Late Victorian Railways and Investor Returns

The expansion of railways in the mid-19th century played a major role in the development of British capital markets (Mitchell, 1964). By the early 1870s, the railway sector represented around one quarter of all securities quoted on the London Stock Exchange, excluding British government debt. Investors, such as the Phoenix Assurance, continued to commit new investment funds to railways through the following decade (Trebilcock, 1998). By the end of the 19th century, domestic railway securities were regarded as "blue chip", a status confirmed by the citing of railway securities as eligible investments for any trust fund under the 1889 and 1893 Trust Investment Acts. This legislation created considerable investor demand for domestic railway debentures in the 1890s, and the rise in debenture prices pushed the yields of the leading companies close to Consols, and considerably below those available from leading foreign railways.[1]

As well as debenture stocks, late Victorian domestic railway companies issued preference shares and ordinary shares. The 15 domestic railway companies in our sample issued a total of 33 different securities continuously quoted on the London Stock Exchange (see Appendix 1).

The annual time-series of the total real returns to each security is taken from Edelstein (1982), the primary source being *The Investors Monthly Manual* (IMM).[2] Total returns are defined as:

$$r_{ijt} = \frac{(P_{ijt} + D_{ijt}) / I_{ijt}}{P_{ijt-1} / I_{t-1}} - 1 \qquad (1)$$

where

P_{ijt} = the sterling price of the security issued by the ith company of the jth type published for the last week of December of the tth year in *The Investors Monthly Manual*.

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[1] "British and Argentine Railway Debentures", *The Economist*, 10 June, 1893, pp.692; and "English and Foreign Railway Debenture Stocks", *The Economist,* 14 March, 1896.

[2] We are grateful to Michael Edelstein for providing us with this data. This was supplemented with the year-end ordinary share returns for Taff Vale based on annual share prices and dividends also taken from the IMM. Any missing observations were checked against the same source. If prices were still missing, they were in-filled with the mean values for the other railway securities of the same class in that year. We also adjusted returns to take account of any capital changes. CR, GNR, LBSCR, LSWR, MSLR/GCR, MR, and NBR split their ordinary shares into preferred ordinary and deferred ordinary shares. In the case of LBSCR, NBR, GNR, and MR and MSLR/GCR in 1883, 1888, 1891, and 1897 respectively, the ordinary shares appear to have been retired and were no longer quoted in IMM. Hence, after these dates we have used changes in dividends and share price returns on the deferred ordinary shares as representing the residual returns to shareholders. We did not adopt this approach with CR and LSWR because the split into preferred and deferred ordinary was at the option of the shareholder, and the ordinary shares both continued to trade and had dividends declared on them.

D_{ijt} = the sterling cash dividend or interest payment by the i[th] company on the j[th] security type published for the last week of December of the t[th] year in *The Investors Monthly Manual*.

I_t = the annual price deflator for the t[th] year.[3]

$i = 1,...,15$ railway companies

$j = 1$ (ordinary shares), 2(preference shares), 3(debentures)

and

$t =$ the calendar year between 1870 and 1913.

The mean and standard deviation of the annual total real returns for each ordinary share, preference share, and debenture are summarised in Table 1. The equally weighted average returns for each of the three railway asset classes are graphed in Figure 1. Ordinary share returns were considerably more volatile than preference share and debenture returns, between which there was little to choose. Further study of all three series also suggests a break in all around 1897/98. This break is consistent with the pattern of quinquennial returns reported by Kennedy and Delargy (2000).[4] Hence, we compute also returns for the sub-periods, 1870-97 and 1898-1913 in Table 1. Ordinary shares, preference shares and debentures on average returned +7.66%, +6.80% and +6.32% per annum respectively between 1870 and 1897. In the later period up to WW1, however, all three railway asset classes generated losses of between 1.5% and 2%.

[INSERT TABLE 1 AND FIGURE 1]

More importantly, there was also a deterioration in the relative returns of domestic railway securities. In the earlier period to 1897, they offered a healthy premium of 2 to 3% over the real return on Consols (+ 4.64%, Table 1, Panel C). Subsequently, this premium shrank to less than 0.5%, as Consols averaged only a slightly inferior real return (-1.96%) compared to railway securities. Similarly, there was a marked decline in domestic railway returns relative to those on foreign railway securities. Hence, although foreign railway debenture returns performed in line with their domestic cousins prior to

[3] To preserve comparability of results, we use the same deflator series, namely, Phelps Brown's cost of living index, as Edelstein (1982) and as Goetzmann and Ukhov (2006). See Edelstein (1982), pp.121.
[4] See pp.85, Table 11a.

the late 1890s, they proved far more attractive investments later on, and in no single year delivered a negative return.[5]

Investors receive their return on any security through price changes and income, either in interest or dividends. Rearranging equation (1), we obtain an expression for total return which in the case of ordinary shares decomposes into its capital return in real terms plus the dividend yield as follows:

$$r_{ijt} = \frac{P_{ijt} / I_t}{P_{ijt} / I_{t-1}} + \frac{D_{ijt}}{P_{ijt-1}} - 1 \qquad (2)$$

Now, we can consider the relative contribution of each component to the total returns of railway shares.

As residual claimants on a company's assets, ordinary shareholders receive dividends on their shares out of any profits remaining after payment of the fixed interest and fixed dividends due to debenture and preference shares respectively. Overall, ordinary share dividends in the sector trended down after about 1890. The drop of approximately 2% in the 5- year moving average of sector dividends paid between 1887 and 1910 is similar in magnitude to the deterioration in the returns on capital employed discussed above *[reference earlier table]*. Dividend yields fell in step with dividends paid as a percentage of par value until the turn of the century.[6]

There was, of course, considerable variation in dividends paid and dividend yields across both companies (Table 2, Panels A and B, 5-year moving averages). This tended to reflect underlying business performance. TVR paid a very healthy dividend throughout. On the other hand, MLSR(GCR) passed their dividend from the late 1890s onwards, whilst the LCDR paid no dividends at all in any year during the period.

[INSERT TABLE 2]

Capital returns to the 15 railway ordinary shares fluctuated considerably more than their dividends, and turned to losses in the early 1890s (Panel C). The relatively stable dividend yield kept total returns on domestic railways in positive territory until the turn of the century; thereafter, capital losses more than offset the dividend yield to push total returns into negative territory (Panel D). Even Taff Vale Railway ordinary shares,

[5] The mean return (standard deviation) of foreign railway debentures was 6.33% (2.92%) and 3.36% (1.61%) in 1870-97 and 1898-1913 respectively, Edelstein (1982).

