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Time is Money: A Re-assessment of the Passenger Social Savings From Victorian British Railways

Timothy Leunig

Department of Economic History
London School of Economics

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Abstract

This paper reassessesvin

gs by two-thirds. We calculate railway speeds, and the amount and value of time saved by railways. Initially small, time savings was three times fare savings by 1912, when total railway passenger social savings exceeded 13% of GDP. The transition from railways saving money to saving time came when railway technology stopped simply fulfilling existing demand more cheaply (travel for the affluent) and became a new good (travel for the masses).

Introduction

Improvements in passenger transport technology can have many effects. The new technology may raise involve more or fewer deaths and injuries for those who travel. Each transport technology will offer a differ combination of attributes. We can say two things with certainty. First, all of these factors are potentially valuable to co could be replaced by an hour's productive work.[4]

hour's walking, that is to say, walking and working offer similar disutility, while travelling to work is less unpleasant than the job itself.[8] In modern studies leisure time is valued equally, irrespective of the person's income, an assumption difficult to square with economic theory, but with obvious political attractions.[9]

That such benefits are not included in measures of GDP is of no concern. Our interest is in consumers' welfare gains from the new technology, whatever form those gains take. If they are valued by consumers then they are part of consumer surplus, if they are part of consumer surplus then they should be included in any cost-benefit analysis.[10]

In addition to the costs and benefits that accrue to users, which represent the transport benefits, there may be externalities to those who do not travel at all, and which need inclusion to estimate the total economic benefits to society. For example, better transport can destroy local monopolies and increase productivi

Fishlow.[11] Their studies aimed to quantify the value of railways to the United States in 1890 and 1859, respectively. Put simply, the social saving from railways is defined as the minimum additional amount that society would have to pay to do what the railways did, without them. In the case of freight, it is the additional cost of using canal or wagon rather than rail, and in the case of passengers, it is the additional cost of coaching, or whatever is roughly double those of Fogel and Fishlow, with much of the difference coming from ‘Hawke’s attempt to quantify the greater convenience and comfort of rail over non-rail passenger service.’[15] He adds ‘Here this reviewer is not convinced’.[16] Similarly, in his Journal of Economic Literature review, Fishlow notes that ‘the largest part of the cost savings emanate from reduced fares for personal travel (in particular first class accommodations)’.[17] Noting that posting costs, at 6 times coaching costs, seem exceptionally high, Fishlow recalibrates Hawke’s social savings figures with a lower cost of posting, and finds that social savings fall by one half. This leads him to comment that ‘it is disquieting to discover how sensitive the calculations of social savings are to modest, and apparently reasonable, changes in Hawke’s underlying assumptions’. Gourvish is more critical, arguing that all we can safely conclude is that the actual value for passenger social savings lies between 0.6% and 14.2% of GDP, bounds so wide as to tell us nothing about the value of railways to passengers.[18]

Hawke does not formally use a generalised cost model of transport, but he splices together the costs of two different non-railway modes of travel to measure the rise in comfort. He does not include any benefit for time savings, arguing that inflexibility of working hours meant that few workers were able to use the additional time saved to work, so it is likely that it was primarily leisure, not production that increased. That said, he acknowledges that excluding time savings imparts a downward bias, in that some travel was for business purposes, and clearly faster journey times did allow greater production. He argues that this bias is likely to

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[15] William J. Baker, "Railways and Economic Growth in England and Wales, 1840-1870," *Journal of Economic History* 31.3 (1971)., pp 718-9.
[16] Baker, "Railways.", p 719.
[17] Albert Fishlow, "Railways and Economic Growth in England and Wales, 1840-1870," *Journal of Economic Literature* 10.1 (1972)., pp. 75-6.

have been small, given that the majority of miles travelled were third class. He also argues that because workers did not have a choice as to working hours, the theoretical construct that workers value leisure at the wage rate is invalid, and therefore he regards such time saved as valueless. Finally, he notes that if we are to compare leisure time savings with GNP, we would need to include the valuation of all leisure time in our estimate of GNP.

Boyd and Walton argue that it is legitimate to compare the value of time saved with money GNP providing that we interpret the social saving result carefully. They note that because much of the social saving from faster passenger travel comes from increased leisure time, the social saving ‘measure *does not* show how much GNP would have been reduced if the railroad had not been available to travellers. It *does* show in the aggregate the percentage of GNP travellers in 1890 would have been willing to exchange for the railway rather than the cheaper boat must mean that people were prepared to pay to save time, and therefore that economic historians should include that valuation in their estimate of social savings.

This paper revises and extends Hawke's social savings for passenger rail travel in England and Wales. It seeks to achieve four things. First, to improve the quality of Hawke's analysis of the monetary savings available from railways. Second, to use modern transport economics to expand the analysis to include time savings. Third, to extend the monetary and non-monetary social savings estimates to cover the period 1843 to 1912. Finally, to divide social savings into money and time components, and between premium and third class passengers. This will allow a better understanding of the new technology's nature, the sources of its welfare gains, and the distribution of those gains.

Analysis

Part A: monetary costs

In this section we first set out Hawke's calculation for 1865, before revising it. Hawke's methodology is simple and correct. He finds the number of people who travelled in each class and assesses the means by which they would otherwise have travelled. The social saving is then the difference in cost per passenger mile, multiplied by the number of passenger miles travelled, summed over the three classes.

For 1865 Hawke takes the total receipts and average fares by class in England and Wales from the Railway Returns. These data are as authoritative as any nineteenth century data. Dividing receipts by the fare per mile should give the number of miles travelled. There are, as Hawke

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[20] A good discussion can be found in A.J. Harrison and D.A. Quarmby, "The Value of Time," *Cost-Benefit Analysis : Selected Readings*, ed. Richard Layard (Harmondsworth: Penguin, 1972).

notes, ‘some complications.’[21] These include return tickets, which had lower prices per mile, and express tickets, which had highuh had hi third class passengers. Hawke uses Lardner's comparison for years up to 1850, and that of the Royal Commission for years from 1865, with a linear transition from one 'comfort comparison' to the other, reflecting the steady improvement in railway comfort.[24] Bagwell shows that posting passenger miles were almost as high as coaching miles prior to the railway age, and that the number of post horses went down rapidly after the introduction of railway services.[25] It seems most plausible, therefore, that first class rail travel replaced posting as soon as the railway began, and for that reason we prefer the Royal Commission approach to that of Lardner. Throughout this paper, therefore, we report figures on the Royal Commission basis. We now construct table 2, which sets out Hawke's costs of pre-rail and rail travel, and the savings that came about from the invention of the railway.

