidence of this is not hard to find. Much of the growth of road transport in the eighteenth and nineteenth centuries was concentrated upon a limited number of operators, agglomerating sizeable road fleets along major trade routes. Gerhold has identified one Frome carrier operating a weekly 'team' to London of five wagons pulled by thirty-nine horses (Barker and Gerhold 1993: 21). Thomas Russell and Company, operating between Exeter and London together with regional services in the early nineteenth century, used about 200 horses and thirty wagons, employed sixty to seventy staff and had premises in each town on the route. These in turn were dwarfed by Pickfords of Manchester with 400 wagons by 1803, and Deacon and Co, serving Yorkshire and Norwich, who were reported to operate with 700 horses, 400 employees and 100 branches by 1838 (Barker and Gerhold 1993: 23).

Since most canal companies were not permitted to act as common carriers before 1845 there were few very large infrastructure enterprises, with typically no more than fifty staff. As with road transport, it was the carrier, lacking a monopoly but with the ability to operate across a wide area, that had the freedom to expand. It was noted earlier that much vertical integration existed between carriers and users of the canal network. However, the largest firms were specialist carriers. Chief among them was again Pickfords, whose services spanned much of England from Liverpool and Bristol in the west to Leicester and London in the east, covered by a fleet which grew from ten canal boats in 1795 to 116 in 1838 (Turnbull 1979: ch. 5).

Shipping generated some very large enterprises, particularly from the mid-nineteenth century with the growth of the major liner companies which exploited huge operational scale economies in the provision of fast timetabled services over major trade-routes. Sometimes, through the aid of government mail subventions, these companies expanded into long-haul trades, including Cunard in the transatlantic trade, Royal Mail in South America, P&O to India and the east, and Elder Dempster to West Africa. By the end of the nineteenth century the 'big 5' of P&O, Royal Mail, Cunard, Ellerman and Furness Withy led the British shipping industry (Boyce 1995). In most cases these firms were not heavily vertically integrated; it was the geographical breadth of their shipping operations, rather than their range of functions, that distinguished them. Some established overseas offices if they traded very regularly with a particular port. In most cases, however, the frequency of their transactions at any port was insufficient to justify setting up a local office, with the additional fixed costs and risks involved. Instead, the agency system was commonly adopted whereby ship owners paid local firms, often specialising in agency and brokerage work, to handle their needs such as the payment of bills, the receipt and delivery of merchandise, and the organisation of victualling and ship repairs.

The railway companies were the true giants among transport enterprise as enormous consumers of fixed capital for construction (bridges, tunnels and stations) and operation (rolling stock). Since the railway system expanded at a time of increasing resort to incorporation among Britain's larger listed firms, this enables size comparisons to be drawn across sectors. By 1850 all of the largest firms listed on the Stock Exchange in Britain were railway companies. Indeed, the top fifteen companies accounted for 62 per cent of total paid-up capital in the UK, thus dwarfing manufacturing industry (Gourvish 1988: 83). The London and North Western Railway (LNWR) had raised more than £29 million by 1851, employed a workforce of 12,000, and operated 800 miles of track (Kirby 1994: 130). This was a giant scale of operations for the time and these figures would have still outstripped most British manufacturers half a century later (Wardley 1999: 102–3). The high degree of co-ordination and interaction required to manage these resources and operate a fast and frequent but safe service favoured the adoption of a single governance structure rather than transacting with other firms. Similarly, these companies had reached output levels where many highly repetitive transactions were most cheaply performed within the company. In other words, railway companies sought to minimise their transactions costs by internalising most activities.

The size and spatial diversity of transport enterprises brought unprecedented organisational challenges yet to be faced in other sectors. These particularly involved the logistical management of large volumes of capital and a sizeable workforce spread over an extensive area, yet requiring very high levels of co-ordination and control for reasons of efficiency and safety. Size and spread of activities worsened problems of workforce control, particularly the risk of unobserved opportunist behaviour from employees. In addition, the fact that transport is a service industry created additional management challenges. Services are non-storable – they are produced at a particular time and place and must be consumed there and then or not at all, leading to the risk of underutilisation. Moreover, demand for transport services varies greatly on a monthly, daily or even hourly basis. Transport firms therefore require managers well skilled in matching a relatively inelastic supply with highly elastic demand. How effectively did they respond to these new challenges?