[6] This long-term fall in dividend yields was, naturally, of considerable concern to shareholders, "Home Railway Problems I, Dividends", pp.13, *The Times*, Dec 23, 1910.

the outstanding performer in the sector, failed to provide a positive total return just before WW1.

Far from considering the investment merits of domestic railways in isolation, investors would have assessed their attractiveness in a diversified portfolio of quoted securities. The benefits from diversification of spreading investment risk was a concept well understood by late Victorian investors.[7] Given the considerable change in the fortunes of this sector in the late 1890s, how might a rational investor have reassessed his exposure to railway securities in such a diversified portfolio?

We can estimate the composition of an optimal portfolio of a late Victorian investor by employing the tools of modern portfolio theory. The starting point of this theory is the assumption that investors possess mean-variance preferences. In other words, they care only about the expected return, defined by mean return, and the risk, defined by variance, of any investment in assembling a portfolio.[8] Furthermore, investors prefer more return and less risk.

[INSERT FIGURE 2]

The decision as to which portfolio chosen from the many securities available is optimal can then be analysed in two stages. Firstly, we identify the minimum variance frontier, which is the hyperbola in Figure 2, and represents those portfolios with the lowest risk for a given level of return. In other words, each point on this curve is associated with a set of weights, w_i, for a subset of *i* securities chosen from the investment universe, where these weights minimise the portfolio variance for a given level of portfolio expected return (μ). Formally, it is solution to the following quadratic programme:

Min $\sigma_p^2 = \sum_i \sum_j w_i w_j \sigma_{ij}$

subject to $\sum_i w_i r_i = \mu$

and $\sum_i w_i = 1$

[7] Lowenfeld (1907).

[8] This theory was originated by Markowitz (1952). An accessible textbook introduction to portfolio optimization is Bodie, Kane and Marcus (2007), ch.7. Danthine and Donaldson (2005), ch.6, is a more advanced treatment.

The efficient frontier is that part of the hyperbola which lies above the minimum variance portfolio (MVP). The intuition here is that any investor will do better to diversify his wealth across a basket of securities, thereby reducing his risk for a given target return. This process will push him to hold a portfolio represented by a point on the efficient frontier.

At the second stage, we identify which portfolio on the efficient frontier investors should choose by assuming that any investor's objective is to maximise his return for a given level of risk. Investors are interested in the portfolio return achieved in excess of the benchmark risk-free asset, such as Consols, which earns a risk-free return. This objective is graphically represented by the line, known as the capital allocation line (CAL), which intersects the y-axis at the risk-free rate (r_f) and forms a point of tangency (P) with the efficient frontier. The slope of this line is equivalent to the expected return on the portfolio (μ) in excess of the risk-free return (r_f) relative to the standard deviation of the portfolio return (σ_p). This is the Sharpe ratio, and is expressed algebraically as:

$$S_p = \frac{\mu - r_f}{\sigma_p}$$

The optimisation problem confronting the rational investor now becomes:

Max $\quad S_p = \frac{\mu - r_f}{\sigma_p}$

subject to $\quad \sum_i w_i = 1$

and $\quad w_i \geq 0$ (short sale constraint)

where w_i.is the weight of the i^{th} security in the portfolio. Again the solution generates a set of weights, w_i^*, of those securities comprising the optimal portfolio, P. These weights are the optimal weights. The portfolio P is also called the market portfolio, since it represents the aggregate portfolio of securities held by all investors, which equates to the market itself.

The intuition of this second stage is that the particular point on the efficient frontier chosen by the investor represents exactly that portfolio which maximises his return in excess of the risk-free asset for the risk taken. The optimal portfolio, P, has the highest Sharpe ratio given the expected returns, variances and covariances of all the securities, or assets, available to investors. A security has two chances to get into the optimal portfolio. The higher its return relative to other securities, the more likely it will be selected. In addition, the lower the contribution made to portfolio risk, the more likely it

will make the cut. Hence, in the case of individual domestic railways, modest return expectations might be compensated by their diversifying advantages when added to a portfolio.

Goetzmann and Ukhov (2006) applied such a theoretical framework in examining how investors would have diversified their portfolios in the pre-1913 period across a total of 19 domestic and foreign broad asset classes. Building on Edelstein's earlier finding that on a risk-adjusted basis investors were more than adequately compensated for investing overseas, and using the same sample, the authors concluded that British investors behaved rationally in acting on these attractive returns and allocating a large portion of their wealth to foreign assets.

More relevant to our line of enquiry, they found that rational investors on the eve of WW1 would have held absolutely no domestic railway securities at all.[9] This is, perhaps, unsurprising given the substantial deterioration in railway returns from the late 1890s onwards, both relative to the benchmark asset, Consols, as discussed above, and to other sectors. Average returns of railway ordinary and preference shares were the poorest amongst domestic sectors with the exception of the insignificant Canals and Docks, and were considerably below those on foreign railway shares.[10] Railway debenture returns, although in line with other domestic sector returns, were inferior to foreign debenture returns by a considerable margin.

In this paper, we examine two related questions regarding domestic railway investment. Firstly, we disaggregate the domestic railway asset classes into their constituent securities, and consider which individual railway securities a rational investor would have held as part of his optimal portfolio, given the considerable cross-sectional variation in total returns described above. Secondly, we identify the point at which he would have begun to reduce his domestic railway exposure in such a portfolio. The decline in their relative returns described above suggests that domestic railway shares were more attractive investments before the turn of the century than afterwards.

We assume that late Victorian investors had mean-variance preferences, were unable to sell short, and maximised their portfolio's Sharpe ratio. The available investment universe comprised 7 domestic asset classes, excluding domestic railways, and 8 foreign asset classes, as represented by the Edelstein sample. This part of the

[9] Goetzmann and Ukhov (2006), Table XI, Panel A. In fact, Panel B shows that had they been able to do so, investors would have been substantial short sellers of the domestic railway ordinary share asset class.
[10] Ibid., Tables IX, X and XI.

sample is similar to that utilized by Goetzmann and Ukhov (2006).[11] In place of the 3 domestic railway asset classes, we substituted the 33 domestic railway securities, consisting of 15 ordinary shares, 6 preference shares and 12 debentures, (see Appendices 1 and 2). This makes a total of 48 assets available for investment.

Given the expected real returns, the variances and the co-variances of these 48 assets, we estimate the weights allocated to individual domestic railway securities given a rational investor maximised his portfolio's Sharpe ratio. We assume investors required at least fifteen years of returns history in order to formulate their returns expectations. Portfolios are then optimized for various periods, all of which start in 1870, and end in any year between 1884 and 1913, as we extend one year at a time the period over which an investor computed his return expectations. The detail of the optimization procedure is described in Appendix 2.

