Myopic Rationality in a Mania

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Abstract

The rationality of investors during asset price bubbles has been the subject of considerable debate. An analysis of the British Railway Mania, which occurred in the 1840s, suggests that investors may have been myopic, as their expectations were only accurate in the short-term, but they remained rational, as they acted in a utility maximising manner given their expectations. Investors successfully incorporated forecasts of short-term dividend changes into their valuations, but were unable to predict longer-term changes. When short-term growth is controlled for, it appears that the railways were priced consistently with the non-railways throughout the entire episode.

Keywords: Railway Mania, myopic rationality, bubbles, dividends

JEL: G01, G11, G12, N23

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Asset price reversals have been a feature of financial markets for many centuries, with periods such as the Tulip Mania, the South Sea Bubble, and the Wall Street Crash being prominent examples. The 'Dot-Com Bubble' and 'Housing Bubble' have led to a renewed interest in such episodes, with popular commentary often associating them with irrationality and mispricing. However, economists have tended to seek explanations in terms of rational behaviour.

To analyse this issue it is helpful to differentiate between what investors expected, and how they acted given those expectations. One approach to examining a bubble episode has been to focus on whether prices were similar to some assessment of a rational expectation, which in many cases resolves into a discussion of investors' lack of foresight, and why they regarded this time as being different. Such an analysis is usually a consideration of whether investor expectations were myopic, meaning that they focussed on the short-term, and were unable to form accurate forecasts of the long-term.

However, it may also be insightful to consider investor behaviour in terms of procedural rationality, which considers whether investors maximised their utility, given their subjective expectations. Investors may be regarded as rational if they ensured that at any time each asset reflected only their expectations of the sum of discounted cash flows. This would imply that each asset was priced consistently with other assets, after controlling for investor expectations of fundamental factors such as dividends, growth and risk. By extension, assets in one industry should have been priced consistently with other industries, after accounting for such factors. Using this definition, it is possible that investors were both myopic, as their expectations may have been short-sighted, and rational, as their actions given those expectations were utility maximising.

This paper argues that in an historical asset price reversal, known as the British Railway Mania, investors had this combination of myopia and rationality. During this episode, which occurred in the 1840s, and which the *Economist* (2008) has referred to as 'arguably the greatest bubble in history', the prices of railway shares changed substantially. A new dataset has been collected from primary sources for this analysis, which consists of weekly stock price and dividend data for every railway that was listed and operating during this period, and a sample of non-railway companies.

The myopia of investor foresight is considered by analysing the relationship between share prices and future dividend growth. The results suggest that companies with a relatively low dividend yield generally went on to experience higher dividend growth during the next few years, as would be expected from standard asset pricing theory. However, there is little evidence of higher longer-term dividend growth, which may imply that investors had imperfect foresight, and were only able to forecast short-term dividend changes.

The rationality, or consistency, of pricing is analysed in a series of 417 cross-sectional regressions, one for each week of the period between 1843 and 1850, relating the cross-sectional variation in dividend yields to future growth and risk. The inclusion of a dummy variable distinguishes the differences between railway stocks, which experienced a substantial price reversal, and non-railway assets, which did not. When future growth is not controlled for, the railways appear to have had significantly higher share prices than the non-railways for a total of 80 weeks. However, when several years of future growth are controlled for, this apparent overpricing is entirely eliminated. These results suggest that given investors' myopic expectations, they acted rationally by pricing the railways consistently with other assets.

The sources of myopia are then discussed, by considering the short dividend history of the railways, the heterogeneity of opinion in the media, and why investors failed to predict the changes in economic growth, the widespread expansion of the railway network, and the revelation of accounting manipulation which eventually occurred. Ex-ante, the negative impact of these changes was difficult to forecast, which allowed asset prices to initially increase. It was only when new information became available that investors revised their expectations, leading to share price declines.

The analysis in this paper expands our understanding of why asset price reversals occur. Previous research has suggested that factors such as irrational exuberance (Shiller, 2005), the widespread adoption of new technology (Pástor and Veronesi, 2009), limits to arbitrage (Shleifer and Vishny, 1997, Ofek and Richardson, 2003, Abreu and Brunnerheimer, 2003), and 'riding a bubble' (Blanchard and Watson, 1983, and Temin and Voth, 2004) may contribute to the rise and fall of asset prices. This paper suggests that myopic rationality may also play a considerable role in such episodes with investors pricing assets consistently given the available information, but their expectations were primarily based on what would happen in the short-term.

These arguments are related to the concept of an 'intrinsic bubble' (Froot and Obstfeld, 1991), which suggests that investors over-react to dividend changes. However, this paper argues that it is not so much an over-reaction to past dividend changes, as myopic expectations of future dividend changes, which is of importance. Prices moved in advance of dividends throughout the Mania, suggesting that investors were using a range of information to predict future growth, rather than responding to experienced dividend announcements. Myopia has been offered as a possible explanation for the equity premium puzzle (Benartzi and Thaler, 1995), but it has not been developed as a reason for bubble episodes.

More generally, this paper contributes to the body of research on historical asset price bubbles, such as the long-term analysis of Reinhart and Rogoff (2009), and the episode specific research on periods such as the Tulip Mania of 1636 (Garber, 2001), the South Sea Bubble of 1720 (Dale et al., 2005) the German stock market boom of 1927 (Voth, 2003), the Wall Street boom of the late 1920s (Donaldson and Kamstra, 1996), and the Nasdaq bull market of the 1990s (Pástor and Veronesi, 2006). The analysis in this paper particularly adds to existing research on the Railway Mania from Odlyzko (2010) who has argued that it was an example of market inefficiency, from Bryer (1991) and Arnold and McCartney (2003) who have debated whether it was a 'swindle' designed to expropriate investors, and from Casson (2009), who has discussed how it resulted in the inefficient duplication of railway lines and overexpansion of the network.

This paper is organised as follows. Section 1 examines the related literature on the definition of bubbles, Section 2 provides a brief background to the Railway Mania, Section 3 discusses the data used, whilst Section 4 estimates the movement in stock prices and dividends during this period. Section 5 considers investor foresight, Section 6 examines the cross-sectional relationship between prices, growth and risk, Section 7 examines the pricing of the new railways, Section 8 discusses the sources of myopia during this episode, Section 9 considers the relationship of myopia to other theories, with Section 10 being a brief conclusion.

1 Bubbles and Rationality

As noted by O'Hara (2008), there has been some ambiguity about the meaning of the term bubble, with previous academic literature generally using two definitions. The popular usage of the term, per Kindleberger (2000, p.16), is an 'upward price movement over an extended range that then implodes', or what Bordo and Jeanne (2002) have described as an 'asset price reversal'. By using this first definition it is relatively easy to detect and label a bubble ex-

post, simply by an observation of nominal prices. As will be demonstrated below, the Railway Mania can be classed as a bubble using this criteria, as there was a considerable stock price reversal during this period.

However, the economic definition of a bubble is a deviation from fundamental value (Flood and Hodrick, 1990, p.88). This occurs when the price of an asset is different from its discounted sum of cash flows. The detection of irrational pricing is still controversial as fundamental value is not necessarily observed directly, making it difficult to conclude that prices have diverged from this value. Two broad approaches have been taken to deal with this difficulty. Neither of these approaches are definitive tests of whether a bubble did or did not exist, but they do provide insights into the characteristics of suspected bubble episodes.

One approach has been to focus on expectations, by considering whether the forecasts of growth or uncertainty implied by asset prices were unrealistic (see Pástor and Veronesi, 2006, and Voth, 2003). Various econometric tests have also been proposed for the detection of bubbles, including variance bound tests (Shiller, 1981), the comparison of the 'actual' relationship and a theoretical 'constructed' relationship between prices and dividends (West, 1987), co-integration tests which determine the orders of integration of prices and dividends (Diba and Grossman, 1988) and the relationship between the dividend yield and the level of dividends (Froot and Obstfeld, 1991). This paper considers the accuracy of investor foresight during the Railway Mania by examining the relationship between prices and future growth. It concludes that investors were myopic, with accurate short-term forecasts, but inaccurate longer-term forecasts.

Another approach has been to consider whether investors acted rationally by pricing assets consistently. Dale et al. (2005) have argued that several assets issued by the South Sea

company were not priced consistently with each other. Lamont and Thaler (2003) have found that during the Dot-Com Bubble the pricing of technology stock carve-outs violated the law of one price. In the context of the Railway Mania, it could be argued that if investors were rational and a bubble did not exist, the railways should have been priced consistently with the non-railways. Consistency of pricing would suggest that railway stock prices were determined by the same fundamental factors as non-railway stock prices, whilst inconsistency could suggest an irrational preference for the railways. This paper goes on to test the consistency of pricing during the Railway Mania by analysing whether railway stock prices were significantly different from other industries, after controlling for growth and risk. It argues that given investors' myopic expectations, the railways were priced consistently with other assets.

2 Background to Railway Mania

The first modern passenger railway was the Liverpool and Manchester, which was promoted in 1824, authorised by Parliament in 1826, and opened in 1830. Over the subsequent decade about another sixty railways were constructed, with most of the lines projected during a minor promotion boom in 1836 and 1837. However, further promotion was subdued until the early 1840s. A period known as the Railway Mania then ensued, with share prices rising substantially from 1843 to 1845, and then falling steadily until 1850.