The challenges were of limited significance for the emerging road and canal network. Most firms were small and localised, helped by the fact that management was generally divided into separate owner and operator firms. However, the leading transport operators, such as Pickfords, had relatively large and spatially dispersed workforces requiring careful monitoring and detailed transport planning. They tackled these challenges in a number of ways. The natural co-ordination yielded by their fast and regular transport services provided them with good up-to-date information

about their enterprise. Pickfords spread their management across three regional centres, Manchester, Leicester and London, and linked these with intermediate depots and agencies along the major routes and with their own local manager. Ownership of offices along the route reduced the distance between different outposts of the firm. At the senior strategic level, decision-making was shared across a series of partners and, when the firm came close to collapse in 1817, new partners entered the firm with trust-building kinship ties and connections to strong financial networks (Turnbull 1979: 36–41).

Shipping companies were far more geographically distended, and developed a range of strategies. Internal subcontracting was widely practised. This was also a popular strategy among early factory owners and involved delegating some labour recruitment and management tasks to senior employees. In this case, the appointment of the ship's master was one of the key decisions for a firm; upon him fell the responsibility for hiring his crew, keeping a set of onboard accounts, and conducting business with shipping agents and merchants in foreign ports. Owners relied heavily upon masters' regular correspondence back to the company on trade conditions and the performance of the crew. The threat to withhold monthly payments to seamen's families back in England exerted a powerful form of social control over these distant workforces. The ship owner rewarded his masters with higher pay rates, regular employment and sometimes a share in ownership. The owner also dealt directly with shipping agents through correspondence, and often built up close long-term business bonds through reciprocity (Ville 1981). Ship owners also drew upon the services of ship brokers who served as specialist intermediaries in the freight market. Shipping firms also benefited from co-operation with one another (Boyce 1995). The growth of public trading information in the eighteenth century gave the ship owner a further means of assessing the performance of his masters as well as benchmarking the performance of different vessels in his fleet against each other.

The earliest railway enterprises drew upon the experience of canal and shipping companies. The Stockton and Darlington subcontracted major functions such as rolling stock repairs and track maintenance to other companies (Kirby 1993). However, the growth of longer-distance rail lines and company amalgamations from the 1840s required a quite different response: the internalisation of most activities and the modernisation of corporate management. Railway companies were pioneers of modern business organisation, separating ownership from management to create a professional executive class organised into a systematically conceived managerial structure for the company. This idea of 'managerial capitalism' was generally slower to develop in Britain than other comparable nations such as the United States and Germany, but it was notable amongst the railway companies from an early stage. The companies were

generally organised into functional departments staffed by professional managers with particular expertise in areas such as engineering, finance, legal matters and traffic operations, enabling them to handle more effectively such issues as safety and maintenance, and matching traffic flows to demand estimates. Mobile and capable professional executives with experience across firms and industries dominated the senior management of Britain's railways by the late nineteenth century; 56 per cent of their chief executive appointments (1890–1909) had worked for at least three other companies (Channon 1988; Hughes 1992).

The separation of ownership from management, a key tenet of the modern business enterprise, solved some problems but created others. A separate managerial class creates a divergence of interests between owner and manager. The risk exists that the manager may use his superior information of some of the day-to-day operations of the firm in an opportunist manner, for example putting private business interests or career promotion ahead of what is best for the company. While this corporate governance problem still exists today, it was particularly serious during this transitionary stage between personal and managerial capitalism because firms had not yet learned ways of exerting closer control over their executives. Moreover, many railway managers had not made the full transition to being professional executives. They maintained personal business interests, often connected to the railway industry where their expertise lay, thereby creating a potential conflict of interest between their professional duties and their private business ventures. An example of this occurred in the 1850s when Daniel Gooch, a manager with the Great Western Railway (GWR), acquired a coal company, Ruabon, along with some fellow employees. The Ruabon became a major coal supplier to the railway under a ten-year contract. A suit against Gooch in the Court of Chancery, alleging undue preference, was unsuccessful, but there remained concern about an employee profiting personally from supply contracts to the company (Channon 1999).

Transport enterprises developed accounting techniques as a management aid. The capital intensity and indivisibility of many major investment items necessitated careful attention to the methods of capital accounting. Financial accounting would aid the assessment and monitoring of geographically distant parts of the enterprise. Arnold (1995) and McLean (1995) have shown how nineteenth-century shipping firms instituted and adopted modern accounting techniques to meet the organisational challenges faced by the industry, but it was the railway companies that made most particular use of accounting techniques. Legislation of the 1840s required railway companies to keep detailed accounts and have them audited half-yearly. Mark Huish of the London and North Western Railway (LNWR) went much further than this by collecting a variety of operating statistics as a tool for managing costs and raising the capacity

utilisation of its services. The importance of railway accountants can be illustrated by the fact that the companies employed as many accountants and cashiers as they did engineers, and that the industry was of central importance in the expansion of many successful accountancy firms, including Deloitte's and Waterhouse (Gourvish 1988: 71).