[INSERT TABLE 3]

The weights of each railway security included in the optimal portfolio are summarised in Table 3. There is a mixture of ordinary and preference shares and debentures, although ordinary shares predominate. Some of the weights such as GWR are very small and insignificantly different from zero as indicated by the bootstrap standard errors in brackets. Overall, the railway portfolio holdings chime with our estimates of railway economic returns. Long-term holdings, TVR and the LSWR, were two of the stronger economic performers, whereas the ordinary shares of poor economic performers such as MSLR(GCR) were never included in the portfolio. Although LNWR, one of the most reputable railways, only saw its ordinary and preference shares feature briefly and insignificantly in the portfolio, its debentures claimed a more substantial 3% holding.

[INSERT FIGURE 3]

[11] The 7 domestic asset classes are the ordinary shares of domestic Banking and Finance, Light Industry and Commerce, Heavy Industry, and Infrastructure, the preference shares of domestic Manufacturing and Commerce, and the debentures of domestic Municipals, and Infrastructure. We excluded the domestic industrial debenture sector because there were too many missing variables. The 8 foreign asset classes are the ordinary shares of foreign Railways, Banking and Finance, Infrastructure, and Tea and Coffee Plantations, and the debentures of Colonial Governments, Colonial Municipals, foreign Railways, and foreign Infrastructure. We excluded the domestic industrial debenture sector because there were too many missing variables.

Edelstein (1982) concluded that foreign assets earned superior risk-adjusted returns, and that domestic railway ordinary shares were a particularly poor investment.[12] However, this was the position looking back from 1913. Our analysis enables us to look at how the investment environment evolved in the years leading up to 1913. Summing our results for individual railway security weights in the optimal portfolio for each period (RAIL WT, Table 3), a clear picture of the decline in the domestic railway allocation emerges (Figure 3). The total weight fluctuates between 23% and 32% from 1884 to 1897, and then falls away sharply to a level of 2 to 3%.[13] In contrast, the allocation to foreign railway securities, predominantly debentures, increased steadily from a level of 6% for the period ended 1884 through to 40% on the eve of WW1 (results not shown). Thus, the rational investor would have produced the sort of portfolio that Edelstein's earlier analysis suggested, but would have started out in the 1880s with the relative weightings in domestic and foreign railways substantially reversed.

Whilst we have focused on deteriorating returns as the main determinant of the decline in the domestic railway weighting, it would appear that the risk characteristics of these securities were unable to rescue the situation. Inclusion of domestic railways after the turn of the century failed to lower overall portfolio risk sufficiently to warrant their inclusion.[14]

The poor relative price performance of railway securities after 1897 indicates that some investors undoubtedly did sell their railway holdings. Phoenix Assurance, for example, reduced its domestic railway weighting from 10% in 1890 to 2.6% in 1900, and then to 1.3% in 1913.[15] Notwithstanding this selling, railways remained the largest single quoted sector accounting for over a quarter of the market in 1913. Domestic railways had declined from 26.4% in 1873 to 14.2% in 1913 of the nominal values of all quoted

[12] Edelstein (1982), ch.5.
[13] Other than the solitary Taff Vale ordinary shareholding of 1%, our optimisation results for the whole period 1870-1913 are similar to Goetzmann and Uhkov's results in omitting domestic railways in favour of foreign railways. Although we adopt a slightly different procedure to them (see Appendix 2), the non-railway sector weights are also similar to those of the top 3 ranked portfolios in their constrained case, pp.289-290, Table X, Panel A.
[14] Beta is the simplest measure of the contribution of a stock to overall portfolio risk. However, the small number of the annual returns and the lack of a suitable world equity index makes the estimation of individual security betas with any degree of accuracy a hazardous business. An examination of the correlation matrix of returns on the 48 assets and securities, however, suggests the absence of diversifying properties among domestic railways. This matrix is available on request.
[15], Trebilcock (1998), Table 1.6, pp.73.

ordinary, preference and debenture securities, excluding British government securities.[16] In comparison, foreign railways increased their overall weight from 24.8% to 34.3%.

Why then did other investors hold on to their railway securities? It was certainly not because they expected to be able to exert any influence through their votes. Hannah (2007) claims that, following the adoption by British railways of democratic rules of corporate governance dating from 1845, there was little point in any investor accumulating a large block of ordinary or preference shares, and incumbent managements effectively held control.[17] Investors therefore could only express their dissatisfaction with underperforming managements by "exiting", in other words, selling their shares.

The fact that more investors did not sell is down to their unwillingness to revise their return expectations downwards. Rather, they clung to the belief that railway securities after 1898 would bounce back and do just as well as they had in the earlier part of this pre-1913 period. Thus, in 1901, *The Economist* counseled its readers as follows:

"When all is said, however, it is hard to believe that the prosperity of British railways is a thing of the past, or even that a permanent reduction of dividends of more than moderate extent is to be regarded as inevitable."[18]

The most vociferous critic of the domestic railway sector was *The Investors' Review*, as widely regarded as the *Investor's Monthly Manual*, and carrying far more financial commentary. This journal bemoaned the inability of railway management to control capital expenditures and working expenses. However, they reserved their most stinging criticisms for the senior management themselves.[19] Yet, as late as 1909, the

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[16] These weightings are based on the *Stock Exchange Daily Official List* figures quoted in Michie (2001), Table 3.3. British government securities, as the risk-free asset, are excluded in the denominator. Any change in weights, of course, reflects both the relative amount of new issues as well as relative price changes.

[17] Hannah (2007), pp.409. According to the author, 1 vote per £100 stock for the initial holding of £1,000; 1 vote per additional £500 thereafter up to £10,000; and beyond £10,000, only 1 vote per additional £1,000. Most industrial firms preferred 1 share 1 vote (footnote 26).

[18] *The Economist*, "Are Home Railway Stocks Cheap?" 17 August, 1901, pp.1238.