Table 2: Social savings: Hawke's 1865 estimates

		1st class	2nd class	3rd class	season	total
1	miles (m)	367	659	1089	106	2220
2	rail fares (d/mile)	2.11	1.55	1.01	0.9	
3	rail costs (£m)	3.2	4.3	4.6	0.4	12.5
4	pre-rail fares (d/mile)	24	4	2.5	2.5	
5	pre-rail costs (£m)	36.7	11.0	11.3	1.1	60.1
6	rail saving (£m)	33.5	6.7	6.8	0.7	47.7

Note: rounding errors make these numbers trivially different to those given in Hawke page 44.
Sources: Row 1: table 1, row 3; Row 2: Hawke p. 43; Row 3: Railway Returns; Row 4: Hawke p. 44; Row 5: Row 1 x Row 4; Row 6: Row 5 – Row 3

on the Continent, and in America. (New York: Harter and Brothers, 1855)., p. 164, Parliamentary Papers: Report from Commissioners: Railways, 1867, vol XXXVIII, part

Thus Hawke assesses the alternative cost of travel in 1865 at £60m, giving social saving of £48m, or 5.8% of GDP.

A: i

We make three revisions to the calculation of monetary social savings for 1865, and note each of their effects separately. First, we noted earlier that, in the absence of any data, Hawke assumes that all season ticket holders paid a third class fare, travelled in the first and second classes, but would have travelled as third class passengers in the absence of railways. The division of season tickets revenues by class is not generally available, but is given in the Railway Returns for 1875.[26] This shows that 58% of season ticket revenues came from first class, 35% from second class, and the remaining 7% from third class. We assume that this ratio holds for all years, and that the price paid per mile was equal to one half the regular fare. This second assumption is on838 475.803

posting as 2s per person per mile, which cannot be correct. Fishlow drew attention to the very high – 6:1 – ratio between the cost of posting and the cost of travelling inside a carriage.[28] No other author suggests such a ratio, with Bagwell, for example, arguing that the cost of posting was ‘at least twice as expensive’ as travelling inside a coach. The 2s cost, mentioned in the Royal Commission and elsewhere, is in fact for a post-chaise per mile, not per person per mile.[29] Since a chaise could carry 3 or 4 people, the cost per mile was between 6d (four people in the chaise) and 2s (

both Henry Gray and Thomas Cass argued that they would be able to provide posting at 1s per mile were the tax to be abolished.[32] Similarly, Copeland reports various early nineteenth century advertisements for a post chaise and pair of horses at 1s – 1s 6d per mile.[33] Although tolls may have been in addition, it is clear that some journeys could be done 'post haste' for less than 2s per mile. Finally, it seems likely that the 2s included the cost of hiring a postillion to return the horses at the end of the stage, and the tolls on the horses on their return. Since the average first class rail journey was under 15 miles long in 1865, some journeys would have been short round trips to relatively local places, for which it would have been cheaper, when travelling by chaise, to have retained the horses at the destination until return, rather than paying the postillion and tolls for the return legs.[34]

We have no reliable information as to how many people travelled in the typical chaise, but given that they could carry 3 and perhaps 4 people, and given that 2s appears to be towards the upper end of the likely cost per chaise mile, an average cost of 10d per passenger mile seems reasonable.[35] This estimate – 2.5 times the inside coach cost – is in keeping with Bagwell's statement that posting was 'at least twice as expensive' as coaching. We can now revise table 3 accordingly.

May 1823, p. 4, col D, References to 1s 6d: Issue 7246, 1 January 1808, p. 3, col B and issue 9008, 6 September 1813, p. 3 col E.

[32] Parliamentary Papers 1837 Vol. XX, p. 9 (305), para 145, p. 11 (307), para 178

[33] Copeland, *Roads and Their Traffic 1750-1850*., p. 155, see also similar figures on pp. 156-160.

[34] 369 million miles divided between 25,053,443 passengers, both from Railway Returns, Parliamentary Papers, 1866, lxiii, p. 36.

[35]

Table 4: Revised estimates of 1865 social savings: new post-chaise costs

	1st class		2nd class		3rd class		Total
	standard	season	standard	season	standard	season	

of travelling except by wagon or on foot.'[37] This is in keeping with evidence given to various parliamentary enquires. For example, Sir Rowland Hill, when describing the improvements brought about by railways, notes that 'even those whose best attainable means of travelling were wagons proceeding at the rate of two or three miles an hour, are now conveyed by third-class carriages in tolerable comfort and with great speed.'[38] G. Duncan, the Director of the Dundee and Arbroath Railway, when asked how his third class passengernss carriages in toler2707Tj13.02 0 0 13.0155.

Table 5: Revised esti

relatively new, the concept is not. Lardner, for example, included the time saving in his analysis of the importance of railways.[43] Furthermore, the economic literature is clear that all time, including non-working time, has a positive value.

In the nineteenth century trains were much faster and often much more frequent than coaches, and became both faster and more frequent over time. Furthermore, train companies believed that customers valued speed: it played an important part of their advertising strategy, and they were keen to set new records. In addition, faster trains were generally more costly to operate, so given increasing speeds, we know that railway companies believed that passengers were prepared to pay more for faster travel. This would also fit with the finding that Britain had faster trains than elsewhere in Europe: as the richest country, British people were rationally prepared to pay more to save a given amount of time, and train companies catered for their needs accordingly.[44] In addition, the fastest trains within Britain often required the purchase of an express ticket, demonstrating a willingness on the part of travellers to pay to save time.