A key part of the new management techniques of the railway companies was their pioneering role in the development of internal labour markets. The companies employed some of the largest and most geographically dispersed workforces of nineteenth-century industry. Internalisation sought to maintain the same employees as long-term members of the company, enabling them to draw on their large workforce to fill positions as they arose. This mitigated many of the costs and uncertainties of labour recruitment, while additionally increasing the company's control over its employees and the work process when compared with either an external labour market or internal subcontracting. Howlett (2000) has shown how the Great Eastern Railway used promotion ladders and seniority wage payments to retain their workforce. Non-wage welfare benefits were used for the same purpose (Kingsford 1970).

ASSESSMENT OF ECONOMIC IMPACT

The question of transport's impact on the economy has produced an extensive historical and conceptual literature, and in the process generated two of the most interesting but controversial historical methodologies, the Rostowian leading sector thesis and the counterfactual social savings calculation. There seems little doubt that the sequential waves of transport innovations in the eighteenth and nineteenth centuries did have an important impact; our challenge is to provide a balanced evaluation of their effects and how these were distributed. In this chapter we have distinguished between direct benefits (or costs) of transport investment to the parties to the contract (owners, operators and users) and the indirect or unintended impact on third parties. The latter are often referred to as externalities or secondary effects. In transport studies, the secondary effects are often more substantial than the direct impact. For example, the negative transport externality of pollution and the positive externality of lower prices can flow widely through the economy.

Rostow and Szostak as transport advocates

Earlier sections of this chapter have highlighted the major developments in each transport mode over our period and summarised the improvements to transport provision that resulted. This involved a mix of reduced freight rates, faster speeds, greater regularity and broader geographic

coverage. As previously noted, the effects can be so broad ranging that it is difficult to measure them accurately, particularly for earlier historical periods where our evidence is far from complete. The work of Szostak (1991), however, provides us with at least some conceptual guidelines for evaluating the impact.

Szostak sought to explain why an industrial revolution occurred in England in the late eighteenth century by reference to road and waterway improvements, and used France as a control experiment: a less effective inland transport system here prevented or delayed industrial modernisation. He detailed improvements to the system of inland transport and their effects in a complex flow diagram (Szostak 1991: 29). By widening markets, improving access to raw materials, introducing new distribution methods and reducing inventory stocks, transport improvements fostered the main features of the industrial revolution, namely regional specialisation, increased scale of production and the introduction of new industries. These three features, in turn, created more favourable conditions for an increase in the rate of technological innovation.

A shortcoming of Szostak's analysis is the extent to which it draws upon a view of a British 'industrial revolution' at the end of the eighteenth century that is no longer widely accepted. An alternative longer-term process of industrialisation, which characterises British experience as well as that of other European nations, leaves the Szostak model as telling only the beginning of a much longer story. His model might aptly be applied to the railway age where the new technologies of steam and metal sustained the earlier progress; or to ocean shipping with its influence on the early stages of globalisation. His conceptual framework will help guide our discussion later in this section.

An alternative perspective was provided by Rostow (1960), who argued that modern economic development was driven by a 'leading sector', which experienced very rapid growth as a result of technological innovation. This leading sector ignited a 'take-off' in economic development through the stimulus that it imparted to the macroeconomy, and specifically through its linkages or 'spreading effects' to related industries. Rostow sought to place the railway centrally within his schema of economic development by arguing that it was 'historically the most powerful single initiator of take-offs' (Rostow 1960: 302). His work has been subject to critical analysis; as with Szostak, particular criticism has focused upon his interpretation of the pattern of economic development as a revolutionary change. Again, however, the methodology and nomenclature he developed have survived as valuable tools and will help to guide our analysis in this section.

We begin with an examination of the likely economy-wide impact of transport through its share of national aggregates such as investment, productivity and earnings. Thereafter, we look at more specific aspects of its role: its social overhead capital features; its linkages and spillovers to

particular industries and sectors; its impact on market integration; and finally the extent of social savings yielded by transport innovations.