[19] *The Investors' Review*, "The Home Railway Position", 17 February, 1906, pp.199: "We cannot look at such figures without feeling that there is a lack of business perspicacity in the management of our railways. They are still amateurish in many respects, presided over by great landowners and gentlemen of means….and the presiding directorate too frequently stands in the way of thorough reform, of good account keeping, of careful husbandry in finance." See also "State Ownership of the Railways", 15 February, 1908, pp.205, poor management "is tending to reduce the railways to a state of unprofitableness unexampled in the history of this branch of modern scientific development in any other part of the world".

magazine despaired of the vast majority of investors investing the time and effort to understand the degree of mismanagement taking place.[20]

Inadequate monitoring of management by railway investors may be evidence of their not choosing to maximise the risk-return trade-off, or the Sharpe ratio. One possible reason for not doing so was the existence of the above-mentioned Trustee Acts, which restricted the type of security into which any trustee was permitted to invest. Prominent in this list of eligible securities along with British government debt, Indian railway securities, water company stocks, municipal borough stocks, and Colonial stocks were domestic railway debenture and preference stocks.[21] As mentioned above, their eligibility created considerable investor demand for these securities in the 1890s, and, thereafter, they remained popular with trustees not least because their perpetual status made yield calculations straight forward.[22]

In criticising these Acts for their resulting lack of diversification, Lowenfeld (1907) gave an example of a Trustee stock portfolio of 10 securities which included 3 domestic railway securities. Some investors were, therefore, trapped in supposedly low risk, but low return assets. Consequently, they were denied the opportunity of reducing their domestic railway exposure, and of investing in a higher returning, diversified portfolio of securities whilst still achieve modest overall investment risk.

[20] *The Investors' Review*, "Why Home Rails Refuse to Rise", 29 September, 1909, pp.363: "Even now we doubt if one railway shareholder in five thousand has really taken the trouble to master what a loose and free and easy treatment of the capital account is coming to mean to him."
[21] Burdett's *Stock Exchange Official Intelligence* 1914, pp.1698-1700. Eligibility was conditional upon a railway company having paid a dividend on its ordinary shares in each of the last ten years. However, ordinary shares were not eligible.
[22] *The Economist*, "The Range of Yield on British Railway Trustee Stocks" 4October, 1903.

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Table 1: Annual Total Returns to Ordinary Shares, Preference Shares and Debenture Stocks of British Railways, 1870-1913

Total returns are defined as capital returns in real terms plus the dividend yield for the calendar year. See text.

Panel A: Railway Ordinary Shares

		EWMEAN	CR	GER	GNR	GWR	LBSCR	LCDR	LYR
1870-1913	MEAN	4.33%	4.10%	4.07%	3.42%	5.62%	6.53%	1.94%	2.47%
	STDEV	10.07%	14.81%	14.21%	9.05%	14.49%	17.06%	22.43%	9.04%
1870-1897	MEAN	7.66%	8.61%	8.56%	5.57%	9.39%	11.17%	3.63%	4.90%
	STDEV	9.80%	16.05%	15.06%	7.98%	16.51%	18.68%	24.13%	8.64%
1898-1913	MEAN	-1.51%	-3.80%	-3.79%	-0.32%	-0.99%	-1.60%	-1.00%	-1.77%
	STDEV	7.77%	7.81%	8.19%	9.81%	6.16%	9.78%	19.47%	8.34%

		LNWR	LSWR	ISLR/GC	MR	NBR	NER	SER	TVR
1870-1913	MEAN	4.28%	4.45%	1.96%	4.51%	5.35%	4.20%	4.04%	5.60%
	STDEV	8.04%	8.99%	21.70%	8.39%	20.68%	9.42%	11.84%	7.88%
1870-1897	MEAN	7.29%	8.49%	4.52%	6.70%	9.12%	7.05%	7.91%	8.02%
	STDEV	7.22%	7.18%	20.99%	6.74%	23.83%	9.92%	10.44%	7.53%
1898-1913	MEAN	-0.97%	-2.62%	-2.51%	0.67%	-1.24%	-0.78%	-2.72%	1.35%
	STDEV	6.73%	7.42%	22.87%	9.76%	11.43%	5.96%	11.35%	6.74%

Panel B: Railway Preference Shares

		EWMEAN	GERP	GNRP	GWRP	LNWRP	MRP	NERP
1870-1913	MEAN	3.71%	4.21%	3.73%	3.79%	3.53%	3.64%	3.34%
	STDEV	5.74%	6.70%	5.93%	5.94%	5.58%	5.75%	5.45%
1870-1897	MEAN	6.80%	7.63%	6.82%	6.96%	6.53%	6.65%	6.20%
	STDEV	3.55%	4.90%	3.84%	3.92%	3.57%	3.51%	3.37%
1898-1913	MEAN	-1.70%	-1.77%	-1.66%	-1.76%	-1.72%	-1.64%	-1.66%
	STDEV	4.75%	5.06%	5.06%	4.65%	4.50%	5.09%	4.74%

Panel C: Railway Debentures

		EWMEAN	CRDB	GERDB	GNRDB	LCDRDB	LYRDB	LNWRDB
1870-1913	MEAN	3.47%	3.42%	3.53%	3.16%	4.58%	3.20%	3.40%
	STDEV	5.51%	5.67%	5.68%	5.53%	5.84%	5.64%	5.79%
1870-1897	MEAN	6.32%	6.36%	6.53%	6.05%	7.43%	6.09%	6.45%
	STDEV	3.37%	3.55%	3.61%	3.51%	4.02%	3.89%	3.93%
1898-1913	MEAN	-1.80%	-1.74%	-1.72%	-1.89%	-0.39%	-1.87%	-1.94%
	STDEV	4.65%	5.00%	4.78%	4.77%	5.23%	4.56%	4.53%

		LBSCRDB	MSLRDE	MRDB	NBRDB	NERDB	SERDB	CONSOLS
1870-1913	MEAN	3.47%	3.53%	3.25%	3.48%	3.19%	3.42%	2.24%
	STDEV	5.68%	5.90%	5.67%	5.57%	5.53%	5.66%	4.75%
1870-1897	MEAN	6.46%	6.28%	6.23%	6.44%	6.14%	6.51%	4.64%
	STDEV	3.85%	3.77%	3.70%	3.42%	3.67%	3.18%	4.86%
1898-1913	MEAN	-1.75%	-1.28%	-1.96%	-1.70%	-1.95%	-2.00%	-1.96%
	STDEV	4.46%	5.96%	4.70%	4.80%	4.36%	4.95%	4.98%

Table 2: Railway ordinary share dividends paid (% par value), dividend yields, capital returns and total returns

Total returns are defined as capital returns in real terms plus the dividend yield for the calendar year. See text. In the case of LBSCR, NBR, GNR, and MR and MSL/GCR, the dividends from 1883, 1888, 1891, and 1897 are those received on deferred ordinary shares.

Panel A: Dividends paid (% par value) – 5 year moving average.