The initial phase of the Mania was associated with strong economic growth, and a low rate of interest, with 3 per cent Consols, government debt perpetuities, reaching par for the first time for over a century (*Economist*, April 13, 1844, p.674). A widespread reduction in fares, combined with the economic conditions, produced a rapid increase in passenger numbers and revenues for the railways. Between 1843 and 1846, first class traffic on the ten largest railways increased by 33 per cent, whilst second class and third class traffic increased by 68

per cent and 187 per cent respectively. This resulted in an overall increase in passenger receipts of 41 per cent, whilst receipts from goods traffic also increased, by 42 per cent (*Parliamentary Papers*, 1847, LXIII, p.179). These increases in traffic and receipts were achieved with a relatively small increase of 25 per cent in the mileage open of the largest lines.

The downturn in asset prices, beginning in the autumn of 1845, coincided with the discovery of a potato blight, and defective harvest, which led to an economic downturn, the repeal of the Corn Laws, and the Irish Famine. A financial crisis then followed in 1847, which involved distress amongst many banks and merchants, and led to a further reduction in economic growth (Evans, 1849).

The initial falls in share prices also followed a dramatic increase in the promotion of new railway lines, which reached unprecedented levels in the autumn of 1845. Some estimates suggested that over one thousand new railways were promoted at this time (*The Times*, November 17, 1845, p.4). Those lines which Parliament authorised were constructed during the latter half of the decade, leading to a substantial expansion in the railway network. These new lines exposed existing railways to the threat of competition, and tended to earn lower returns on capital.

Between 1847 and 1850 railway receipts continued to rise, with an increase of 17 per cent in passenger receipts for the ten largest railways, and a rise of 101 per cent in receipts from transporting goods, which resulted in an overall increase in receipts of 44 per cent (*Parliamentary Papers*, 1851, LI, p.229). However, the mileage open amongst these ten largest railways had more than doubled, rising by 110 per cent, and the resulting increase in operating expenses and issue of equity reduced the dividends per share.

Commentary throughout the period suggested that dividends were regarded as an important consideration in the valuation of railway stocks. For example, the *Economist* (November 8, 1845, p.1109) noted that 'with regard to the finished and dividend paying lines, they are of course calculated so as to yield a given rate of interest which must always have some reference to the rate which other securities yield, and so far the price of shares should fluctuate with other securities.' Similarly, an investment pamphlet entitled the *Short and Sure Guide to Railway Speculation* advised that 'as regards the purchase of shares in the established lines we have simply to compare the market price of the share with the dividend which it pays' (Anon., 1845, pp.5-6). It went on to note that 'taking the value of money at four per cent, the shares in a railway which pays six per cent per annum are worth £150 each; or in one which pays ten per cent they are worth £250 each. If bought below these prices, the purchaser is receiving, *pro tanto*, a better rate than four per cent, and he will accept this better rate, in proportion to any doubt he may have with respect to the dividend being maintained.'

3 Data

To improve our understanding of the Railway Mania, a unique and comprehensive dataset has been constructed, by inputting the original share price tables published in a weekly newspaper, the *Railway Times,* between 1843 and 1850. The share price dataset was supplemented with data on dividends, collected from the *Course of the Exchange*, an official stockbroker list for the London stock market, and from supplementary tables in the *Railway Times*. As this paper focuses entirely on those companies which were capable of paying dividends during the boom, only the railways in operation at the beginning of the Mania, and the firms which resulted from mergers involving these lines, are included. The pricing of the new railways are considered in Section 7.

There were 64 railways listed in the *Railway Times* in the first week of 1843. However, there was dividend data on only 39 of these railways. Due to a high number of mergers and acquisitions, the number of railway companies fell throughout the sample. If an established railway, in existence at the start of 1843, participated in a merger then the new company was also treated as an established railway and it was assumed that investors in the original company went on to receive the dividend of the merged firm. By the end of 1850 there were 25 established railways listed in the *Railway Times*, and dividend data was available for 22 of these railways.

Data on the 22 largest non-railway companies by market capitalisation was also obtained from the *Course of the Exchange*. The sample includes Bank of England stock, India stock, six banks, five insurance companies, three canals, three docks, two gas, light, and coke companies, and one waterworks company included. These companies represented 70.2 per cent of total non-railway market capitalization at the beginning of 1843, suggesting that they give a good representation of the overall market.

The number of shares in issue *(N)*, the share price *(P),* the par value *(Z),* and the dividend *(D)* for each of the securities was recorded for each of the 417 weeks in the sample period. The logs of each variable are expressed in lower case letters. To enable the analysis of dividend changes beyond the main sample period the dividend rates of companies until 1856 were included in the dataset.

Fama and French (1992) suggest that risk dimensions can be proxied by beta, size and book-to-market variables. Rather than using portfolio formation, the beta and size of each firm has been controlled for directly by including these variables in the regressions, due to the relatively small number of companies involved in this sample. The beta (*B*) of each firm has

been estimated for each company for the 52 weeks preceding the end of each year, by regressing the weekly returns of each asset minus the risk free rate, against the weekly returns of the market portfolio minus the risk free rate. The market portfolio has been approximated by the non-railways' market index, which is likely to be more representative of a portfolio of all assets than a stock market index which is dominated by the railways. It is also consistent with the approach of Pástor and Veronesi (2009) when calculating the beta of the early US railroads. For robustness the beta has also been re-calculated using a market portfolio consisting of both the railways and non-railways, and results using both estimates of beta are reported. The results are generally similar and do not affect the conclusions. The risk-free rate has been approximated by the yield on 3 per cent Consols.

The size *(S)* of the company has been measured as the total par value of the firm, calculated as the number of shares in issue multiplied by the par value of each share, and expressed in £millions. The par value of a share was the total amount of equity which shareholders had paid to the company for that security, and is considered as a proxy for book value. As another measure of pricing relative to fundamentals will be used in the following analysis, namely the dividend yield, the book-to-market variable is not considered. A railway dummy variable *(R)* has also been created, which equals one when the company was a railway, and zero otherwise.

Only those companies which had been traded, and had an observable share price, could be included in the analysis, which reduced the sample size slightly. This was most pronounced at the beginning of the sample with eleven companies not being traded at all during 1843. During the remainder of the period an average of 4.8 companies could not be included as they had not traded. As a zero dividend yield does not reveal any information about pricing, an

average of 3.0 observations had to be excluded due to some established companies not paying a dividend. The pricing of these zero dividend companies will be considered in Section 7.

The average number of companies analysed each week in the cross-sectional regressions was 41.8, which involved a total of 17,412 observations over the sample. When periods of future dividend growth are included, these figures are reduced slightly due to data availability. For regressions involving two years of dividend growth the average number of companies was 36.9, and for those involving six years of dividend growth there was an average of 33.5 companies.

4 Movement of Stock Prices and Dividends

Weekly market indices for the established railway companies and the non-railway companies, for which share price and dividend data are available, have been constructed and are plotted in Figure 1. In each case the market return has been calculated on a weekly basis by weighting the capital gains of each company by its market capitalisation at the end of the preceding week.

<<INSERT FIGURE 1>>

The index representing the established railways rose from a base of 1,000 in January 1843 to a peak of 1,717 on August 8, 1845, but the non-railways index had risen to just 1,158 by this time. The established railway index then fell substantially, declining by 18.4 per cent by the end of November 1845, whilst the non-railways fell by 4.3 per cent during the same period. The established railway index then stabilised throughout 1846, before beginning a steady decline from January 1847 onwards, with the sample ending in 1850 with the established railway index at 734, and the non-railway index at 1,126.

Figure 2 illustrates the weekly return on established railway shares, showing that the boom period of the Mania was characterised by moderate, positive, returns. Volatility tended to be higher during the downturn, particularly during the initial decline in prices in the autumn of 1845, and during 1848 when there were concerns about the impact of the French Revolution, and the amount of construction which the railways were undertaking.

<<INSERT FIGURE 2 >>

Whilst the prices of railway shares changed dramatically, railway dividends also rose and fell substantially. As can be seen from Figure 3, the dividends, as a percentage of par value, paid by established railways at the beginning of 1843 averaged 4.4 per cent. They then increased steadily, reaching a peak of 7.3 per cent in July 1847, before falling to just 2.9 per cent by the end of 1850. Higher dividends were evident in almost every one of the major railways during the boom, and dividend declines were almost universal during the downturn. The dividends paid by the non-railways were much less volatile, beginning 1843 at an average of 7.2 per cent, and remaining close to this level for most of the period, except during 1847 and 1848 when the average was raised by a higher Bank of England dividend rate. The peak in railway share prices occurred almost two years before the peak in railway dividends, perhaps suggesting that investors were including estimates of future dividend changes into prices before the rates had actually changed.

<<INSERT FIGURE 3 >>

The dividend/price ratios of the railway and non-railway industries are plotted in Figure 4. The railway industry dividend yield has been calculated as the total dividends paid by all the established railways as a fraction of the total market capitalisation of those railways, with the non-railways calculated in a similar manner. At the beginning of 1843 the dividend yields of

the railway and non-railway industries were close, being 4.6 per cent and 4.3 per cent respectively. Although railway prices and dividends both rose and then fell during the sample period, prices seem to have moved in advance of dividends, resulting in a changing dividend yield. The railway industry dividend yield initially fell, reaching a minimum of 3.3 per cent in February 1844, but then rose substantially, reaching a peak of 7.3 per cent in October 1848. During the same period, the non-railway industry dividend yield remained between 3.7 and 4.8 per cent.