Capital formation

Feinstein has estimated the size and distribution of gross domestic fixed capital formation for the century to 1860, disaggregated by broad sectors: agriculture; industry and trade; transport; and residential and social. Transport's share fluctuates between 15 and 21 per cent before 1840, the peak coming in the 1790s with the boom in canal construction and the increased demand for shipping tonnage during the French Wars. Transport's share then begins to rise in the 1830s with the beginning of railway construction and peaks in the 1840s at 39 per cent with the rapid expansion of the rail network. Feinstein notes that a similar magnitude fall in residential and social (especially housing) occurred in those final two decades of our period but is uncertain whether railway investment occurred at the expense of social capital (Feinstein 1981: 133–4; Feinstein and Pollard 1988: 444). His figures are decennial averages. A more disaggregated approach reveals that transport investment was highly cyclical from year to year, as indicated by the canal and road building manias in the mid-1790s and the railway surges in the late 1840s. In the latter case, railway investment may have constituted as much as a half of gross domestic fixed capital formation (Gourvish 1988: 60–1).

The large and highly cyclical nature of transport investment raises questions about its impact upon capital and factor product markets. In particular, is there evidence of crowding out in capital or factor markets, possibly resulting in sub-optimal resource allocation? Since the funds for capital hungry transport projects were often raised during periods of optimism in the hope of future growth in transport demand, did this restrict the opportunities for developing other new industries with important growth potential? Contemporary opinion viewed transport projects as a panacea for economic backwardness, which may have skewed investment. However, it should be remembered that there is a much larger supply of investible funds available during boom periods owing to optimism and higher income levels. Moreover, as we saw earlier, transport played an important role in capital market innovations, which helped to attract additional sources of finance. This growth in capital markets is reflected in a rising investment ratio into double figures during the railway age (Gourvish 1988: 62). Major transport projects requiring parliamentary approval were characterised by a long gestation period from original planning to completion. Thus, projects planned and financed at the top of economic cycles often generated a demand for labour and other production factors during subsequent downturns, providing in some cases a much needed contra-cyclical stimulus to the economy. The second half of the 1840s is a case in point, as we shall see below.

Table 11.7 Productivity growth in transport by mode (cent per annum)

	Roads	Per Canals	Shipping	Railways
Annual compound growth (%)	0.7	0.8	1.4	2.2
	(1690–1840)	(1780–1830)	(1780–1860)	(1830–60)

Sources: *Roads, Gerhold 1996: 511; canals, McCloskey 1981: 125*; shipping, McCloskey 1981: 125; Harley 1993: 199–200; railways, McCloskey 1981: 125.

Productivity

What evidence do we have for productivity growth in transport that may have mitigated the risks of crowding out by using a fixed amount of resources more efficiently? Many of the sources of productivity growth have been identified in the earlier sections of this chapter. They included better roads, vehicles and horse breeds. On inland waterways this meant better navigation by way of canal and the development of flying services. Shipping benefited from organisational improvements associated with specialist ship owning such as better stowage and navigation, and from rapid technological changes, particularly the shifts to metal and steam. Railways were still in their relative infancy by 1860 but rationalisation through amalgamation and the operation of the clearing house was already impacting upon productivity. As we have also seen on pp. 000–00 above, these improvements were reflected in falling freight rates, and faster and more regular journeys. Calculating productivity change provides us with a single statistic, reported in Table 11.7 which captures most of these varied improvements.

McCloskey evaluated the size and importance of productivity improvements in some of the key 'modernised' sectors of the British economy, 1780–1860. He calculated this by multiplying a sector's annual productivity growth by the weighting of its output in the economy. This led to the result that transport's contribution was the largest among the 'modernised' sectors, that is, 0.23 per cent per annum of the modernised sectors' total growth of 0.52 per cent. McCloskey concluded that 'transportation was therefore among the more notably progressive parts of the economy' (McCloskey 1981: 114; 1994: 252). Table 11.8 reports McCloskey's estimates, and also Harley's (1993) downwards revision of McCloskey's calculations for the modernised sectors. The contribution of shipping is drastically reduced, from 0.14 to 0.03 per cent, by substituting Harley's own productivity growth estimates while retaining the same weightings. Transport's share (0.12) is now slightly behind that of cotton, although the modernised sectors' contribution to national performance is now greater as a result of using Crafts' more recent and more conservative calculations for total productivity growth. Harley's figures are an improvement in that they take some account of productivity in the coastal trade, but his location of productivity improvements in technological changes in

Table 11.8 Sectoral contributions to productivity: annual percentage growth, 1780–1860