	EWMEAN	CR	GER	GNR	GWR	LBSCR	LCDR	LYR	LNWR	LSWR	MSL/GCR	MR	NBR	NER	SER	TVR
1872	5.1	2.86%	0.68%	6.95%	4.83%	2.18%	0.00%	7.35%	7.28%	5.31%	2.35%	6.65%	0.00%	7.78%	4.26%	10.40%
1877	5.2	5.58%	0.75%	5.73%	4.03%	5.33%	0.00%	5.73%	6.58%	5.63%	2.50%	5.58%	1.40%	7.08%	5.50%	11.00%
1882	5.7	3.95%	1.65%	4.95%	5.63%	4.75%	0.00%	4.85%	7.28%	5.71%	2.53%	5.88%	2.93%	7.88%	5.50%	15.90%
1887	5.1	4.20%	2.23%	4.48%	5.68%	4.05%	0.00%	3.90%	6.58%	5.28%	1.95%	5.05%	3.10%	5.98%	4.85%	13.55%
1892	4.5	4.33%	2.25%	3.45%	5.93%	7.20%	0.00%	3.80%	6.60%	6.03%	1.85%	5.65%	0.83%	6.23%	4.23%	7.50%
1897	4.4	4.85%	3.00%	1.85%	5.20%	6.50%	0.00%	5.01%	6.68%	6.50%	0.68%	4.73%	0.90%	6.25%	4.48%	7.16%
1902	3.8	4.03%	3.18%	0.85%	5.03%	4.70%	0.00%	3.95%	6.00%	5.90%	0.00%	2.63%	1.45%	5.73%	2.49%	8.38%
1907	3.8	3.50%	2.95%	1.60%	5.28%	4.50%	0.00%	3.90%	6.05%	5.78%	0.00%	2.58%	0.90%	5.70%	2.60%	8.74%
1910	3.9	3.20%	2.83%	1.90%	5.48%	4.30%	0.00%	4.05%	6.25%	5.75%	0.00%	3.03%	0.55%	5.85%	3.08%	8.61%

Panel B: Dividend yields (%) – 5 year moving average.

	EWMEAN	CR	GER	GNR	GWR	LBSCR	LCDR	LYR	LNWR	LSWR	MSL/GCR	MR	NBR	NER	SER	TVR
1872	3.60%	2.86%	1.56%	5.06%	4.36%	2.73%	0.00%	4.92%	4.89%	4.94%	3.24%	4.75%	0.00%	4.58%	4.19%	5.91%
1877	3.68%	4.87%	1.42%	4.60%	3.87%	4.23%	0.00%	4.35%	4.54%	4.34%	3.20%	4.27%	1.00%	4.72%	4.28%	5.57%
1882	3.60%	3.72%	2.38%	4.07%	4.06%	3.72%	0.00%	3.82%	4.28%	4.26%	2.90%	4.28%	1.75%	4.64%	4.27%	5.83%
1887	3.39%	3.84%	3.17%	3.82%	3.88%	3.22%	0.00%	3.36%	3.88%	3.86%	2.66%	3.81%	1.93%	3.71%	3.80%	5.96%
1892	3.11%	3.63%	2.70%	3.01%	3.70%	4.73%	0.00%	3.45%	3.82%	3.45%	2.66%	3.68%	0.51%	3.89%	3.49%	3.87%
1897	2.76%	3.23%	2.60%	3.23%	3.09%	3.65%	0.00%	3.47%	3.36%	3.05%	1.49%	3.54%	0.51%	3.57%	3.05%	3.60%
1902	2.88%	3.49%	3.33%	2.03%	3.62%	3.82%	0.00%	3.57%	3.69%	3.53%	0.00%	3.88%	1.01%	3.84%	2.66%	4.69%
1907	3.22%	3.24%	3.98%	3.51%	4.12%	4.58%	0.00%	4.01%	4.19%	3.99%	0.00%	4.07%	0.63%	4.17%	3.47%	4.40%
1910	3.51%	3.88%	4.31%	3.91%	4.50%	4.57%	0.00%	4.45%	4.63%	4.31%	0.00%	4.65%	0.44%	4.60%	3.89%	4.52%

Table 2: Railway ordinary share dividends paid (% par value), dividend yields, capital returns and total returns (cont.)

Panel C: Capital returns (%) – 5 year moving average.

	EWMEAN	CR	GER	GNR	GWR	LBSCR	LCDR	LYR	LNWR	LSWR	MSL/GCR	MR	NBR	NER	SER	TVR
1872	8.47%	8.43%	3.09%	5.29%	18.12%	19.38%	14.30%	-2.60%	4.37%	5.00%	10.80%	2.41%	17.87%	7.12%	9.08%	4.39%
1877	4.06%	4.57%	10.32%	-0.64%	1.97%	10.16%	5.53%	-0.51%	1.56%	4.61%	3.98%	1.36%	11.49%	-0.46%	4.01%	2.89%
1882	0.88%	-0.06%	3.80%	-1.34%	4.91%	-1.23%	-5.95%	-1.19%	2.81%	-1.39%	-0.73%	0.11%	5.28%	2.54%	-0.35%	5.92%
1887	4.22%	6.04%	5.50%	2.68%	5.42%	7.17%	5.20%	1.85%	2.27%	5.11%	5.36%	2.69%	10.89%	2.45%	2.41%	-1.72%
1892	-0.26%	1.70%	-0.52%	-1.63%	-3.48%	1.90%	-2.31%	-0.28%	1.10%	6.03%	-6.05%	2.30%	-5.84%	0.33%	1.59%	1.21%
1897	1.70%	1.97%	10.70%	1.17%	-0.01%	1.11%	7.51%	5.03%	2.29%	0.92%	-9.59%	2.18%	2.41%	0.66%	1.05%	-1.96%
1902	-4.35%	-6.93%	-6.27%	-7.08%	-3.75%	-5.98%	-6.68%	-5.39%	-5.41%	-6.15%	3.73%	-6.43%	5.45%	-5.71%	-7.55%	-1.08%
1907	-5.60%	-6.17%	-9.03%	-1.94%	-4.32%	-6.13%	-10.50%	-5.24%	-4.26%	-4.40%	-8.46%	-3.31%	-9.94%	-2.56%	-7.57%	-0.19%
1910	-2.10%	-7.10%	-8.23%	1.39%	-4.97%	-4.31%	12.50%	-5.82%	-4.50%	-7.00%	2.57%	2.42%	1.97%	-5.54%	0.43%	-5.34%

Panel D: Total returns (%) – 5 year moving average.