<<INSERT FIGURE 4>>

Total return indices have also been constructed, which combine both capital gains and dividends, and are shown in Figure 5. The established railways total return index reached a peak of 1,898 in August 1845, and ended the sample period at a level of 1,067, implying that even after dividends have been included the total return to investors in established railways was close to zero between 1843 and 1850. In contrast, the non-railways reached a level of 1,566 in 1850, which was the peak for the sample period.

<<INSERT FIGURE 5>>

Descriptive statistics for each of the key variables included in the subsequent regression analysis have been reported in Table 1, by industry and by year. The mean dividend yield of the railways shows more change over time than that of the non-railways, with the railways having a relatively lower yield from the end of 1843 to 1846, before a dramatic rise gave them a relatively higher yield from 1847 to 1849. For the railways, dividends grew consistently during the boom, but then declined by an average of over 30 per cent per year, for two years during the downturn, which was much more volatile than the non-railways. The

standard deviation of dividend changes was also greater amongst the railways than the non-railways in every year of the sample.

<<INSERT TABLE 1>>

The size variable, reported in Table 1, reveals that the average par value of non-railways was greater than that of the railways at the start of the period, although much of this was due to the size of the Bank of England. Throughout the Mania the railways continued to expand, but the non-railways remained relatively stable, resulting in the railways ending the sample period an average of over three times as large. The average beta of the railways based on a market portfolio of non-railway shares, peaked in 1845, whilst the beta based on a market portfolio of railways and non-railways had peaks in 1844 and 1850.

5 Investor Foresight

To analyse pricing during the Railway Mania a standard asset pricing relationship is considered, based on the traditional Gordon (1962) dividend growth model. Although the relationship between dividends and price is linear in this model, the relationship with the other variables, namely the discount and growth rates, is non-linear. To avoid this problem Campbell and Shiller (1988, p. 201) have proposed the dividend ratio model, or 'dynamic Gordon model', shown in Equation 1, which is linear in logs. This expresses the log of the dividend-price ratio (δ) as the expected discounted value of future discount rates (r) and dividend growth rates (Δd), with several terms which can be treated as constants (ρ, c, and k). ρ is the average ratio of the price to the sum of the price and the dividend, c is the risk premium in stock returns, and k is a term which makes the equation hold in levels.

$$\delta_t \approx E_t \sum_{j=0}^{\infty} \rho^j \left(r_{t+j} - \Delta d_{t+j}\right) + \frac{c-k}{1-\rho} \quad (1)$$

The rest of this paper uses this relationship to examine both investor foresight, and the consistency of pricing, during the Railway Mania. One approach to considering the accuracy of investor foresight has been to illustrate the association between two of the variables from Equation 1, namely the dividend yield and future dividend growth, as per Campbell and Shiller (1998). Figure 6 plots the relationship between the log of the dividend yield and the dividend growth for railway companies between t and t + 1 year, for each company in the sample, with one observation per company at the end of each year of the sample. The negative correlation, of -0.650, implies that companies with a low dividend yield, meaning a relatively high price, went on to experience relatively higher growth during the subsequent year.

<< INSERT FIGURE 6 >>

Table 2 reports fixed effects panel regressions which explain future dividend growth, for a range of horizons, using the log of the dividend yield, controlling for beta and size. There is one observation for each railway company, for the end of each year. The results suggest that a low dividend yield was a significant predictor of higher growth in dividends between t and t+1, and between t+1 and t+2. This confirms that the relationship between relatively high prices and high short-term dividend growth was significant, as would be suggested by standard asset pricing theory, which implies that investors had a degree of foresight in their valuations of railway shares during this period.

<< INSERT TABLE 2 >>

For longer term changes in dividends, the effect of the dividend yield is reversed, with the dividend yield having a positive and significant relationship with dividend changes between t+3 and t+4, and t+4 and t+5, which may suggest that investors were mistaken about longer term changes in dividends. This suggests a lack of long-term foresight, which may help to explain why asset prices rose and fell, rather than incorporating all future growth into their calculations from the beginning.

These results suggest that investors during the Railway Mania incorporated short-term future dividend fluctuations into their valuations, but they were unable to forecast longer-term changes. This represents a possible explanation for why the prices of railway shares rose and fell during the Railway Mania. Investors during the boom responded to expectations of short-term increases in dividends, and did not forecast the longer-term declines, leading them to raise prices. When investors eventually did revise their expectations, and began to forecast lower dividends, prices began to fall. This implies that the myopic nature of investor expectations may have played an important role in the development and bursting of the Mania.

6 Consistency of Pricing

The previous section considered expectations, and suggested that investors during the Railway Mania had imperfect foresight with regards dividend changes. This section considers rationality in terms of procedure, and examines whether investors priced different assets consistently given their expectations. A cross-sectional regression for each week of the sample is used to estimate the relationship between the variables in Equation 1 at particular times during the Railway Mania.

The log of the dividend yield (δ), is expressed as a function of future dividend growth (Δd), with differences in the discount rate approximated by the risk factors of beta (B), and size (S),

as shown in Equation 2. A dummy variable for the railways (R) is also included to reveal if there was a significant difference between the railways and non-railways.

For week = t

$$\delta_{i,t} = \beta_0 + \beta_1 E_t\left(\Delta d_{i,t+n}\right) + \beta_2 B_{i,t} + \beta_3 S_{i,t} + \beta_4 R_i + \varepsilon \quad (2)$$

A cross-sectional regression is estimated for each week, with Table 3 reporting the coefficients and standard errors for regressions without the inclusion of any dividend growth variable, on selected weeks, as an example. A regression for the start of the period, the last week of each year and for the peak in prices on August 8, 1845 is shown. This analysis was repeated for each of the 417 weeks of the sample period, with the last column reporting the number of weeks during which each variable was significant.

<< INSERT TABLE 3 >>

Panel A of Table 3 reveals that when the variation in the log of dividend yields are analysed, without controlling for dividend growth, and using the beta calculated using the non-railways as the market portfolio, the railway dummy was significant for 168 weeks. This consists of 80 weeks when the railway dummy was significantly less than zero, which in this specification implies a relatively higher price, and 88 weeks when the railway dummy was significantly greater than zero, implying a relatively lower price.

To estimate the extent of mispricing whenever future dividend growth has been accounted for, the cross-sectional regressions have been extended by the inclusion of varying numbers of future changes in dividends. In Panel A of Table 4 the number of weeks that each variable was significant when explaining the log of the dividend yield is reported. The next year of dividend growth was significant for between 253 and 379 weeks, depending on the number of

future changes included, with the second year of dividend growth significant for between 217 and 262 weeks. Longer-term growth measures are significant on a relatively small number of weeks. The number of weeks that the railway dummy was significant declines from 168 weeks to between 56 and 61 weeks, when one or two years of dividend growth are controlled for.

<< INSERT TABLE 4 >>

Table 5 analyses the number of weeks that the railway dummy was significant, by year, and considers whether this implied that the railways were overpriced or underpriced, given that the other variables had been controlled for. The railways were estimated to be overpriced during a particular week when the railway dummy was significantly less than zero, and underpriced when the railway dummy was significantly greater than zero. Results are shown for the number of weeks of overpricing and underpricing when varying numbers of years of dividend growth are accounted for.

<< INSERT TABLE 5 >>

When no future dividend growth was controlled for, the railways appear to have been significantly overpriced for 80 weeks, which represented 19.2 per cent of the full sample period. This implies that a simplistic comparison of dividend yields would lead to the conclusion that the railways were not priced consistently with the non-railways for a sustained period during the Railway Mania. However, when two years of dividend growth are included this apparent overpricing is entirely eliminated, with the railway dummy implying zero weeks of overpricing.

Panel A of Figure 7 illustrates this result, and shows that when the next two years of dividend growth are considered, the coefficient of the railway dummy remains very close to zero throughout the boom in prices, and is never significantly less than zero. These results imply that if investors were basing their valuations on their expectations of short-term dividend growth, they priced railway assets consistently for almost the entire duration of the Railway Mania.

<< INSERT FIGURE 7 >>

If longer-term dividend growth is considered, the apparent overpricing of the railways reappears. For example, when variables accounting for growth up to six years ahead are included, the railway dummy suggests that the railways had a significantly higher price than the non-railways for 41 weeks of the sample. These results imply that when short-term dividend changes are considered, the railways were priced consistently with the non-railways, but when longer-term changes are controlled for, the railways may have been overpriced for a substantial period.

When the beta was estimated based on a market portfolio consisting of both railways and non-railways, the railway dummy was much less likely to be significant when no future dividend growth was included, as shown in Panel B of Tables 3 and 4, and Table 6, showing the lack of power of the railway dummy using this specification. When calculating beta with the railways representing a major component of the market index, the relationship between the railways and the market portfolio appears stronger, and beta becomes a proxy for differences between the industries. This leads to a multicollinearity problem when both beta and the railway dummy are included in the same regression, making it less likely the railway dummy will be significant. However, the key results of importance remain the same.

Consistent with the other specification of beta, the railways are not overpriced at all during the boom when two years of dividend growth are included, but overpricing reappears when longer term dividend growth is included. Regardless of which specification of beta is used, the results support the hypothesis that railway and non-railway assets were priced consistently when short-term dividend growth is considered, but not when longer-term changes are included.