		McCloskey estimates		Harley estimates		Ville estimates	
	Share	Productivity	Contribution	Productivity	Contribution	Productivity	Contribution
Cotton	0.070	2.6	0.18	1.9	0.13	1.9	0.13
Worsteds	0.035	1.8	0.06	1.3	0.05	1.3	0.05
Woollens	0.035	0.9	0.03	0.6	0.02	0.6	0.02
Iron	0.020	0.9	0.02	0.9	0.02	0.9	0.02
Canals and railways	0.070	1.3	0.09	1.3	0.09	1.3	0.09
Shipping	0.060	2.3	0.14	0.5	0.03	1.4	0.08
Roads	0.040					0.7	0.03
Sum of modernised sectors	0.330	1.8	0.52	1.2	0.34	1.3	0.42
Agriculture	0.270	0.4	0.12	0.7	0.19	0.7	0.19
All others	0.850	0.6	0.55	0.02	0.02		
Total	1.450		1.19		0.55		0.61

Note: Estimates of roads' share based on evidence in Gerhold 1996: 497–8.

Sources: McCloskey 1981: 114; Harley 1993: 199–200; Table 11.7 above.

the later nineteenth century may understate earlier advances in organisation and infrastructure. Therefore, we offer a middle point between the work of McCloskey and Harley as a figure for shipping productivity growth. The substantial improvements in road services before the mid-nineteenth century have now been estimated by Gerhold (1996: 511) and can be included. As a result, total productivity growth in agriculture and the 'modernised sectors' aggregates to a figure (0.61 per cent per annum) that is larger than Crafts's (1985: 86; 1987a: 250) aggregate national estimates (0.55 per cent per annum). Harley's lower estimate for transport productivity, when aggregated with the other modernised sectors and agriculture (0.53 per cent per annum), is almost equivalent to the Crafts national figure. This suggests either that all productivity growth in the British economy was confined to the sectors indicated in Table 11.8, or that Crafts's widely recognised downward revisions of national productivity growth for this period are too conservative.

Gemmell and Wardley (1990: 307) have calculated that by 1856 (and through to 1913), 'productivity levels in . . . transport services would appear to have been high relative to manufacturing'. Besides lending some credence to the idea of productivity growth in the sector over the previous century and a half, this additionally suggests that heavy investments in transport were unlikely to have starved more productive sectors of scarce resources.

Earnings

How important were the transport industries as a source of earnings and profits in the British economy? Information on profits is sketchy and

there is no compelling evidence for consistently high profits in transport industries. Government intervention, or just the threat of it, may have prevented widespread or persistent monopoly profits, thereby helping to achieve a more efficient allocation of the benefits of new transport systems. It was noted above that the profitability of inland waterways was not exceptional. Davis (1957) doubted whether ship owners achieved outstanding returns in the early eighteenth century, although subsequent periods of war, especially the French Wars, provided exceptional temporary returns to the industry owing to the increased demand for large numbers of transport ships (Ville 1987). The earnings of shipping companies made an important contribution to Britain's trade balance by the boost they provided to invisible earnings. Britain's invisible trade grew more rapidly than its visible trade in the eighteenth century as local ship owners took over much of the international carrying trade from the Dutch (Thomas 1981: 92). Some of the earliest railways, such as the Liverpool to Manchester, achieved good returns, though many later ones, especially regional and branch lines, performed poorly (Donaghy 1965–6). The significance of transport earnings lies perhaps in specific regions and aspects of the economy rather than in national aggregates. Port hinterlands, such as around Liverpool, Glasgow and Bristol, benefited from substantial reinvestment of mercantile profits into evolving trade and industry.

Social overhead capital

While transport featured prominently in a number of economic aggregates, this evidence tells us little about the dynamics of change. Put simply, did transport provide the stimulus to economic expansion or just a reactive force to initiatives elsewhere in the economy? Rostow leaves us in little doubt about the dynamic role of the railway as a leading sector but says nothing of the other transport modes. Figures in the first section of this chapter show that most transport infrastructure and services grew more rapidly than national income throughout the period. This suggests, perhaps, that the transport sector was playing a leading rather than a following role in the accelerated growth of the British economy from the late eighteenth century. However, it does not preclude the possibility that this represented periods of catch-up by transport providers.

A helpful manner of extending this analysis is through transport's role as the major form of social overhead capital (SOC) in the eighteenth and nineteenth centuries. Investment in an economy can usefully be divided into SOC, which supports production across the economy (for example transport, education), or directly productive activities, which involve specific types of production (for example manufacturing). Hirschman (1958), who developed this model, believed expansion in industrial output would stretch the finite resources of SOC and thereby encourage increased investment in transport, communications, education and health. Thus,

SOC is seen as a passive reactor. Alternatively, it has been argued that investment in SOC, by improving the infrastructure for production, can induce directly productive investment in a process referred to as development by excess social overhead capital.