There were two contemporaneous estimates of the value of faster travel in Victorian Britain. Lardner argued that in 1848 coaches travelled at 7.5mph and trains at 25mph. With 170m passenger miles the time saved amounted to just under 16m hours, which at Lardner's 6d per hour value of time implies a saving of £0.4m.[45] Chambers Journal, discussing the railways in 1854, was more optimistic, arguing that 111m passenger hours were saved, which, even at a lower value of time of 4.5d per hour,

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1867, vol XXXVIII, part 1p. cvii, para 2), then, with an average coach fare of 3d per mile for the second class, the social saving falls to £13.8m, which is again 1.7% of GDP.
[43] Lardner, *Railway Economy*., p. 164.
[44] Ernest Foxwell and Thomas Cecil Farrer, *Express Trains : English and Foreign : Being a Statistical Account of All the Express Trains of the World* (London: s.n., 1889)., pp. 66, 163-179.
[45] Lardner, *Railway Economy*., p. 164.

Coach services does the same for coaches in 1836.[49] Of course, neither trains nor coaches would always have operated precisely to their timetables, but it seems more likely that punctuality was better on the railways than on coaches, and that punctuality improved over time. Thus although timetables will overstate the true speeds, the effect is likely to be small and declining over time. It is obviously not practical to computerise every journey, and nor, having done so, would we be able to allocate passengers to each journey with any degree of accuracy. Instead we construct two samples, consisting of 50 'important' and 222 'minor' journeys respectively.

The important routes are defined by the likely traffic on them.[50] These include the obvious intercity pairs, such as London to Birmingham, but also many shorter but high density routes, such as London to Reading and Manchester to Oldham.[51] For these 50 routes we computerised every journey on each route in 1836, 1850, 1870, 1887 and 1910. The timetables give the time of every journey during the day,[52] but simply averaging these would overstate the average time taken, since people will not take an earlier train if it will be overtaken en route by a later-leaving, but faster-travelling, service. We eliminate trains and coaches that were

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average the ‘useful’ journeys on each route using a ‘twin-peak’ weighted average, that is to say, we assume more people wish to travel at peak times than at off-peak times, and give higher weight to trains at those times in calculating the average speeds on each route in each benchmark year.[53] The averages for individual routes are then averaged in proportion to each journey’s importance, as defined by the likely traffic on the route. For tractability we assume that any passenger could have travelled on any train. In reality this was not the case in the early years, when not all trains had third class carriages. That said, the effect of this bias is small, since only a relatively low proportion of passengers travelled in third class in the early years.

We calculate miles per hour by dividing the ‘crow-flies’ mileage between the two towns by the time taken. We use ‘crow flies’ rather than ‘track’ miles because this is what matters to travellers. This also has the useful property that the construction of a shorter line, on which trains travel at the same speed, counts as an increase in speed.[54] As a rule of thumb, track mile speeds exceed crow flies speeds by around fifteen percent.

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[53] We assume that people wish to travel in the following ratios: each hour between 1am and 6am, 1 passenger unit per hour, between 6am and 7am, 11am and 5pm, 9pm and 1am, 100 units per hour, between 7am and 8am, 10am and 11am, and 8pm and 9pm, 400 units per hour, and between 8 am and 10am, and 5pm and 8pm, 1000 units per hour. We then assume that these passenger units wish to depart evenly within the hour bands, and that they catch the first useful train after their preferred departure time. This allows us to calculate the number of people on each train, and that is the number used to produce the weighted average. Many different weightings were used, including uniform inherent demand over the 24 hour period. Contrary to our initial expectations, the pattern of demand does not alter the results by more than a few minutes, and does not alter the final social savings results. Both coaches and trains were sufficiently frequent, and fairly uniform in speed, that the precise allocation of passengers to individual trains is of no great importance.

[54] Thus, for example, the Great Western Railway shortened its routes from London to South Wales and the West in the later Victorian years by building straighter lines through new cuttings through hills it had previous detoured around. As such, it lost its nickname of the ‘Great Way Round’. P. J. Cain, "Railways 1870-1914: The Maturity of the Private System," *Transport in Victorian Britain,* eds. Michael J. Freeman and Derek H. Aldcroft (Manchester: Manchester University Press, 1988)., p. 93.

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Table 6: ‘In-train’ train speeds at different dates, crow-flies miles per hour

	Important journeys	Minor journeys	All journeys
1850	22.7	17.8	20.1
1870	28.4	18.4	23.2
1887	32.8	18.9	25.6
1910	36.9	20.4	28.3

Source: Bradshaw’s Railway Directories.

As table six makes clear, train speeds on important routes were considerably higher than on minor ones, and grew more quickly over time. Overall, a rise in speeds from 7.8 or 2.5mph in the pre-railway era to 20 and then later to 28 mph in the railway era represents a major improvement in quality for consumers. Tables 5 and 6 are used to calculate the number of hours saved by railways in 1865.

Table 7: Time savings in 1865

		1st class	2nd class	3rd class	Total
1	miles (million)	420	702	1101	2223
2	pre-rail speed (mph)	43	450.39607	375.50031	Tm(2)Tj13.02 0 0 135 lTT0 1

because they represented the largest single category of traveller, and because their alternative methods of transport – walking, or wagons moving at walking pace – were very slow. As with all social savings numbers, we need to be careful in how these figures are used. Just as Hawke's social saving figure of £48m did not mean that society spent £48m less on transport in 1865 than at some previous date, nor does table 7 mean that 485m hours were actually saved. Rather, it tells us that to make the journeys made by rail, without the railways, would have taken an additional 485m hours.

B: ii

We also know that trains were more frequent than coaches, and that people value frequency, because it reduces the overall journey time. This was appreciated by contemporaries. Thus Mr Edward Bury, superintendent of locomotive power on the London and Birmingham Railway, told the 1840 Committee on Railways that 'The great advantage to the public will be, in not having a single train per day carrying all the passengers that go, but in having a multiplicity of trains throughout the day', adding later in his evidence that 'I think the public would not have the convenience the railway ought to give them, unless there were frequent trains'.[59] Competing coaches, in contrast, often departed at similar times to each other, so that passengers wanting to leave at other times would have had to wait many hours. Thus, for example, all London to Leeds and London to Liverpool services departed in the afternoon, while the six coaches to Manchester all went either first thing in the morning, or in the early evening, with no departures between 8.30am and

[59] Parliamentary Papers 1840 XIII p. 112 (306), para 2327, p. 115, (309), para 2392.

into a smooth series.[63] This tells us that a departure 30 minutes after the passenger would like to leave has the same disutility as one that departs at exactly the preferred time, but takes 23 minutes longer. Similarly a one hour gap is equivalent to a 35 minute longer journey, a two hour gap to 51 minutes, and a 12 hour gap to 82 minutes. The falling marginal cost reflects the fact that the longer you have, the better you are able to deploy your time usefully, and so the marginal disutility is lower.