Given our ex-post view of what happened to longer-term dividends we may be led to the conclusion that investors had no justification for their actions. However, the ex-ante situation of investors, who saw that dividends were rising, and successfully forecast that they would continue to rise in the short-term, was very different. Given their expectations, based on the available information, they believed they were pricing the railways consistently with other assets. This suggests that their behaviour may be best described as myopic, but rational.

7 New Railways

The previous sections have analysed the asset price reversal which took place amongst the established railways, but there was also a substantial number of new railways promoted, many of which were listed on the stock market. These companies had to obtain Parliamentary authorisation for their route, construct their lines, and begin operating, before they could earn revenues. This process generally took several years, meaning that during the promotion boom none of these new companies did, nor could be expected to, pay dividends. This makes their relative valuation more difficult.

An additional complication is that the shares in these new companies were paid in instalments, whereby investors made a small initial deposit and then paid the remaining ‘calls’ when capital was required for construction. The instalment structure of these shares meant that investors were purchasing a leveraged asset, which often magnified returns,

especially during the first day of trading. Dale et al. (2005) has shown that these partially paid shares can be modelled as future contracts. The price of an equivalent fully paid share can be calculated by taking the price of the partially paid share and adding the discounted sum of future calls. Similarly, the par value of an equivalent fully paid share can be calculated by taking the par value of the partially paid share and adding the discounted sum of future calls. This makes it possible to calculate the price/par ratio of equivalent fully paid shares.

The price/par ratio is an imperfect measure of valuation as it does not take account of differences in the dividends and growth of each company. However, it can be used as a basic approximation as it standardises prices by a common measure, the amount of capital which has been invested in the company. Table 7 shows the price/par ratio, at the end of each year and at the peak in prices, of established railways which were paying a dividend, of established railways which were not paying a dividend, and of the new railways. The discounted sum of calls has been calculated assuming that all calls were paid at the end of the sample period in 1850, using a discount rate of 3 per cent, which was close to the yield on Consols, and an approximation for the risk-free rate. Robustness tests suggest that the results are not sensitive to either the timing of calls or the value of the discount rate.

<< INSERT TABLE 7 >>

The results suggest that the new railways were not overpriced, with their price/par ratio being substantially lower than that of the established dividend-paying railways throughout the period. Similarly those established railways which were not paying a dividend had a much lower price/par ratio than those which were paying dividends. This provides further evidence that investors were pricing assets consistently, with those companies which were younger, riskier and not paying a dividend being given lower valuations. The changes in price/par

ratios also suggest that the prices of the new railways tended to move with those of the dividend-paying railways, suggesting that their prices were also influenced by the myopic expectations which investors had of the established railways.

8 Sources of Myopia

The results discussed in the previous sections suggest that during the boom phase of the Railway Mania, investors were unable to predict the eventual declines in dividends which would later occur. To place the changes of the Mania in context, the longer run trends in railway dividends are shown in Figure 8. The dividend rates of all railways listed in the *Course of the Exchange*, and the supplementary tables of the *Railway Times*, have been collected on an annual basis, and aggregated to calculate the dividend/par ratio of the railway industry. Average dividend rates are shown for when those young railways which had never paid a dividend thus far are excluded, and when they are included.

<< INSERT FIGURE 8 >>

8.1 Dividend History

Panel A of Figure 8 shows that few of the railway companies established prior to the Mania had a long dividend history. The majority of the railways began paying dividends only in 1840, just a few years before the Mania began. This suggests that investors could not base their expectations for each company on their historical record of dividend payment.

The dividend history of those companies which had been paying dividends during the 1830s, suggested that the railways could potentially earn high returns on capital. The average dividend rate throughout this decade had remained almost continually above 6 per cent, and had risen to over 7 per cent by 1840, as shown in Panel B of Figure 8. The Liverpool and Manchester had sustained a rate of between 9 and 10 per cent continually since 1835. It was

only when the younger companies began paying dividends in the early 1840s that the average fell. However, it would have been plausible that when these younger companies matured, their dividends would also rise.

The short dividend history of the railways was a possible source of investor myopia. The majority of railways had been in operation for just a few years, and those which had been operating for longer tended to pay high dividends. It was therefore not unrealistic for investors to expect dividends to rise, as they went on to do until 1847.

8.2 Economic Environment

The *Economist* (November 8, 1845, p.1109) had argued that whatever affected trade inevitably affected the traffic on the railways. Panel A of Figure 9, plots the relationship between annual changes in the dividend/par ratio of the railways, and GDP growth from 1832 to 1870 from Mitchell (2003, p.905-907). The changes in these variables indicate that there was a positive association between railway dividends and economic growth over the long-term, and Granger Causality tests imply that there was a significant relationship. It is therefore possible that investor expectations may have been affected by changes in the economy.

<< INSERT FIGURE 9 >>

In the 1840s the British economy was still largely dependent on agriculture, and the state of the money market often varied with the abundance of the harvests. The substantial crops of 1842-44 increased the wealth of the public and the capital available for investment, contributing to the boom. The downturn in asset prices beginning in October 1845 was associated with a potato blight and defective harvest which led to an economic downturn, the repeal of the Corn Laws, and the Irish Famine. The Bank of England also raised its discount

rate in October and November 1845, from 2.5 per cent to 3.5 per cent, in an attempt to steady the volume of gold being exported in payment for grain. These changes occurred rapidly, and would have been difficult to predict just a few months earlier, with the first references to the blight occurring in the *Dublin Freeman's Journal* on September 11, 1845, and the *Belfast Newsletter* on September 12, 1845. When investors did realise the problem in October 1845, share prices fell considerably.

These initial problems were compounded by the Commercial Crisis of 1847 during which many merchants failed, and trade suffered (Evans, 1849). Panel A of Figure 9 confirms that the late 1840s saw a sharp decline in both economic output and the dividends paid by the railways. Investors may have been able to forecast that an economic downturn would eventually arrive, but it would have been difficult for them to predict the severity of the problems which occurred in the latter half of the 1840s.

8.3 Expansion of Railways

A more permanent cause of the declines in railway dividends was the overexpansion in the railway network which resulted from the construction of lines projected during the Mania. The rise in railway share prices during the boom was followed by a dramatic increase in the promotion of new routes. Although Parliament only authorised a fraction of the promoted lines the length of track open increased from 2,057 miles in 1843, to 6,123 miles in 1850 (Mitchell, 2003, p.674). Panel B of Figure 9, suggests that there was a negative relationship between the opening of new railway track, and the change in railway dividends, and Granger Causality tests confirm there was a significant relationship. During both the earlier promotional boom of the 1830s, and the Railway Mania of the 1840s, a sharp increase in railway mileage was associated with declines in dividends.

Casson (2009) has suggested that the construction of the railway network was inefficient, compared to a counterfactual, with excessive duplication of lines. The most immediate impact of this duplication was to expose the established railways to the threat of competition, encouraging them to project their own lines. These new routes tended to earn lower returns than the original trunk lines. For example, a Committee of Inquiry into the York and North Midland Railway found that those parts of its network authorised before the Mania were yielding 7.0 per cent, those authorised in 1845 were yielding just 0.6 per cent, and those authorised in 1846 less than 0.1 per cent (*Railway Times*, November 3, 1849, p.1117).

The volume of railway construction was useful to the economy in terms of the social savings which accrued from shorter journey times (Leunig, 2006), but it was not beneficial to railway shareholders. Panel B of Figure 9 illustrates that the peak in the opening of new railway track in 1848, coincided with the most dramatic falls in railway dividends. During the subsequent two decades the rises in dividends were modest and rates barely returned to their pre-Mania levels. Previous research has suggested that returns on capital employed (Crafts, Leunig and Mulatu, 2008), and dividends (Mitchell, Chambers and Crafts, 2011, p.815) continued to remain low in the period prior to the First World War[1].

Investors may have found it difficult to predict how successful the newly promoted routes would be ex-ante, and how many new lines would be authorised. The promotion boom reached its peak immediately prior to the November 1845 deadline for the submission of proposals to Parliament, and coincided almost exactly with the market crash in railway share prices. This suggests that when investors realised the extent of expansion which would occur, they revised their expectations.

[1] Goetzmann and Ukhov (2006) have suggested that British railway securities would not have had any place in an optimal portfolio immediately prior to the First World War, but Mitchell, Chambers and Crafts (2011) have found that low share prices, producing high dividend yields, would have led to quite attractive returns between 1870 and the late 1890s, but not thereafter.

8.4 Heterogeneity of Opinion

The heterogeneity of media reporting may have been another source of myopia during the boom. *The Economist* and *The Times* were both sceptical of the Mania, and wrote a number of editorials which raised concerns about the number of new railway companies which were being promoted. The first analysis from the *Economist* came in April 1845, when they argued that the amount of new railway construction which had been proposed would divert capital from other uses, and have damaging consequences for the economy (*Economist*, April 5, 1845, p.310). *The Times'* negative commentary began in July 1845 with a similar concern, when they asked 'whence is to come all the money for the construction of the projected railways?' (*The Times*, July 1, 1845, p.4). However, this negative reporting did not have an immediate effect, with further price increases and an even greater rate of new company promotion for several months thereafter.