Investing in transport infrastructure ahead of demand is most likely to occur where government plays a proactive role in stimulating economic development. Even in an economy dominated by private investment decisions, transport infrastructures can be built ahead of demand. The belief in transport as a universal panacea for economic backwardness together with the success of early projects often led to investment and construction ahead of demand, as perhaps is illustrated by the 'mania' phases that characterised transport development. The success of the earliest and most viable projects stimulated a 'demonstration effect': industrialists hoped that further investment would yield similar industrial benefits and would avoid 'trade diversion' to neighbouring areas where the transport infrastructure had already been improved, while investors hoped for similar rates of return to earlier projects. In fact, the fears and expectations were often overstated, since the earlier investments were often the most promising. The lack of profitability of many later railway lines and canals became notorious; the demand for them did not yet exist, and in some cases never would.

State provision of subventions to a few steamship companies to carry the mail to areas where there was little commercial trade provides another example of development by excess social overhead capital. From 1839 the Royal Mail Steam Packet Company was paid a subvention by the British government to carry mail to Mexico, Panama, Colombia, Venezuela and the West Indies, while the Pacific Steam Navigation Company began a similar service to the west coast of South America in the following year. In the early 1850s, mail contract payments to the West Indies and Brazil were three times the postage revenue thereby generated (Daunton 1985: 159). Such evidence has caused one writer to note that, 'without British investment in shipping and ancillary services . . . economic growth in Latin America would probably have begun later and at a slower pace' (Greenhill 1979: 265).

Linkages and spillovers

We turn now to look more specifically at transport's links to different sectors and aspects of the British economy. Rostowian backward, forward and lateral 'spreading effects' help us to understand the extent of interconnectedness. These linkages flowed backwards to supply industries, forwards to industries benefiting from improved transport services, and laterally to the local economy. Recent insights into economic development associated with the school of new or 'endogenous' growth theory have emphasised the importance of externalities or beneficial 'spillovers'

between sectors. These particularly relate to transfers of 'useful knowledge' that enable industries to modernise and individual firms to enhance their competitiveness (see chapters 1 and 5 above).

Input–output models are used to analyse the multiplier effects of transport investment on supply industries. In his study of German railways, Fremdling (1977) modified Rostow's leading sector concept to a leading sector 'complex' by intertwining the railways with several heavy industries. Mitchell (1964) and Gourvish have each shown the input linkages to several key 'complex' industries including coal, iron and steel, and engineering. The linkages were strongest during the construction booms; thus railways have been estimated to have consumed 39 per cent of pig iron production in 1844–51 and 6–10 per cent of coal output (Gourvish 1980: 24–5). The impact upon iron and steel demand was greater if account is taken of the materials used in engineering products for the industry. Knowledge spillovers from railways particularly relate to their pioneering role in meeting the challenges of large-scale enterprise which was discussed above (pp. 000–0) and the precedents they set for new forms of capital raising in finance markets (see pp. 000–0).

Similar analysis could be used in relation to other transport modes. Ships require large amounts of material in their construction. In the earlier part of the period this necessitated substantial timber imports from the Baltic and North America, but also the use of domestic rolled copper sheet for the sheathing of vessel hulls as a protection against marine life (see chapter 15). The metal steamship drew more heavily upon the domestic coal, iron, steel and engineering industries. Indeed, Palmer (1979: 337–9) has estimated that bunker coal represented 20 per cent of British coal exports by the end of the nineteenth century. Shipbuilding contributed to the clustering of heavy industries in conurbations in Tyneside, Clydeside and Belfast, which yielded local external economies of scale such as a highly skilled workforce (see chapter 14). Canal construction had a limited direct impact on supply industries. However, it provided spillover effects through confronting many civil engineering challenges such as tunnels, bridges and embankments, thereby setting a precedent for railway builders and many areas of construction.

Market integration

Quicker, cheaper, more regular and more comprehensive transport fosters market integration. It provides for the widening of markets, the breakdown of local monopolies and other restrictions on competition, the decline of subsistency, the opening up of new areas to production, and improvements in information flows on which producers and markets rely. It can also concentrate markets by ensuring the necessary food supply and residential expansion associated with urbanisation. Similarly, improved transport impacts upon institutions operating within those

markets. Wider markets create the opportunity for larger-scale production and economies of scale. Greater regularity of transport facilitates the reduction of inventories, thus enabling the conversion of circulating into fixed capital to finance such expansion. A more flexible and efficient location of production may result, and provide the opportunity for geographical expansion by individual firms nationally and even internationally. Improved information flows, and increased personal mobility, facilitate the geographical expansion of enterprise.