	EWMEAN	CR	GER	GNR	GWR	LBSCR	LCDR	LYR	LNWR	LSWR	MSL/GCR	MR	NBR	NER	SER	TVR
1872	12.07%	11.29%	4.65%	10.35%	22.48%	22.10%	14.30%	2.31%	9.27%	9.94%	14.04%	7.16%	17.87%	11.70%	13.26%	10.30%
1877	7.74%	9.44%	11.74%	3.95%	5.84%	14.39%	5.53%	3.83%	6.10%	8.95%	7.18%	5.64%	12.49%	4.26%	8.29%	8.46%
1882	4.47%	3.65%	6.17%	2.73%	8.97%	2.50%	-5.95%	2.64%	7.09%	2.87%	2.17%	4.39%	7.03%	7.18%	3.91%	11.75%
1887	7.62%	9.88%	8.67%	6.50%	9.30%	10.39%	5.20%	5.21%	6.15%	8.96%	8.02%	6.50%	12.82%	6.16%	6.21%	4.25%
1892	2.84%	5.33%	2.18%	1.38%	0.22%	6.63%	-2.31%	3.17%	4.92%	9.49%	-3.39%	5.98%	-5.33%	4.22%	5.08%	5.07%
1897	4.46%	5.19%	13.30%	4.39%	3.08%	4.76%	7.51%	8.51%	5.65%	3.97%	-8.10%	5.72%	2.91%	4.23%	4.10%	1.63%
1902	-1.47%	-3.44%	-2.94%	-5.04%	-0.13%	-2.16%	-6.68%	-1.82%	-1.73%	-2.62%	3.73%	-2.54%	6.46%	-1.87%	-4.88%	3.61%
1907	-2.38%	-2.92%	-5.04%	1.57%	-0.20%	-1.55%	-10.50%	-1.24%	-0.08%	-0.41%	-8.46%	0.76%	-9.31%	1.61%	-4.09%	4.21%
1910	1.68%	-2.94%	-3.70%	5.37%	-0.18%	0.44%	12.50%	-1.06%	0.42%	-2.44%	2.57%	7.58%	2.68%	-0.64%	4.64%	-0.05%

Table 3: Weights (%) of railway securities included in optimal portfolios

The table reports the weights in the optimal portfolio for periods beginning 1870. See Appendix 1 for list of railway securities. N is the total number of holdings including the non-railway sectors, and RAIL N is the number of railway holdings. RAIL WT is total railway weighting. For periods ending 1906 onwards, the TVR ordinary share weight ranged between 0.010 and 0.024. There were no holdings in 1907. Bootstrap standard errors are in parentheses (10,000 draws).

PERIOD	N	RAIL N	RAIL WT	ORD									DEBS			PREFS	
				GER	GWR	LBSCR	LNWR	LSWR	MR	NBR	TVR	LCDR	LNWRDB	MSLRDB	NBRDB	LNWRP	NERP
1884	20	7	0.327	0.006		0.005				0.013	0.261	0.015			0.021		0.005
				(0.005)		(0.006)				(0.007)	(0.046)	(0.015)			(0.018)		(0.011)
1885	24	9	0.279	0.006		0.005				0.013	0.212	0.004			0.014	0.007	0.017
				(0.006)		(0.007)				(0.007)	(0.039)	(0.008)			(0.014)	(0.012)	(0.021)
1886	22	7	0.241	0.011		0.007				0.014	0.156	0.030			0.009		0.014
				(0.008)		(0.007)				(0.008)	(0.032)	(0.023)			(0.012)		(0.019)
1887	26	11	0.324	0.007		0.010	0.003			0.017	0.159	0.046		0.001	0.019	0.006	0.056
				(0.006)		(0.008)	(0.006)			(0.008)	(0.029)	(0.029)		(0.003)	(0.016)	(0.010)	(0.027)
1888	25	10	0.312	0.007		0.007	0.005			0.012	0.131	0.039		0.002	0.022	0.009	0.077
				(0.005)		(0.007)	(0.008)			(0.006)	(0.026)	(0.026)		(0.005)	(0.017)	(0.012)	(0.030)
1889	23	9	0.319	0.008		0.007				0.011	0.121	0.035		0.006	0.019	0.011	0.102
				(0.005)		(0.007)				(0.005)	(0.024)	(0.022)		(0.009)	(0.014)	(0.014)	(0.032)
1890	23	10	0.236	0.014		0.006	0.002			0.006	0.084	0.043		0.013	0.010	0.004	0.054
				(0.007)		(0.006)	(0.004)			(0.004)	(0.020)	(0.025)		(0.013)	(0.011)	(0.008)	(0.024)
1891	26	13	0.264	0.013		0.004		0.002	0.011	0.003	0.090	0.034	0.020	0.005	0.010	0.003	0.071
				(0.007)		(0.005)		(0.003)	(0.007)	(0.002)	(0.021)	(0.022)	(0.015)	(0.007)	(0.010)	(0.006)	(0.029)
1892	23	11	0.313	0.010		0.004		0.007	0.009		0.091	0.054	0.022	0.015	0.024	0.001	0.075
				(0.005)		(0.004)		(0.007)	(0.007)		(0.020)	(0.025)	(0.015)	(0.013)	(0.016)	(0.003)	(0.026)
1893	22	10	0.290	0.007		0.006		0.021	0.006		0.077	0.066	0.037	0.006	0.018		0.046
				(0.004)		(0.006)		(0.011)	(0.005)		(0.019)	(0.027)	(0.019)	(0.008)	(0.013)		(0.020)
1894	23	11	0.230	0.008	0.003	0.007		0.024	0.005		0.075	0.043	0.035	0.003	0.010		0.017
				(0.004)	(0.003)	(0.006)		(0.011)	(0.005)		(0.017)	(0.020)	(0.018)	(0.006)	(0.009)		(0.012)
1895	22	10	0.238	0.009	0.003	0.010		0.030	0.006		0.087	0.039	0.034	0.011			0.010
				(0.005)	(0.002)	(0.007)		(0.013)	(0.005)		(0.019)	(0.019)	(0.017)	(0.010)			(0.009)
1896	22	10	0.239	0.009	0.002	0.009		0.031	0.004		0.097	0.035	0.037	0.011			0.006
				(0.005)	(0.002)	(0.006)		(0.012)	(0.004)		(0.020)	(0.017)	(0.019)	(0.011)			(0.006)
1897	20	10	0.254	0.010	0.003	0.008		0.057	0.008		0.102	0.023	0.035		0.006		0.002
				(0.005)	(0.003)	(0.005)		(0.016)	(0.007)		(0.020)	(0.014)	(0.018)		(0.007)		(0.004)
1898	22	8	0.158	0.008		0.013		0.057	0.009		0.049	0.007	0.013		0.002		
				(0.005)		(0.008)		(0.016)	(0.008)		(0.015)	(0.007)	(0.011)		(0.005)		
1899	19	7	0.075	0.005		0.004		0.019	0.002		0.033	0.006	0.005				
				(0.004)		(0.003)		(0.010)	(0.003)		(0.012)	(0.008)	(0.006)				
1900	20	7	0.039	0.002				0.009	0.002		0.017	0.002	0.004		0.004		
				(0.002)				(0.006)	(0.003)		(0.008)	(0.004)	(0.005)		(0.005)		
1901	15	3	0.018					0.003			0.013		0.003				
								(0.003)			(0.006)		(0.004)				
1902	16	4	0.022					0.005			0.012	0.002	0.002				
								(0.005)			(0.006)	(0.003)	(0.004)				
1903	17	4	0.022					0.002			0.015	0.003	0.002				
								(0.003)			(0.007)	(0.003)	(0.004)				
1904	16	3	0.027					0.002			0.023	0.002					
								(0.003)			(0.008)	(0.002)					
1905	16	3	0.035					0.004			0.028	0.003					
								(0.004)			(0.008)	(0.004)					