A possible reason for the lack of impact was that there was another section of the media, namely the railway-specific periodicals, which remained positive and provided heterogeneity of opinion. Even when the crash in prices did come in October 1845 the *Railway Times* maintained that it provided an opportunity to 'get the possession of valuable stock at reduced prices' (*Railway Times*, October 18, 1845, p.1961). Although investors could have appreciated that railway coverage by the railway press could have been biased, the fundamental factors appeared to support their views. The dividends paid by the established railways continued to increase, and would do so until 1847. With heterogeneity amongst the media, investors were required to form their expectations based on other factors, which contributed to their myopia.

8.5 Fraudulent Accounting

Another possible error of investors was to rely on dividends which were actually the result of accounting manipulation. Bryer (1991, p.456) has suggested that some companies may have

stopped including depreciation in their accounts in order to raise dividends, in an attempt 'to lure the naive into investing in railways'. There was considerable evidence of malpractice amongst companies which had been controlled by one chairman, George Hudson. However, Committees of Inquiries into other companies found little evidence of any major problems, and Arnold and McCartney (2003) have argued that the perception of widespread malpractice is more myth than reality.

The reason that investors may have trusted the dividends was that they had traditionally been a signal of firm performance. During the boom there was little suggestion of malpractice, and the first real evidence did not appear until 1849. This was almost four years after the peak in share prices, when allegations of fraud were made against Hudson, and share prices fell further as a result of this.

There were several sources of myopia which could have affected investor expectations during the Railway Mania. The expansion of the railway network, and changes in economic conditions were probably most influential, but the short dividend history of most railways, the heterogeneity of opinion in the media, and fraudulent accounting may have played some role. In each case the initial myopia of investors is understandable, as the extent of the changes was not clear at first. When investors did receive more information they responded by lowering prices, thus ending the boom of the Railway Mania.

9 Relationship to other Theories

Although myopic rationality may be the primary explanation for the development of the Railway Mania, it is possible that some other theories of asset price reversals may explain part of its development. A common explanation for 'bubble' episodes is that investors suffered from some form of irrational exuberance, as discussed by Shiller (2005). Irrational exuberance implies that investor expectations were not related to reality, whilst the myopic

explanation suggests that expectations were plausible, given the available information at the time, but that investors lacked foresight of longer-term changes. The evidence presented in the previous sections on the pricing of the established railways, and of the newly promoted railways, suggests that investor expectations were based on dividend growth which actually occurred, implying that irrational exuberance would not be an accurate description of investor expectations at this time.

A more recent explanation for the development of asset price reversals is the technological revolution hypothesis of Pastor and Veronesi (2009). This theory suggests that when there is a large scale adoption of a new technology, it leads to an increase in systematic risk, and therefore a decline in share prices for new technology firms. This is not necessarily inconsistent with myopic rationality, but the empirical predictions of the technological revolution hypothesis do not seem to be consistent with the British Railway Mania. The theory predicts that volatility and beta should both peak when railway shares reach their lowest point, which occurred in April 1850. However, Figure 2 suggests that volatility peaked in 1845 and 1848, and Table 1 implies beta also rose in 1844 and 1845, by whichever measure of beta is used. The technological revolution hypothesis also entirely fails to explain why dividends changed so dramatically during this period.

Speculation for short term capital gains, sometimes referred to as 'riding the bubble', has been discussed by Blanchard and Watson (1983) and Temin and Voth (2004). This suggests that although some investors expected prices to decline eventually, they still invested because they hoped they could sell to a 'greater fool'. Although this may be an accurate description of some investors, this theory cannot explain the initial price increases which began the bubble, nor why the bubble does not immediately collapse given that everyone knows that it must collapse soon. Consequently, although some investors may have speculated for short-term

capital gains, it was the myopia of other investors which was responsible for beginning and sustaining the price increases during the Railway Mania.

Limited arbitrage is another possible explanation for why a bubble can persist, as suggested by Shleifer and Vishny (1997), Ofek and Richardson (2003) and Abreu and Brunnerheimer (2003). This theory argues that informed investors may believe that prices are too high, but are unable to short stocks effectively, meaning they cannot sell assets which they do not own. This implies that some investors are pessimistic whilst others remain optimistic. The theory of limited arbitrage may help to explain why some investors who had greater foresight had little impact during the boom of the Railway Mania, but myopia explains why many investors retained their high expectations and continued to raise prices to their peak.

10 Conclusion

Using a comprehensive dataset of share prices and dividends for the established railways and non-railways which traded during the British Railway Mania, this paper has found that investors may have had myopic foresight, meaning that it was short-term in nature. An analysis of the relationship between the current dividend yield and future dividend growth suggests that investors incorporated short-term dividend changes into their valuations, but not longer-term changes.

A cross-sectional analysis, which considered whether the railways had a relatively higher price than the non-railways, suggests that when no future growth is accounted for, the railways appear to have been overpriced for a considerable period during the boom. However, when short-term future changes in dividends are included the apparent overpricing is entirely eliminated. When longer-term changes are considered the overpricing is evident again. These results suggest that investors had myopic rationality, meaning that although their

expectations were only accurate in the short-term, they acted in a utility maximising manner by pricing different assets consistently given those expectations.

The myopic nature of investor expectations was due to the short history of dividend payouts on which to base forecasts, heterogeneity of opinion amongst the media, and the inability of investors to predict changes in economic conditions, the rapid expansion of the railway network, and some instances of accounting manipulation. In each case, these developments would have been difficult to accurately predict ex-ante, which explains why the boom occurred initially. It was only when new information became available that investors revised their expectations, and railway share prices declined.

The finding that investors had myopic foresight may suggest that regulators could successfully intervene if they had greater foresight than other market participants. However, Bernanke (2002) has argued that this is questionable, and it may therefore be impractical to expect regulators to be able to forecast and prevent financial instability ex-ante, when investors cannot.

References

Abreu, D. and Brunnermeier, M.K. 2003, 'Bubbles and Crashes', *Econometrica,* 71 (1): 173-204

Anon. 1845. *A Short and Sure Guide to Railway Speculation, a Few Plain Rules How to Speculate with Safety and Profit in Railway Shares*, Effingham Wilson.

Arnold, A.J. and McCartney,S. 2003. 'It May Be Earlier Than You Think': Evidence, Myths and Informed Debate in Accounting History, *Critical Perspectives on Accounting* 14:227–253

Benartzi, S. And Thaler, R.H. 1995. Myopic Loss Aversion and the Equity Premium Puzzle, Quarterly Journal of Economics, 110(1): 73-92.

Bernanke, B. S. 2002. Asset-Price 'Bubbles' and Monetary Policy. Speech delivered at the New York Chapter of the National Association for Business Economics, New York, October 15.

Blanchard, O.J. and Watson, M. W. (1982) Bubbles, Rational Expectations and Financial Markets, in *Crises in the Economic and Financial Structure:* 295-316

Bryer, R. A. 1991. Accounting for the 'Railway Mania' of 1845–a Great Railway Swindle?, *Accounting, Organisations and Society,* 16(5/6): 439-486.

Bordo, M. D. and Jeanne, O. 2002. Monetary Policy and Asset Prices: Does 'Benign Neglect' Make Sense? *International Finance*, 5(2):139-64.

Campbell, J.Y. and Shiller, R.J. 1988. The Dividend-Price Ratio and Expectations of Future Dividends and Discount Factors. *Review of Financial Studies* 1(3):195-228.

Campbell, J.Y. and Shiller, R.J. 1998. Valuation Ratios and the Long-Run Stock Market Outlook. *Journal of Portfolio Management* 24(2):11-26

Casson, M., 2009, *The World's First Railway System: Enterprise, Competition, and Regulation on the Railway Network in Victorian Britain*, Oxford University Press.

Crafts, N., Leunig, T. And Mulatu, A. 2008, Were British Railway Companies Well Managed in the Early Twentieth Century? *The Economic History Review*, 61: 842–866.

Dale, R., Johnson, J.E.V. and Tang, L. 2005. Financial Markets can Go Mad: Evidence of Irrational Behaviour during the South Sea Bubble. *Economic History Review,* 58(2):233-271.

Diba, B. and Grossman, H. 1988. Explosive Rational Bubbles in Stock Prices? *American Economic Review,* 78:520-30.

Donaldson, R.G. and Kamstra, M. 1996. A New Dividend Forecasting Procedure that Rejects Bubbles in Asset Prices: The Case of 1929's Stock Crash. *Review of Financial Studies*, 9:333-383.

Economist. 2008. The Beauty of Bubbles, December 18.

Evans, D.M. 1849. *The Commercial Crisis, 1847-1848*, David and Charles, Devon.

Fama, E.F. and French, K.R. 1992. The Cross-section of Expected Stock Returns. *Journal of Finance,* 47(2): 427-465.

Flood, R.P. and Hodrick, R.J. 1990. On Testing for Speculative Bubbles. *The Journal of Economic Perspectives* 4(2): 85-101.

Froot, K.A. and Obstfeld, M. 1991. Intrinsic Bubbles: The Case of Stock Prices. *American Economic Review* 81(5):1189-1214.

Garber, P.M. 2001. *Famous First Bubbles, the Fundamentals of Early Manias*, MIT Press.

Goetzmann, W. N. and Ukhov, A. D. 2006. British Investment Overseas, 1870-1913: a Modern Portfolio Theory Approach, *Review of Finance*, 10: 261-300.

Kindleberger, C.P. 2000. *Manias, Panics, and Crashes: A History of Financial Crises*, John Wiley and Sons.