The impact varied according to transport mode: roads and canals generally stimulated local and regional markets, while railways impacted more on national markets, and shipping on international, reflecting the different types of service and cost functions of these modes. Improved road services in England led to the decline of many local markets and their replacement by fewer, larger regional centres (Pawson 1977: 323). This view has been reinforced for waterways by Turnbull, who argued that the economic impact 'was heavily local and regional'. Most freight movement was over comparatively short distances, and long hauls were restricted by the slow development of trunk routes and the 'extreme parochialism of most canal companies' (1987: 540–1). The major regions of industrial expansion in England by 1800 were inland coalfield areas with a canal network; particular beneficiaries were the urban centres of Manchester, Leeds and Sheffield. Coal prices were reduced through lower transport costs and a redistribution of output in favour of lower-cost producers (Turnbull 1987: 557–8). In Scotland the economic integration of the central lowlands region owed much to transport (see chapter 14).

The integration of national markets through the railway can be seen in the decline of regional price differences between producing and consuming areas that enabled greater regional specialisation of production. These included a concentration of brewing firms at Burton, Alloa and Glasgow, food processing at Reading, and confectionery at Birmingham (Cain 1988: 99). Such firms could be located at their preferred location and use the rail system to distribute to a national market. Chandler (1977) has shown the central role of the railroads in facilitating large national firms in the United States, which were able to draw upon remote sources of raw materials and supply long-distance markets. While transport networks evolved over a longer period of time in Britain, railways with their higher terminal but lower per mile costs helped to create national markets and national firms.

The integration of international markets in the eighteenth century was largely restricted to the North Atlantic. Productivity improvements in the tobacco, rice, oil and bullion trades helped to turn the North Atlantic ocean into 'an English inland sea', according to Menard (1996: 270). Overall, however, Ralph Davis's verdict that the shipping industry contributed 'a very small part indeed' (1962: 391) to the changes associated with the classic industrial revolution period remains the consensus. Lower freights

provided consumers with cheaper goods and permitted a greater volume of trade but stimulated no major industrial transformation in Britain, a process we now know to have taken longer and stretched through the first half of the nineteenth century.

Harley has drawn attention to the extension of the European and North American trading economies after 1860 as a result of lower international shipping costs (1994: 324–6). O'Rourke and Williamson (1999: 35) argue more broadly that 'it was falling transport costs that provoked globalization' in the second half of the nineteenth century. Commodity market integration in the form of spatial price convergence and production specialisation is used as evidence of this early period of globalisation. They argue that this was brought about by reduced transport costs, or the reduced transport 'wedge' between export and import prices (O'Rourke and Williamson 1999: 30–1). Primarily, this was the coming to fruition of the major advances in shipping over the last fifty years of the nineteenth century, although improved internal transport helped to mitigate the additional wedge of moving freight to and from port.

As well as providing opportunities for increased export penetration, improved transportation facilitated the growth of multinationals. While British firms did not grow as large and dominant in their home market as American ones, they were particularly noted for their activity in international business in the nineteenth century, which owed much to the falling ratio of transport costs as a share of total production costs. Wilkins (1977: 579) has argued that the growth of European, predominantly British, multinationals in the later nineteenth century can be traced to the speeding up of rail and ship communications, which eased the problems of long-distance management. Improved transportation enabled better international transfer of technologies, more effective monitoring of employees and reduced uncertainty regarding conditions in overseas markets.

Social savings

Of the many possible ways of assessing transport's economic impact, the most novel, stimulating but also controversial has been a counterfactual exercise, the social savings methodology, which asks how the economy would have developed without the railway. The methodology adopted is to estimate the additional costs to the economy of carrying goods by other means in the absence of the railway, using data for a specific year post-dating the actual introduction of the railway. Thus, it is the equivalent of closing down the railway system for a year. The initial advocates of social saving analysed American railroads: Fogel (1964) concluded that the economic impact of the railway was modest, and had been previously overstated relative to its main forerunner, the canal. Within the broader debates of economic development, this conclusion challenged

the Rostowian idea of unbalanced development – that innovation in a leading sector could cause the 'take off' of an economy.