There were almost four times as many useful services on important routes in 1910 as in 1836 or 1850. That said, there were still sufficient coach and train services in the earlier years that increasing frequenccmilutes aftpatuten c

longer (r years)Tj13.02 0 0505. 13485 13.260452.780.r yearsr years ch andvalerriv36 futesicient

Table 8: Train speeds at different dates, crow-flies miles per hour, including allowance for waiting

	Important journeys	Minor journeys	All journeys
1850	19.4	11.1	15.1
1870	24.2	11.2	17.4
1887	[illegible]	[illegible]	[illegible]
1910	32.0	13.0	22.1

[illegible] railway directories.

for the train. Second, Britain was already a remarkably developed economy prior to the railway. Stage coach services were particularly extensive on core routes, but were also well established on relatively minor cross country journeys as well. Bates records regular, usually daily, services on 786 different routes excluding those that started or ended in London.[64] The finding that the British transport system was well-developed in the pre-railway era fits with recent work by Bogart, which looks at the significance of turnpike trusts in speeding up coach journeys.[65] It is also in keeping with the recent article by Crafts and Mulatu, which finds that British railways did not lead to a geographical relocation of production: previous transport had been sufficiently good to allow industry to be located in economically efficient locations.[66] Since the figures for time saved are so similar, we limit ourselves to considering only in-vehicle time saved.

B: iii

We now turn to valuing time saved. As we noted earlier, the value of time saved during working hours is taken as the gross wage rate, plus overhead costs. In the nineteenth century overhead costs would have been small, and we disregard them. This introduces a downward bias, but it is hard to believe that the bias is large in an era without payroll taxes on employers, and with few employer funded pensions or other such benefits.

We also noted earlier that it is common to value wages by the type of transport used, with higher values attributable to those travelling by modes used more extensively by the affluent. One initially plausible

[64] Bates, *Directory*., pp. 85-138.
[65] Dan Bogart, "Turnpike Trusts and the Transportation Revolution in 18th Century England," *Explorations in Economic History* (2005).
[66] N. F. R. Crafts and A Mulatu, "What Explains the Location of Industry in Britain, 1871-1931?," *Journal of Economic Geography* 5 (2005).

assumption is that the typical third class passenger was a typical member of the working class, and can thus be proxied by the standard working class wage data. Feinstein finds that in 1911 average earnings for both sexes were £58 10s which, taken backwards using his wage growth series, gives an hourly wage estimate of 3.3d in 1865.[67] This is only half the 6-7d per hour put forward by Chadwick as the typical wage for third class passengers in 1867.[68] Relative to earnings, the cost of travelling by third class rail was significant in 1865. With earnings of 3.3d per hour, an average member of the working class could afford to travel a little over 3 miles for one hour's wage decent but not spectacular wage.[69] Again, we index this series using the Feinstein series, to give a value per hour of 16.8d for 1865.

As noted above, the current literature assumes that travel today is no more or less pleasant than being at work. Although conditions at work would have been poor for many workers, it is easy to imagine that hours spent on a stage coach – or walking – could have been far less pleasant than the equivalent time at work. Under those circumstances, the cost of labour will understate the value of time saved. It is not possible to make any correction for this, but instead we simply note that the discomfort means that it would be plausible to argue that the time saved should be valued more highly than the figures used here.

B: iv

The next issue is the proportion of people travelling during work that handloom weavers travelling on business made up most of the third class custom on the

the Chadwick value of time, and assume that two-thirds of premium class and one third of third class travel was on business, the social saving is £15.4m. This estimate seems realistic, and represents 1.9% of UK GDP.

B: v

Since we now have a revised figure for the monetary saving, and a figure for the value of time saved, we can calculate the total social saving. Hawke divides the social saving for railways in England and Wales by GDP for the UK. As Gourvish noted, this is inappropriate.[73] Crafts has recently broken down British GDP figures into regions.[74] He finds that in 1871 England and Wales accounted for 79% of UK GDP, a ratio that we assume holds for 1865, implying 1865 England and Wales GDP of £649m.

Table 11: Money and time social savings for 1865, £m

	1st class	2nd class	3rd class

Table 11 tells us that both the monetary and time savings were significant, with the money savings slightly larger than the time savings. Together they amount to 3.9% of UK GDP, or 4.9% of England and Wales GDP, one-third lower than Hawke's estimate. For premium passengers the gains were primarily monetary: lower fares represent almost 90% and 70% of the total gains to first and second class passengers respectively. For third class passengers the picture is very different: their fares increased by £4.6m, but they saved £9.9m worth of time.

Table 12: The effect

Part C: Extending the social savings numbers to 1843-1912

We now go on to extend the series to cover the years 1843 to 1912. We do this in four parts. First, we assess the fares and miles travelled prior to 1865, for which good data are available. Next we assess the same for the period after 1865, for which the data are poorer. Third we calculate the value of monetary savings, and finally we calculate and value the time saved.

Hawke uses Lardner's passenger mile estimates for 1843-8, and the Railway Returns until 1870, when his analysis stops.[79] Gourvish is sceptical about Hawke's reliance on Lardner, but that scepticism is not well-founded.[80] Both Lardner and the Railway Returns give figures for 1845-8, and the two series are identical. For that reason is seems reasonable to trust Lardner's figures for 1843-4.[81]

We make a few small changes to the procedure followed by Hawke. First, he uses passenger mileage figures given in the Railway Returns from July 1851 to December 1859. However, a few companies did not submit passenger mileage returns between 1851 and 1855. We add a proportionate allowance to passenger miles, based on their train miles, raising total passenger miles by 1 to 5%, depending on the year. Since rail receipts remain unaltered, and non-rail costs rise 1-5% with the additional miles, the social savings rise. The effect is, however, small, never exceeding 0.3 percentage points.