Lamont, O.A. and Thaler, R.H. 2003. Can the Market Add and Subtract? Mispricing in Tech Stock Carve-outs, *Journal of Political Economy*, 111(2): 227-268.

Leunig, T. 2006. Time is Money: A Re-Assessment of the Passenger Social Savings from Victorian British Railways. *The Journal of Economic History* 66: 635-673

Mitchell, B.R. 2003. *International Historical Statistics: Europe, 1750-2000,* Palgrave Macmillan.

Mitchell, B.R., Chambers, D. and Crafts, N. 2011. How Good was the Profitability of British Railways, 1870-1912. *Economic History Review*, 64(3): 798-831.

McCartney, S. and Arnold A. J. 2003. The Railway Mania of 1845-1847: Market Irrationality or Collusive Swindle Based on Accounting Distortions? *Accounting, Auditing and Accountability Journal* 16(5): 821-52.

Odlyzko, A. 2010. *Collective Hallucinations and Inefficient Markets: The British Railway Mania of the 1840s*, University of Minnesota.

Ofek, E. and Richardson, M. 2003, 'DotCom Mania: The Rise and Fall of Internet Stock Prices', *The Journal of Finance* 58 (3): 1113-1138.

O'Hara, M. 2008. Bubbles: Some Perspectives (and Loose Talk) from History. *Review of Financial Studies* 21(1):11-17.

Parliamentary Papers. 1847. Summary of Returns, Showing the Number of Passengers Carried on 63 railways of the United Kingdom during the Year ending 30 June 1846, the Fares of each Class, and the Receipts from each Class of Passengers, and for Goods, LXIII:179.

Parliamentary Papers. 1851. Railways. Return, showing the Number of Passengers Conveyed on All the Railways in England and Wales, Scotland, and Ireland, respectively, during the half-year ending the 30th June 1850, LI:229.

Pástor, L. and Veronesi, P. 2006. Was there a Nasdaq Bubble in the Late 1990s? *Journal of Financial Economics* 81(1):61-100.

Pástor, L. and Veronesi, P. 2009. Technological Revolutions and Stock Prices. *American Economic Review* 99(4):1451-1483.

Reinhart, C.M. And Rogoff, K. 2009. *This Time Is Different: Eight Centuries of Financial Folly*. Princeton University Press.

Shiller, R.J. 1981. Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends? *American Economic Review* 71:421-436.

Shiller, R.J. 2005. *Irrational Exuberance*, 2nd Edition, Woodstock: Princeton University Press.

Shleifer, A. and Vishny, R. 1997, The Limits of Arbitrage, Journal of Finance 52(1):35-55.

Temin. P. and Voth, H.J. 2004. Riding the South Sea Bubble, *American Economic Review*, 94(5): 1654-1668.

Voth, H.J. 2003. With a Bang, not a Whimper: Pricking Germany's 'Stock Market Bubble' in 1927 and the Slide into Depression. *Journal of Economic History* 63(1):65-99.

West, K. 1987. A Specification Test for Speculative Bubbles, *Quarterly Journal of Economics* 102:553-80.

Table 1: Descriptive Statistics of Companies by Industry on Selected Dates

			Jan 6, 1843	Dec 29, 1843	Dec 27, 1844	Aug 8, 1845	Dec 26, 1845	Dec 25, 1846	Dec 31, 1847	Dec 29, 1848	Dec 28, 1849	Dec 27, 1850
Number of Companies	Established Railways	N	19	22	21	22	21	19	18	21	15	18
	Non-Railways	N	22	22	22	22	22	22	21	21	22	22
Dividend Yield (D/P)	Established Railways	Mean	5.64%	3.58%	3.59%	3.15%	3.73%	4.65%	5.89%	6.75%	6.28%	3.65%
		St. Dev.	2.42%	1.34%	1.03%	1.12%	1.10%	1.30%	1.49%	1.70%	3.01%	0.92%
	Non-Railways	Mean	4.75%	4.61%	4.35%	4.26%	4.74%	5.02%	5.15%	5.48%	4.94%	4.84%
		St. Dev.	1.00%	1.01%	1.16%	1.04%	1.62%	2.20%	1.43%	1.99%	1.93%	1.61%
Log of D_{t+1}/D_t (Δd_{t+1})	Established Railways	Mean	-11.64%	9.61%	22.26%	12.06%	23.68%	-6.76%	-11.21%	-36.07%	-37.64%	21.62%
		St. Dev.	35.50%	37.42%	55.64%	48.61%	48.13%	28.75%	23.40%	49.48%	52.74%	25.86%
	Non-Railways	Mean	9.75%	0.75%	-2.14%	1.89%	-0.97%	0.46%	-2.26%	-0.76%	3.04%	-3.59%
		St. Dev.	32.35%	2.66%	7.10%	5.37%	9.28%	10.23%	7.15%	17.92%	17.73%	13.49%
Size in £millions (S)	Established Railways	Mean	1.44	1.38	1.55	1.87	2.01	2.48	4.14	4.82	5.03	5.90
		St. Dev.	1.03	1.05	1.21	1.45	1.52	2.03	3.85	4.49	5.38	5.47
	Non-Railways	Mean	1.72	1.72	1.73	1.73	1.73	1.73	1.77	1.77	1.75	1.76
		St. Dev.	3.14	3.14	3.14	3.14	3.14	3.14	3.21	3.21	3.15	3.15
Beta (BN) using market portfolio of non-railways	Established Railways	Mean	0.35	0.46	0.49	2.50	2.52	0.32	0.94	0.90	1.60	0.58
		St. Dev.	0.81	1.07	1.47	1.83	1.82	1.29	0.70	2.04	1.44	1.99
	Non-Railways	Mean	0.71	0.71	0.31	0.35	0.35	0.44	0.43	0.32	0.61	1.31
		St. Dev.	1.62	1.62	0.55	0.68	0.68	0.81	0.85	0.48	1.90	4.19
Beta (BNR) using market portfolio of non-railways and railways	Established Railways	Mean	1.52	1.73	2.17	1.84	1.57	1.34	1.61	1.33	1.90	2.50
		St. Dev.	1.64	2.45	1.29	1.31	1.25	1.22	1.11	2.05	1.57	1.59
	Non-Railways	Mean	0.75	0.75	0.28	0.10	0.10	0.08	0.21	0.11	0.26	0.22
		St. Dev.	1.86	1.86	0.45	0.19	0.19	0.32	0.36	0.26	0.74	1.00

Notes: Source data from the *Railway Times* and *Course of the Exchange*. Dividend Yield (D/P) calculated as dividends per share/share price. Dividend growth (Δd_{t+1}) calculated as the log of the change in dividends during the subsequent year. Size (S) measued in terms of par value of equity. Beta (B) estimated by regressing the weekly returns of each asset minus the risk free rate, against the weekly returns of the non-railway market portfolio minus the risk free rate.

Table 2: Yearly Entity Fixed Effects Panel Regressions using Future Growth in Dividends as Dependent Variable

Panel A: Using Beta based on Market Portfolio of Non-Railways

	Dividend Growth between years					
	t and t+1	**t+1 and t+2**	**t+2 and t+3**	**t+3 and t+4**	**t+4 and t+5**	**t+5 and t+6**
δ_t	-0.860***	-0.212**	-0.056	0.382**	0.217***	0.023
	(0.094)	(0.094)	(0.088)	(0.148)	(0.055)	(0.069)
BN_t	0.004	-0.029	-0.016	-0.050*	0.010	0.026*
	(0.018)	(0.023)	(0.019)	(0.025)	(0.021)	(0.014)
S_t	-0.016*	-0.014	0.014	0.027**	0.027***	0.018***
	(0.009)	(0.010)	(0.009)	(0.010)	(0.008)	(0.006)
Constant	-2.648***	-0.611*	-0.212	1.078**	0.490***	-0.073
	(0.299)	(0.303)	(0.287)	(0.490)	(0.176)	(0.215)
Observations	190	164	157	147	142	138
Companies	48	41	40	36	34	34
Overall-R^2	0.548	0.054	0.010	0.214	0.136	0.050

Panel B: Using Beta based on Market Portfolio of Non-Railways and Railways

	Dividend Growth between years					
	t and t+1	**t+1 and t+2**	**t+2 and t+3**	**t+3 and t+4**	**t+4 and t+5**	**t+5 and t+6**
δ_t	-0.875***	-0.194*	-0.002	0.380**	0.222***	0.024
	(0.095)	(0.105)	(0.068)	(0.153)	(0.053)	(0.071)
BNR_t	-0.042	0.066	0.125***	0.033	0.013	-0.044
	(0.032)	(0.056)	(0.043)	(0.032)	(0.016)	(0.034)
S_t	-0.012	-0.023**	-0.001	0.017	0.027***	0.024**
	(0.012)	(0.011)	(0.012)	(0.011)	(0.008)	(0.010)
Constant	-2.641***	-0.652**	-0.222	1.006**	0.487***	0.018
	(0.278)	(0.316)	(0.210)	(0.449)	(0.173)	(0.243)
Observations	190	164	157	147	142	138
Companies	48	41	40	36	34	34
Overall-R^2	0.558	0.069	0.120	0.183	0.136	0.059