Hawke (1970: 241–5) applied the social savings approach to Britain's railways. Using the year 1865, he calculated that the use of railways for passenger traffic yielded a saving equivalent to between 1.5 and 6.0 per cent of national income, depending upon whether a reduction of travelling comfort was deemed acceptable. Hawke looked at freight traffic separately and estimated a saving of about 4 per cent of national income. While his results were not much higher than those of Fogel for the United States, he concluded positively for the important growth-inducing role of the railways. He additionally accepted that the social savings approach provided only a partial examination, mostly of the direct economic impact of the railway, and added to this an assessment of the beneficial external economies of the railways in the form of induced cost-savings and growth-inducing secondary effects to other industries. To capture some of the broader impact Hawke calculates a social rate of return of railways of about 15 to 20 per cent and notes that this might be higher if one takes account of changes elsewhere that were not *dependent* on railways but were *facilitated* by them (Hawke 1970: 405–8).

The methodology has attracted as much attention as its conclusions. Among its shortcomings is the terminal weighting problem; the economy would have developed differently without the railway, perhaps to rely less upon transport services and with a different set of relative freight rates. Thus, the social saving would have been different in reality, probably lower. Imperfect substitutability between the railway and other transport modes is a second problem in collecting data. Hawke has been criticised for the limited evidence he produces of freight rates, which also focuses on coaches and canals for passenger and freight traffic respectively but says nothing about highly competitive coastal shipping.

As a comparison, it is interesting to note that a contemporary of the railway era, Dudley Baxter, undertook a similar exercise in calculating that to have conveyed 1865 railway traffic by canal and road at pre-railway rates would have saved the equivalent of 9 per cent of national income, a not dissimilar result from that of Hawke (Gourvish 1988: 82). An alternative counterfactual model could involve deciding which goods would not have been moved in the absence of the railways and thereby calculating the loss to national income in terms of reduced production and trading. Conceivably, this is a more realistic approach, although assumptions about the competitive structure in transport would still hinder its accuracy. Interest in the social savings concept dwindled from the mid-1970s, after a decade of extensive debate that concluded that the concept provided, at best, only a partial analysis of rail's economic impact.

Foreman-Peck revisited the question in 1991, asking the alternative question: how much higher would national income have been if the performance of the railway system had been better? His reworked social

savings calculations for 1865, 1890 and 1910 led him to conclude that 'railways were as important to the late Victorian economy as contemporaries thought, and call into question Fogel's claim that railways were only essential in economies like Mexico or Spain where water was scarce' (Foreman-Peck 1991: 90).

The social saving methodology has never been applied extensively to other transport modes, probably because it was only the railway that was particularly novel, unlike new forms of road and water transport. However, a study of malt movements by canal from Hertfordshire to east London by brewers Truman in the first half of the nineteenth century calculated the 'social saving' as a proportion of the company's expenditure. By this means it was estimated that waterways were a 1 to 3 per cent saving on the roads, while the railway was a saving of only 0.19 to 0.29 per cent on waterways (Jones 1986). Hawke and Higgins (1981: 248–9) calculated a 'conjectural, non-factual' social saving for freight carried on canals over road transport as 1.4 to 6.9 per cent, depending on whether the average journey was closer to 20 or 100 miles. Hawke suspects it was closer to 20, giving a result not very different from Jones.

CONCLUSION

Transport featured heavily in the economic history of Britain in this period. It witnessed the introduction of the railway system and the extension of road, inland waterway, shipping and urban transport structures and services. Technological and organisational changes drove the growth of output and productivity, while financial innovations and legal instruments helped overcome potential impediments. Strategic, monopoly and public good elements of transport attracted an uncommon degree of government attention. Besides questions of defence, particularly associated with shipping, policy makers sought a degree of balance between social and private returns from transport for reasons of both equity (distribution of benefits and costs) and efficiency (optimal levels of investment). Government concern at the market power of some transport firms is not surprising: they were among the largest, most capital hungry, spatially diverse and thus organisationally complex businesses of the time. Responses to these challenges included the development of close working relations with other firms, particularly specialist agencies and intermediaries. For the larger railway companies in particular, new internal information, accounting and labour management strategies were developed under the control of professional executives within new organisational structures. Assessing the overall economic impact of transport services is perhaps the hardest task in light of the pervasive, and difficult to measure, externalities of this major form of social overhead capital. Transport has represented a nationally important form of investment that was

increasingly productive over time and frequently drove, as well as responded to, change. It was closely linked to, and facilitated the growth and innovation of, leading industries such as iron and steel, coal, engineering and building materials. The increased speed, coverage, regularity but falling cost of transport services help to support the belief that they facilitated market integration and economic linkages. The impact of transport extended from the local stimulus of road and waterway through the growth of national markets by way of rail, to the early phases of globalisation occasioned by ocean shipping.