Second, between 1852 and 1859 a few companies, never accounting for more than three percent of the total passenger miles, did not divide their passenger miles by class. Hawke allocates them to the third class, we distribute them pro-rata, in line with the average of other companies. Again, this raises the social saving, since it increases the

[79] Hawke, *Railways and Economic Growth*., pp. 45-7.
[80] Gourvish, *Railways and the British Economy 1830-1914*., p. 38.
[81] Lardner,

alternative non-rail cost, without altering the rail cost. The estimate of social savings rises by a maximum of 0.2 percentage points.[82]

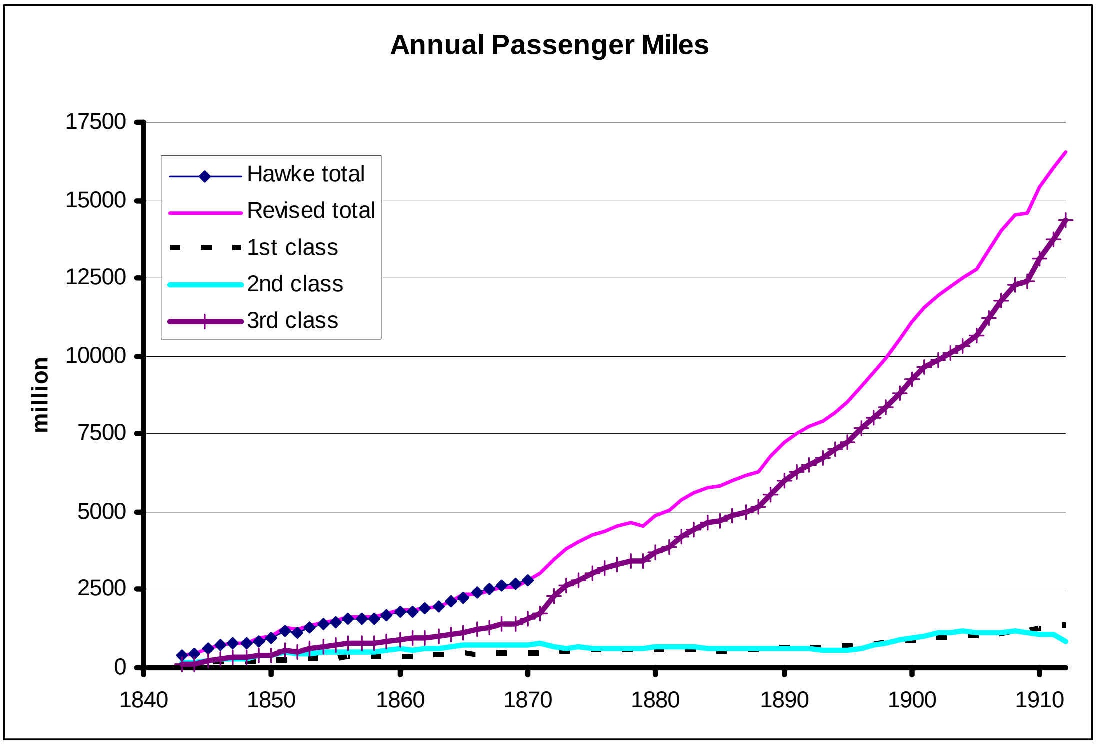
We know both receipts and fares per mile by class for the periods 1843-8, July 1851-December 1859, and for 1865. It is therefore fairly straightforward to divide the former by the latter to find the number of passenger miles. We interpolate fares per mile for 1849-Jun 1851 and 1860-1864 from observations immediately on either side, and use these prices to calculate miles travelled from the receipts given in Railway Returns. The price per mile was very stable in this period, so this cannot involve any significant error.

C: i

Our numbers, like those used by Hawke, for the post-1865 period are less precise, because no information on average fares are available, and season tickets, workman's and excursion fares become more important. Like Hawke, we note Acworth's statement that the average fare fell to 0.55d per mile by the outbreak of war.[83]

which are close enough to our figures of 0.71d and 0.56d.[84] Paish gives fares for the five main railway companies for 1900, which when averaged give 0.775d per mile.[85] This is higher than both our estimate and that of Cain, probably reflecting higher prices on the faster, mainline routes that make up Paish's sample. In short, our figures are plausible, even though they lack the authority of the earlier data. We then divide receipts – given in Railway Returns for all years – by the estimated fares per mile, to give the number of miles travelled in each class.

Figure 1.



Sources: Lardner & Railway Returns.

Second class mileage peaked in 1871, after which time the number of second class passenger miles fell in absolute terms for some years, as railway companies began to move to a two class system (known as first

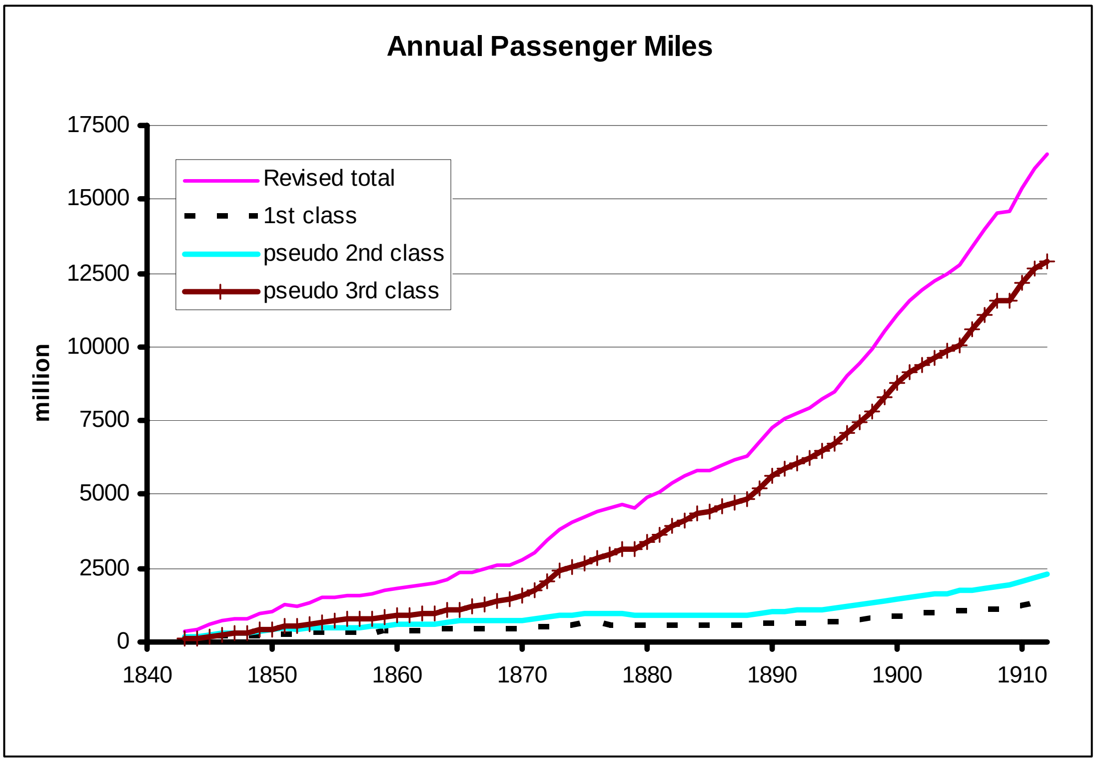
[84] Cain, "Railways.", p. 124.