Notes: δ=Log of Dividend Yield, BN=Beta using market portfolio of non-railways, BNR=Beta using market portfolio of non-railways and railways, S=Size. One observation per company at the end of each year of the sample. Robust standard errors in parentheses. Significance given by *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Cross-sectional Regressions on Selected Weeks using Log Dividend Yield as Dependent Variable

Panel A: Using Beta based on Market Portfolio of Non-Railways

	Jan 6, 1843	Dec 29, 1843	Dec 27, 1844	Aug 8, 1845	Dec 26, 1845	Dec 25, 1846	Dec 31, 1847	Dec 29, 1848	Dec 28, 1849	Dec 27, 1850	Total No. of Weeks Sig.
R	0.115	-0.335***	-0.242**	-0.369**	-0.297*	-0.055	0.090	0.227**	0.280*	-0.280**	168
	(0.111)	(0.111)	(0.112)	(0.173)	(0.162)	(0.093)	(0.093)	(0.104)	(0.155)	(0.113)	
BN	0.010	-0.047*	-0.009	0.004	0.018	-0.101	0.029	-0.010	-0.025	-0.006	3
	(0.024)	(0.028)	(0.082)	(0.036)	(0.036)	(0.065)	(0.031)	(0.025)	(0.031)	(0.020)	
S	-0.019*	-0.006	-0.011	0.001	-0.013	-0.004	0.011	0.001	-0.016	-0.003	6
	(0.011)	(0.010)	(0.017)	(0.017)	(0.012)	(0.013)	(0.010)	(0.013)	(0.014)	(0.008)	
Constant	-3.046***	-3.053***	-3.142***	-3.185***	-3.079***	-3.010***	-3.031***	-2.953***	-3.024***	-3.056***	417
	(0.069)	(0.052)	(0.060)	(0.060)	(0.073)	(0.088)	(0.069)	(0.074)	(0.086)	(0.064)	
Obs.	41	44	43	44	43	41	39	42	37	40	17,412
R^2	0.052	0.191	0.098	0.197	0.121	0.113	0.100	0.130	0.114	0.189	0.056

Panel B: Using Beta based on Market Portfolio of Non-Railways and Railways

	Jan 6, 1843	Dec 29, 1843	Dec 27, 1844	Aug 8, 1845	Dec 26, 1845	Dec 25, 1846	Dec 31, 1847	Dec 29, 1848	Dec 28, 1849	Dec 27, 1850	Total No. of Weeks Sig.
R	0.104	-0.290**	0.058	-0.158	-0.212	0.035	0.075	0.235**	0.171	-0.127	50
	(0.103)	(0.117)	(0.216)	(0.164)	(0.149)	(0.122)	(0.102)	(0.098)	(0.180)	(0.093)	
BNR	0.010	-0.034*	-0.159	-0.117*	-0.032	-0.066	0.022	-0.012	0.083	-0.075*	47
	(0.033)	(0.018)	(0.140)	(0.063)	(0.052)	(0.070)	(0.060)	(0.030)	(0.054)	(0.040)	
S	-0.019*	-0.006	0.002	0.005	-0.009	0.002	0.011	0.001	-0.032**	0.002	29
	(0.011)	(0.010)	(0.021)	(0.018)	(0.012)	(0.021)	(0.013)	(0.014)	(0.014)	(0.010)	
Constant	-3.046***	-3.062***	-3.123***	-3.179***	-3.077***	-3.058***	-3.023***	-2.956***	-3.033***	-3.056***	417
	(0.070)	(0.053)	(0.062)	(0.061)	(0.076)	(0.087)	(0.065)	(0.075)	(0.085)	(0.061)	
Obs.	41	44	43	44	43	41	39	42	37	40	17,412
R^2	0.054	0.199	0.231	0.267	0.122	0.034	0.097	0.131	0.142	0.261	0.106

Notes: A regression estimating Equation 2 is reported for selected weeks of the sample, with no dividend growth variable included. Robust standard errors in parentheses. Significance given by *** p<0.01, ** p<0.05, * p<0.1. The total number of weeks that a variable is significant is shown in final column. δ=Log of Dividend Yield, d=Log of Dividend, BN=Beta using market portfolio of non-railways, BNR=Beta using market portfolio of non-railways and railways, S=Size, R=Railway Dummy.

For week = t

$$\delta_{i,t} = \beta_0 + \beta_1 E_t(\Delta d_{i,t+n}) + \beta_2 B_{i,t} + \beta_3 S_{i,t} + \beta_4 R_i + \varepsilon \quad (2)$$

Table 4: Number of Weeks during which Variables are Significant from Cross-Sectional Regressions

Panel A: Using Beta based on Market Portfolio of Non-Railways							
R	168	56	61	102	108	104	106
BN	3	31	39	78	102	87	74
S	6	28	63	86	97	72	90
(Δd) t+1		253	333	360	371	379	363
(Δd) t+2			217	233	262	248	235
(Δd) t+3				169	175	179	167
(Δd) t+4					81	95	144
(Δd) t+5						82	98
(Δd) t+6							89
Cons.	417	417	417	417	417	417	417
Ave Obs.	41.8	38.7	36.9	35.9	34.8	34.2	33.5
Obs.	17,412	16,138	15,388	14,976	14,525	14,249	13,974
Ave. Adj R^2	0.056	0.287	0.402	0.487	0.530	0.543	0.530
Panel B: Using Beta based on Market Portfolio of Non-Railways and Railways							
R	50	40	44	55	59	54	51
BNR	47	60	57	37	48	57	42
S	29	60	86	97	106	94	103
(Δd) t+1		273	335	357	366	367	359
(Δd) t+2			216	204	219	239	216
(Δd) t+3				140	157	171	152
(Δd) t+4					78	95	140
(Δd) t+5						90	106
(Δd) t+6							78
Cons.	417	417	417	417	417	417	417
Ave Obs.	41.8	38.7	36.9	35.9	34.8	34.2	33.5
Obs.	17,412	16,138	15,388	14,976	14,525	14,249	13,974
Ave. Adj R^2	0.106	0.322	0.417	0.486	0.529	0.543	0.529

Notes: A regression estimating Equation 2 was calculated for each week of the sample, with varying numbers of years of dividend growth included. The total number of weeks that a variable is significant is shown for each specification. δ=Log of Dividend Yield, d=Log of Dividend, B=Beta, S=Size, R=Railway Dummy.

For week = t (2)

$$\delta_{i,t} = \beta_0 + \beta_1 E_t\left(\Delta d_{i,t+n}\right) + \beta_2 B_{i,t} + \beta_3 S_{i,t} + \beta_4 R_i + \varepsilon$$

Table 5: Estimates of the Number of Weeks of Over and Under Pricing of Railway Shares between 1843 and 1850 using Railway Dummy from Dividend Yield regressions, with Beta based on Market Portfolio of Non-Railways

No. of Years of Future Changes in Dividends Included	Overpriced or Underpriced	1843	1844	1845	1846	1847	1848	1849	1850	Total	Relative to n=0	Total (% of sample)	Relative to n=0 (% of sample)
n = 0	Overpriced	7	37	20	12	0	0	0	4	80	-	19.2%	-
	Underpriced	0	0	0	0	0	48	28	12	88	-	21.1%	-
n = 1	Overpriced	0	6	1	0	0	0	0	0	7	-73	1.7%	-17.5%
	Underpriced	2	0	0	0	0	19	0	28	49	-39	11.8%	-9.4%
n = 2	Overpriced	0	0	0	0	0	0	0	0	0	-80	0.0%	-19.2%
	Underpriced	7	0	1	0	1	6	8	38	61	-27	14.6%	-6.5%
n = 3	Overpriced	0	0	0	0	2	0	0	0	2	-78	0.5%	-18.7%
	Underpriced	11	18	1	0	0	6	17	47	100	12	24.0%	2.9%
n = 4	Overpriced	0	0	0	4	1	0	0	0	5	-75	1.2%	-18.0%
	Underpriced	33	2	0	0	0	21	9	38	103	15	24.7%	3.6%
n = 5	Overpriced	0	0	9	11	0	0	0	0	20	-60	4.8%	-14.4%
	Underpriced	27	1	0	0	0	14	8	34	84	-4	20.1%	-1.0%
n = 6	Overpriced	0	13	16	12	0	0	0	0	41	-39	9.8%	-9.4%
	Underpriced	10	0	0	0	0	15	4	36	65	-23	15.6%	-5.5%

Notes: A regression estimating Equation 2 is calculated for each week of the sample, with varying numbers of years of dividend growth included. The railways are estimated to be overpriced during a particular week when the railway dummy (β_4) is significantly less than zero, as this implies that railways had a significantly lower dividend yield than non-railways during that week, when future dividend growth is controlled for. Conversely they are estimated to be underpriced when the coefficient of the railways dummy was significantly higher than zero. The total weeks of overpricing and underpricing for each year were then calculated. δ=Log of Dividend Yield, d=Log of Dividend, BN=Beta using market portfolio of non-railways, S=Size, R=Railway Dummy.