Figure 1: Total Real Returns to Railway Securities 1870-1913

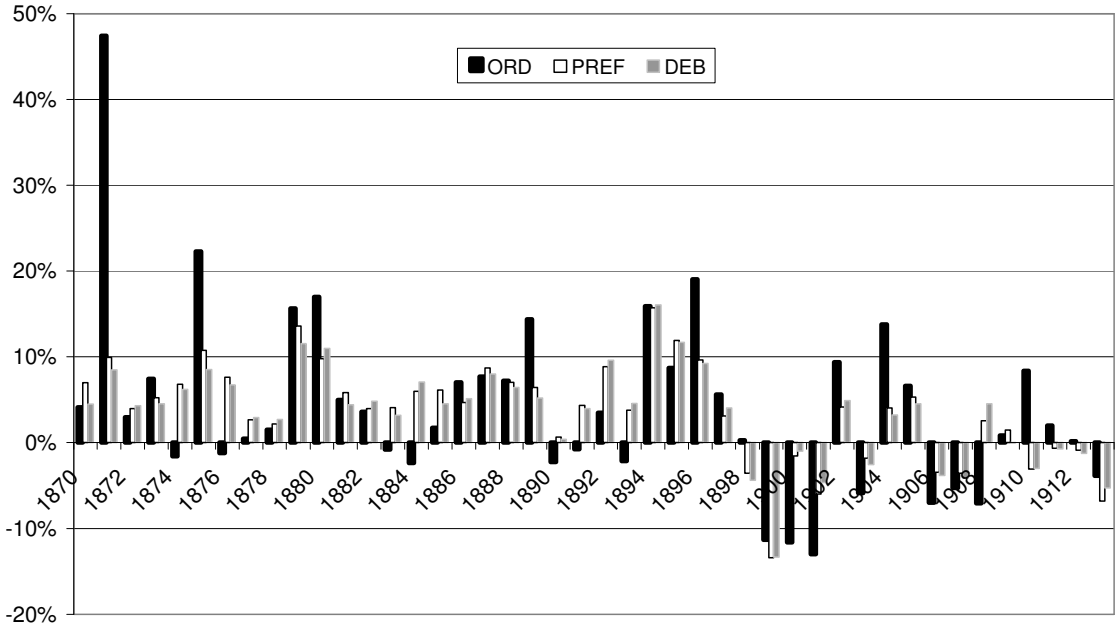


Figure 2: Efficient Frontier and Optimal Portfolio

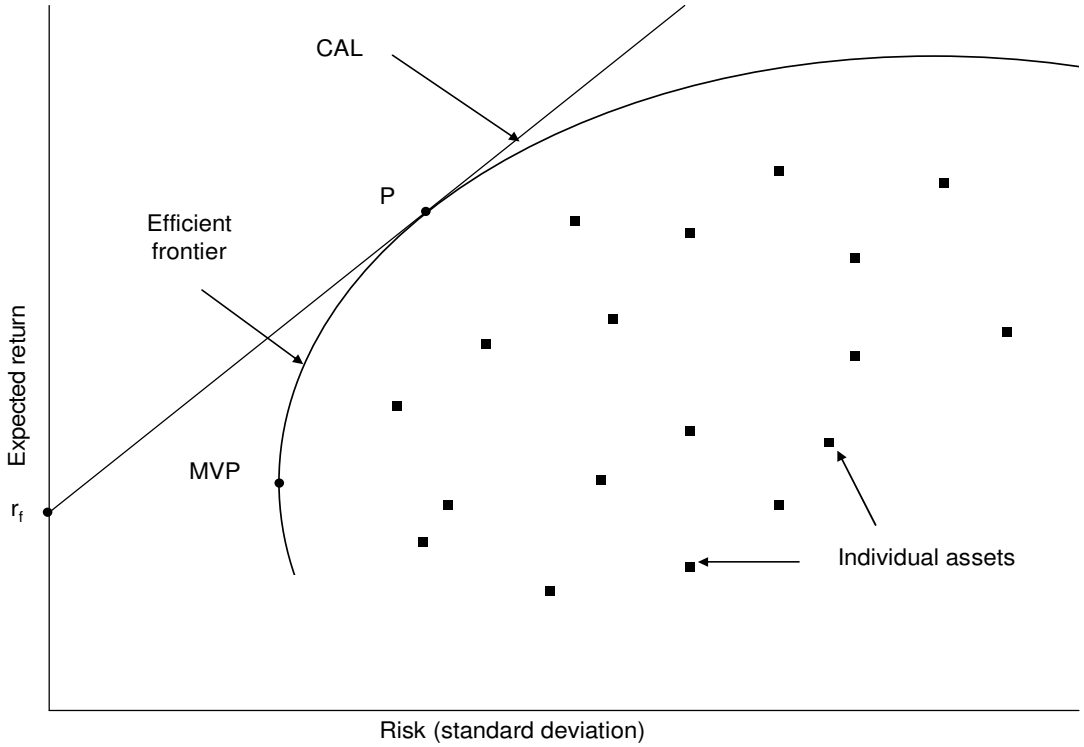
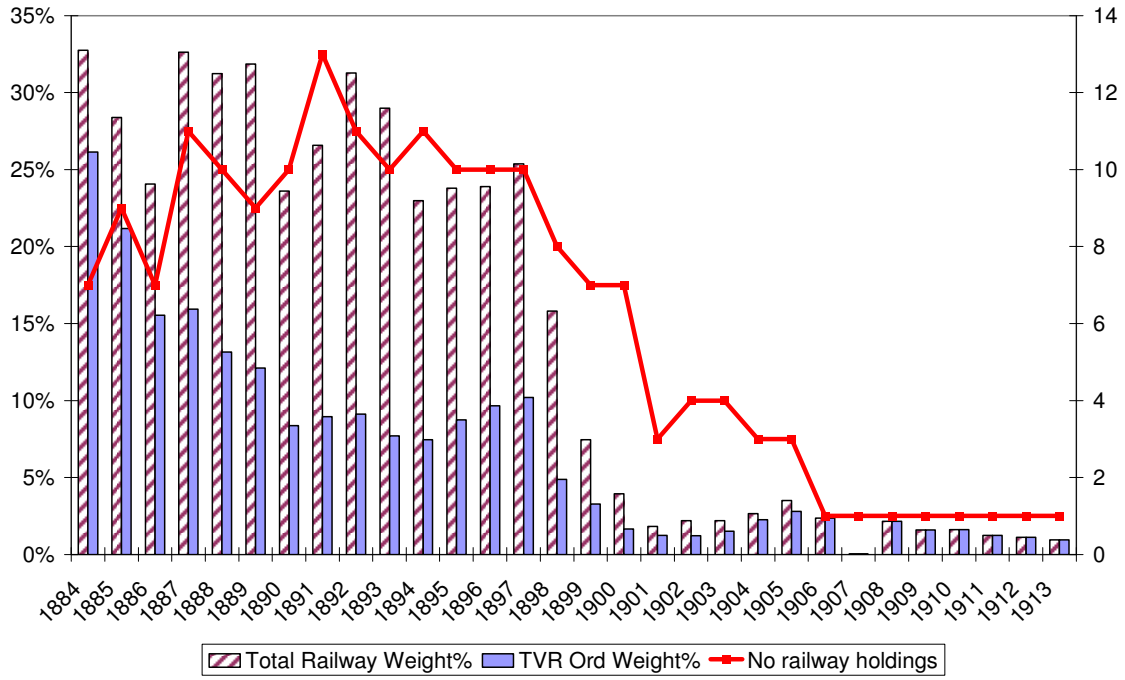