and third classes). It was the third class, rather than the first, that gained. It would be wrong, however, to assume that people who now travelled third class, but would have travelled second class in earlier years, would have walked in the absence of the railway. To avoid that implication, we construct a pseudo-second class from 1872 onwards, which simply follows first class traffic, at the 1871 1st to 2nd class ratio. The pseudo-third class is then the actual number of third class passengers, less those who are transferred into the pseudo-second class.[86] This procedure raises the monetary social savings estimate, but lowers the value of time saved. For simplicity we refer to the pseudo-second and pseudo-third classes simply as second and third classes from here on. The revised mileages are given in figure 2.

[85] George Paish, *The British Railway Position* (London: The Statist, 1902)., pp. 40, 180, 202, 222 and 285.

[86] The pseudo second class is 50% larger than the actual second class by 1900, while the pseudo third class is 5% smaller than the actual third class. By the end of the period the effect has roughly doubled.

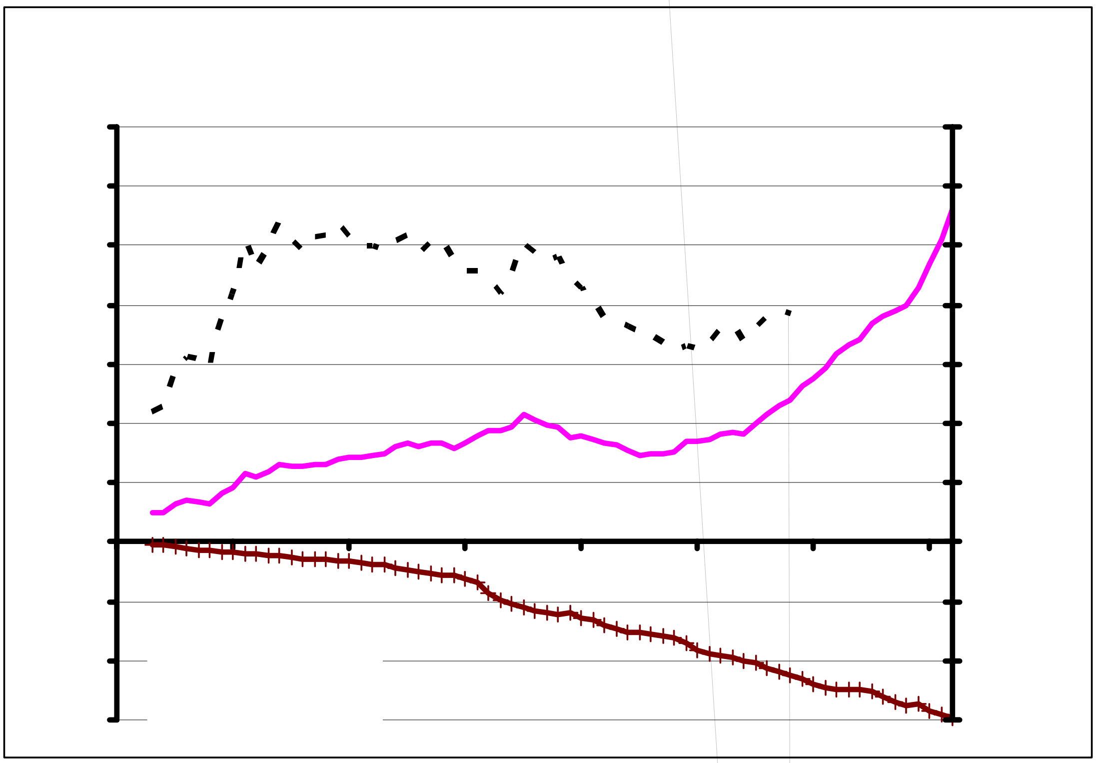
Figure 2.



Sources: Lardner and Railway Returns.

We now know the miles travelled in each year, the railway fares, and the cost of alternative modes of transport. That is sufficient to generate the monetary social savings estimate, which is given in figure three.

Figure 3

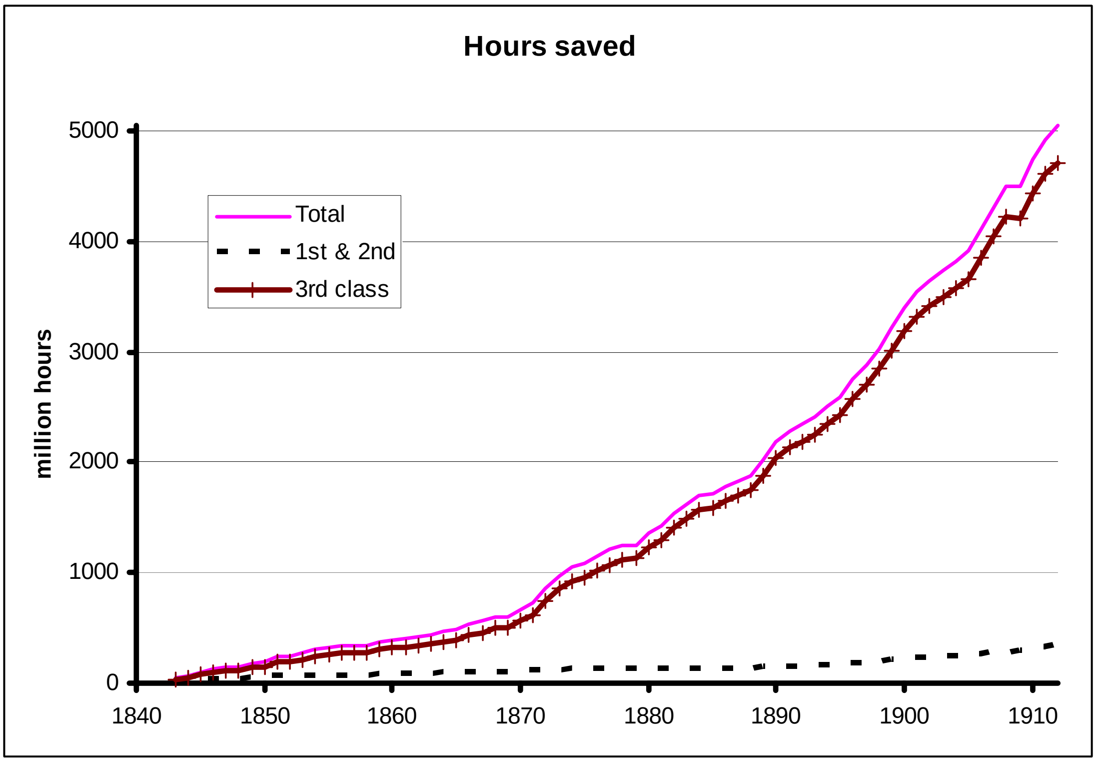


and Cain, but the results in between these two dates must be viewed as an educated guess. It is probably most sensible to see social savings rising to 2.5% in the early 1850s, and remaining in that region for the next fifty years.

C: ii

As well as calculating the monetary savings, we are also able to assess the value of time saved. We do this first by combining the data on speeds given in table 8 (with linear interpolations between benchmark years), and the passenger miles given in figure 2. This gives the total number of additional hours needed to make the railway journeys without them.

Figure 4: not including waiting.



Sources: table 8 and figure 2

The number of hours saved rose dramatically over the r 3.02 121.08 744.86035 Tn the average traveller and the average working class person was smaller in 1912 than in 1865. We assume, arbitrarily, that the 1912 premium of travellers to average wages was half that of 1865, with a linear transformation between the two dates.[89] For years before 1865 we use the Chadwick premium, applied proportionately to Feinstein's series. Table 13 gives the value of the 5bn hours of time saved assuming first that all travel is in work time and second that it is all in non-work time. The estimates range from £111m and £190m. As for 1865, neither extreme makes sense, and using the earlier plausible hypothesis that two-thirds of premium and one-third of third class traffic was for business gives a saving of £175m, just over 10% of England and Wales GDP. It is worth noting that even without any work time travel, the value of time saved still represented 9% of GDP on the Chadwick wages.

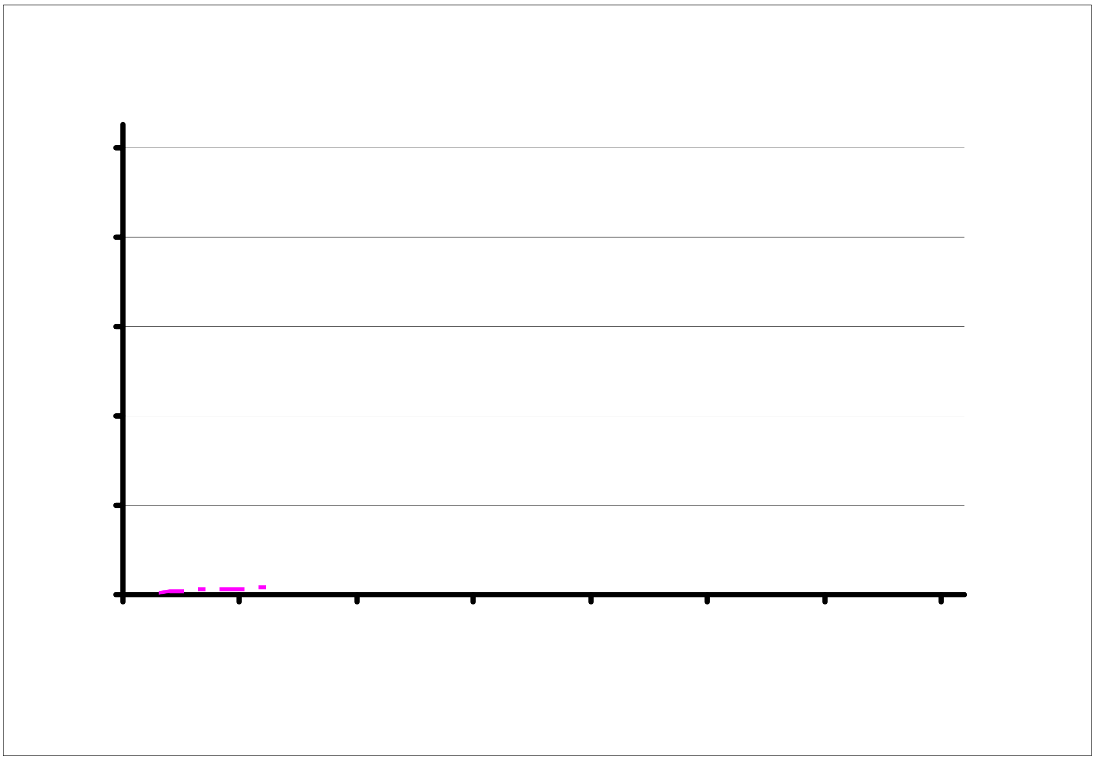
Table 13: Valuing time saved in 1912

		1st class	2nd class	3rd class Feinstein	3rd class Chadwick	Total
1	time saved (m hours)	126.7	214.3	4707.1		5048.1
2	value of one working hour (d)	26.7		5.2	7.8	
3a	value of time saved (£m)			102.3		140.2
3b		14.1	23.8		152.2	190.1
4	value of one non-working hour (d)	12.3		4.8	7.1	
5a	value of time saved (£m)			94.1		111.6
5b		6.5	11.0		140.0	157.4

Rows 1, 2 and 4: see text; Row 3: row 1 x row 2; Row 5: row 1 x row 4; 'a' indicates using the Feinstein 3

The results for all years are given in figure 5, which for clarity shows the absolute value of time only on the assumption that all travel is during work time. The non-work time estimates can be found by multiplying the work-time estimates by 46% for premium class travel, and 92% for 3rd class travel.[90] The saving relative to national income is given on the more plausible basis outlined in the previous paragraph.