Figure 3: Total weighting in domestic railway securities

The bars report the sum of the weights given to individual railway securities in the optimal portfolio for various periods beginning in 1870 and ending in the year indicated on the horizontal axis. The detail of individual railway weights is reported in Table 3.



Appendix 1: Quoted securities of Domestic Railway Companies

CODE	SECURITY
(i)	**ORDINARY SHARES**
CR	***Caledonian Railway***
GER	***Great Eastern Railway***
GNR	***Great Northern Railway***
GWR	***Great Western Railway***
LBSCR	***London, Brighton & South Coast Railway***
LCDR	***London Chatham & Dover Railway***
LYR	***Lancashire & Yorkshire Railway***
LNWR	***London & North Western Railway***
LSWR	***London & South Western Railway***
MSLR/GCR	***Manchester Sheffield & Lincolnshire Railway (Great Central Railway)***
MR	***Midland Railway***
NBR	***North British Railway***
NER	***North Eastern Railway***
SER	***South Eastern Railway***
TVR	***Taff Vale Railway***
(ii)	**PREFERENCE SHARES**
GERP	***Great Eastern Railway***
GNRP	***Great Northern Railway***
GWRP	***Great Western Railway***
LNWRP	***London & North Western Railway***
MRP	***Midland Railway***
NERP	***North Eastern Railway***
(iii)	**DEBENTURES**
CRDB	***Caledonian Railway***
GERDB	***Great Eastern Railway***
GNRDB	***Great Northern Railway***
LBSCRDB	***London, Brighton & South Coast Railway***
LCDRDB	***London Chatham & Dover Railway***
LYRDB	***Lancashire & Yorkshire Railway***
LNWRDB	***London & North Western Railway***
MSLR/GCRDB	***Manchester Sheffield & Lincolnshire Railway (Great Central Railway)***
MRDB	***Midland Railway***
NBRDB	***North British Railway***
NERDB	***North Eastern Railway***
SERDB	***South Eastern Railway***

Appendix 2: Optimisation Procedure

The optimal weights resulting from this type of portfolio optimization technique are sensitive to minor changes in the expected returns of the assets. Consequently, to improve the precision of our estimates we employ a bootstrapping procedure, similar to Jorion (1985) and Goetzmann and Ukhov (2006). According to this procedure, repeated and random draws from the distribution of returns are made for each asset or security. On each draw, the vector of expected returns and the variance-covariance matrix is estimated, and the optimal portfolio weights computed. From the resulting distribution of optimal weights, we calculate their mean values and the standard errors.

Goetzmann and Ukhov (2006) assumed that investors held a maximum of 7 assets in their portfolio, each asset consisting of a diversified portfolio of securities in a given sector. They then estimated optimal portfolios for all possible subsets of 7 assets drawn from a total of 19 assets in the investable universe. Finally, they ranked each of these portfolios by their Sharpe ratio. We depart from their approach in not assuming that investors held a maximum of 7 assets. This assumption seems less plausible once we allow individual railway securities into our investable universe such that the total number of assets rises from 19 to 48.

We therefore proceeded as follows. For each of the 30 periods beginning in 1870 and ending in a year between 1890 and 1913, we first optimised using all 48 assets, bootstrapping 1000 times. We then dropped those assets with a zero, or virtually zero weight, that is less than 0.1%. The remaining number of assets, including railway securities, varied between 14 and 26 assets (see col.2, Table2). Using the expected returns and variance-covariance matrix of the remaining assets, we ran the optimisation once more, again bootstrapping 1,000 times. The resulting optimal weights for domestic railway securities and the foreign railway sector are those reported in Table 3. Due to lack of space, we do not report the weights for the other sectors.

As a robustness check we ran the reduced form optimizations bootstrapping 10,000 times for 1884, 1889, 1894, 1899 and 1904. The resulting optimal weights were similar to those reported and are available on request.

We do not believe our results are sensitive to the dropping of certain non-domestic railway sectors in the reduced form optimizations because their zero weights. A minimum of 11 of these 15 sectors were always included. The sectors most frequently excluded because of their unattractive return and risk characteristics were domestic infrastructure equity and debentures, world infrastructure equity and colonial government debentures.