Figure 5



before railways

after which it stabilised between 20-25% until 1912. The rise in the importance of time relative to money savings reflects the changing nature of the railway in this period. Initially railway companies saw the railway as an alternative to coaching, and offered services that were priced and structured accordingly. But from 1870 onwards, railways became an ever more mass market commodity, whereby train companies often aimed to make a profit by conveying many people, relatively cheaply, at high load factors. We can see this transition in figure 8, which gives the perc

1850, followed by a steadier decline to one-sixth by 1885, after which it stabilised.

This pattern fits with what we know about technological adoption. In the initial period, new technology is used in the same way as the previous technology. In this case, railways were used to carry the well-to-do in comfort, while conditions for those in the third class were very poor, both in terms of comfort and convenience.[92] Only from 1870 did the railways, in part under pressure from legislation, and in part under the threat of nationalisation, appreciate the potential of third class travel, and offer better conditions, greater frequency, and lower fared.

only when train companies realised that the best use of railways was for mass transport, including high load factor commuting and excursion traffic, that society was able to reap the full benefits. It is an open question as to whether the time lag between the railway's invention and its use as a mass transit system was caused by technological bottlenecks, such as inadequate engine power limiting train lengths, or by a significant entrepreneurial failure on the part of railway managers, who failed to see a new market until surprisingly late.

There is another way in which these findings fit well with the more general literature on technology. Nordhaus has shown that, on average, postwar American entrepreneurs in the non-farm sector captured only 2.2% of the total benefit to society from new inventions. The remaining 97.8% went to consumers as additional consumer surplus.[94] Arnold and McCartney have recently compiled data on the return on capital employed for UK railways. They conclude that although returns were initially reasonable, 'From that date [1872], however, through to the outbreak of war in 1914, the industry's results, and t

Conclusions

This paper makes a number of contributions. First it shows that the passenger savings numbers put forward by Hawke cannot be sustained. The use of an erroneous figure for posting means that Hawke's figures need to be reduced by almost one-half. Furthermore, we have produced evidence that those travelling third class would have walked in the absence of the railway. Taking this into account reduces the monetary gain further, to 2% of UK GDP, or 2.6% of England and Wales GDP, a little over one-third of the value given by Hawke. We also extended the social savings series to 1912. Although the price data – which is used to convert total receipts into passenger miles – is not as reliable as for the earlier period, we show that the overall monetary cost savings to railway passengers remained roughly constant as a share of GDP from the 1850s onwards.

We assessed railway speeds more accurately than has been done before. Train speeds rose from 19 mph in 1843 to 29 mph in 1912, on a 'crow-flies' basis. Within that, speeds on important journeys rose much more rapidly, from 21 mph to 37mph, while speeds on minor routes rose much less, from 18 to 21 mph. Including the 'in vehicle time equivalent' of the wait for the train, we find that the average speed increased from 14mph to 22mph, with core route speeds rising significantly from 18 to 32 mph, and minor route speeds only rising from 11 to 13mph. It would have taken an extra 50m hours in the early 1840s, 500m hours in the mid-1860s, and 5bn hours by 1912 to undertaken the journeys made by railways without them.

This paper then went on to value that increase in speed, using modern transport economics. We find that the social saving of time saved rose steadily from under 0.5% of GDP initially, to 10% by 1912. Although the quality of the post-1870 data is weaker than in the earlier period, the size of the results found here means that there can be no doubt that the value of time saved rose dramatically as the period progressed.

Whilst initially money savi

Appendix 1: 50 core routes

Gateshead, Glossop, Gloucester, Grantham, Gravesend, Grimsby, Halifax, Hanley, Harrogate, Hartlepool, Hastings, Hereford, Heywood, Hinckley, Huddersfield, Hyde, Ilkeston, Ipswich, Jarrow, Keighley, Keswick, Kettering, Kidderminster, Kings Lynn, Kingston upon Hull, Kingswood, Kirkby Lonsdale, Lancaster, Leamington, Leeds, Leek, Leicester, Leigh, Leighton Buzzard, Lewes, Leyland, Lichfield, Lincoln, Liverpool, Llandudno, Llanelly, London, Long Eaton, Longton, Loughborough, Lowestoft, Luton, Lyme Regis, Macclesfield, Maidstone, Malvern, Manchester, Mansfield, Margate, Merthyr Tydfil, Middlesbrough, Middleton, Mirfield, Nantwich, Newark, Newcastle, Newcastle under Lyme, Newmarket, Newport, North Shields, Northampton, Northwich, Norwich, Nottingham, Nuneaton, Oldham, Oxford, Padiham, Peterborough, Plymouth, Pontypool, Pontypridd, Portsmouth, Preston, Radcliffe, Ramsgate, Reading, Reigate, Rochdale, Rochester, Rodwell, Rotherham, Rugby, Runcorn, Sale, Scarborough, Seaford, Selby, Sheffield, Shipley, Shrewsbury, Sleaford, Smethwick, South Shields, Southampton, Southport, Sowerby Bridge, St Annes, St Helens, St. Albans, St. Austell, Stafford, Stalybridge, Stockport, Stockton-on-Tees, Stoke on Trent, Stroud, Sunderland, Sutton Coldfield, Tamworth, Taunton, Tewkesbury, Torquay, Tredegar, Tunbridge Wells, Tunstall, Ulverston, Wakefield, Wallasey, Wallsend, Walsall, Warrington, Warwick, Watford, Wellingborough, West Bromwich, Weston super Mare, Widnes, Wigan, Wilmslow, Windermere, Wisbech, Woking, Wolverhampton, Worcester, Wrexham, Yarmouth, York

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