For week = t

$$\delta_{i,t} = \beta_0 + \beta_1 E_t\left(\Delta d_{i,t+n}\right) + \beta_2 BN_{i,t} + \beta_3 S_{i,t} + \beta_4 R_i + \varepsilon \quad (2)$$

Table 6: Estimates of the Number of Weeks of Over and Under Pricing of Railway Shares between 1843 and 1850 using Railway Dummy from Dividend Yield regressions, with Beta based on Market Portfolio of Non-Railways and Railways

No. of Years of Future Changes in Dividends Included	Overpriced or Underpriced	1843	1844	1845	1846	1847	1848	1849	1850	Total	Relative to n=0	Total (% of sample)	Relative to n=0 (% of sample)
n = 0	Overpriced	2	0	0	0	0	0	0	0	2	-	0.5%	-
	Underpriced	0	0	0	0	0	48	0	0	48	-	11.5%	-
n = 1	Overpriced	0	0	0	0	0	0	0	0	0	-2	0.0%	-0.5%
	Underpriced	4	7	0	2	1	14	0	12	40	-8	9.6%	-1.9%
n = 2	Overpriced	0	0	0	0	0	0	0	0	0	-2	0.0%	-0.5%
	Underpriced	7	11	0	1	0	3	0	22	44	-4	10.6%	-1.0%
n = 3	Overpriced	0	0	0	0	1	0	0	0	1	-1	0.2%	-0.2%
	Underpriced	13	22	0	0	0	2	0	17	54	6	12.9%	1.4%
n = 4	Overpriced	0	0	0	1	0	0	0	0	1	-1	0.2%	-0.2%
	Underpriced	28	3	0	0	0	14	0	13	58	10	13.9%	2.4%
n = 5	Overpriced	0	0	5	6	1	0	0	0	12	10	2.9%	2.4%
	Underpriced	25	0	0	0	0	11	0	6	42	-6	10.1%	-1.4%
n = 6	Overpriced	0	11	18	5	0	0	0	0	34	32	8.2%	7.7%
	Underpriced	7	0	0	0	1	5	0	4	17	-31	4.1%	-7.4%

Notes: A regression estimating Equation 2 is calculated for each week of the sample, with varying numbers of years of dividend growth included. The railways are estimated to be overpriced during a particular week when the railway dummy (β_4) is significantly less than zero, as this implies that railways had a significantly lower dividend yield than non-railways during that week, when future dividend growth is controlled for. Conversely they are estimated to be underpriced when the coefficient of the railways dummy was significantly higher than zero. The total weeks of overpricing and underpricing for each year were then calculated. δ=Log of Dividend Yield, d=Log of Dividend, BNR=Beta using market portfolio of non-railways and railways,, S=Size, R=Railway Dummy.

For week = t

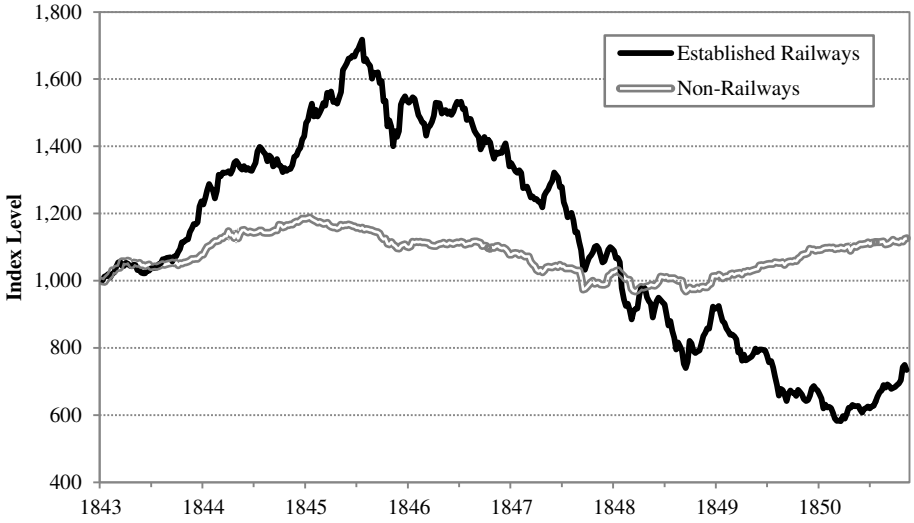
$$\delta_{i,t} = \beta_0 + \beta_1 E_t\left(\Delta d_{i,t+n}\right) + \beta_2 BNR_{i,t} + \beta_3 S_{i,t} + \beta_4 R_i + \varepsilon \quad (2)$$

Table 7: Price/Par Ratios of Established Railways and New Railways

	Established Railways Which Paid a Dividend		Established Railways Which Did Not Pay a Dividend		New Railways	
	N	**Price/Par**	**N**	**Price/Par**	**N**	**Price/Par**
Jan 6, 1843	19	1.02	3	0.55	0	-
Dec 29, 1843	22	1.25	4	0.59	0	-
Dec 27, 1844	21	1.50	2	0.89	39	1.06
Aug 8, 1845	21	1.80	3	1.08	71	1.14
Dec 26, 1845	21	1.60	2	1.08	115	1.05
Dec 25, 1846	18	1.36	3	1.11	100	1.01
Dec 31, 1847	17	1.12	0	-	76	0.89
Dec 29, 1848	20	0.88	0	-	60	0.74
Dec 28, 1849	15	0.70	4	0.43	59	0.66
Dec 27, 1850	18	0.77	3	0.49	46	0.67

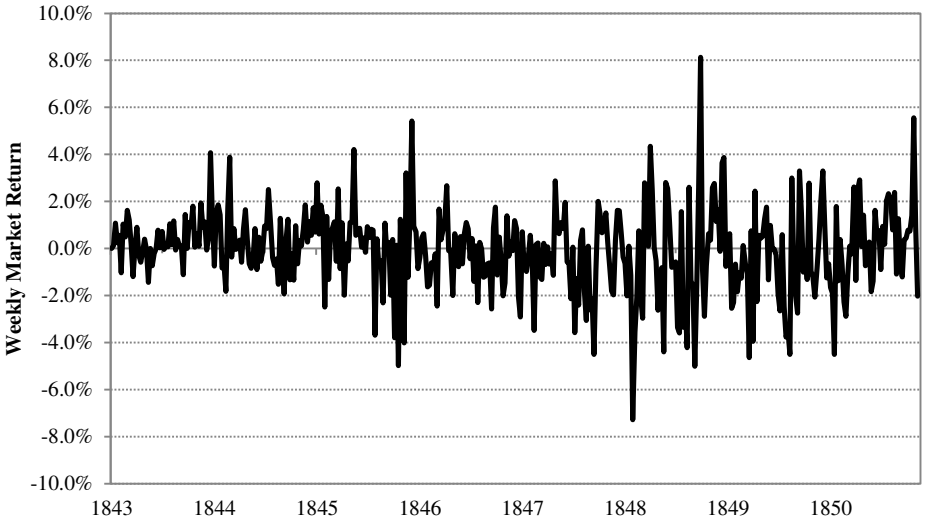
Notes: Source data from Railway Times and Course of the Exchange. The price of an equivalent fully paid share has been calculated by taking the price of each partially paid share and adding the discounted sum of future calls. The par value of an equivalent fully paid share has been calculated by taking the par value of the partially paid share and adding the discounted sum of future calls. The discounted sum of calls has been calculated assuming that all calls were paid at the end of the sample period in 1850, using a discount rate of 3 per cent, which was close to the risk-free rate on Consols. The price/par ratio of established railways which paid a dividend has been calculated as the sum of the market capitalisation of those railways divided by the sum of the par value of those railways. Price/par ratios of established railways which did not pay a dividend, and price/par ratios of the new railways have been calculated in the same manner for their respective companies.

Figure 1: Capital Gains Indices for Established Railways and Non-Railways, 1843-50



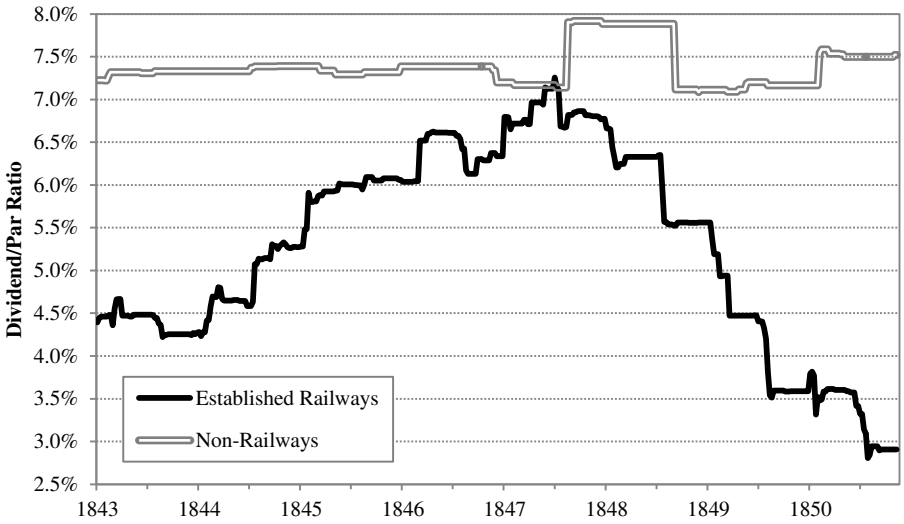
Notes: Source data for railway share prices from Railway Times (1843-50), and for non-railway share prices from Course of the Exchange (1843-50). Established railways index includes those railways which were operating before January 1843 for which share price and dividend data is available. Non-railways index includes the twenty largest non-railways by market capitalisation for which share price and dividend data is available. Capital gains for each company weighted by market capitalisation to produce market indices on a weekly basis.

Figure 2: Weekly Returns of Established Railways, 1843-50



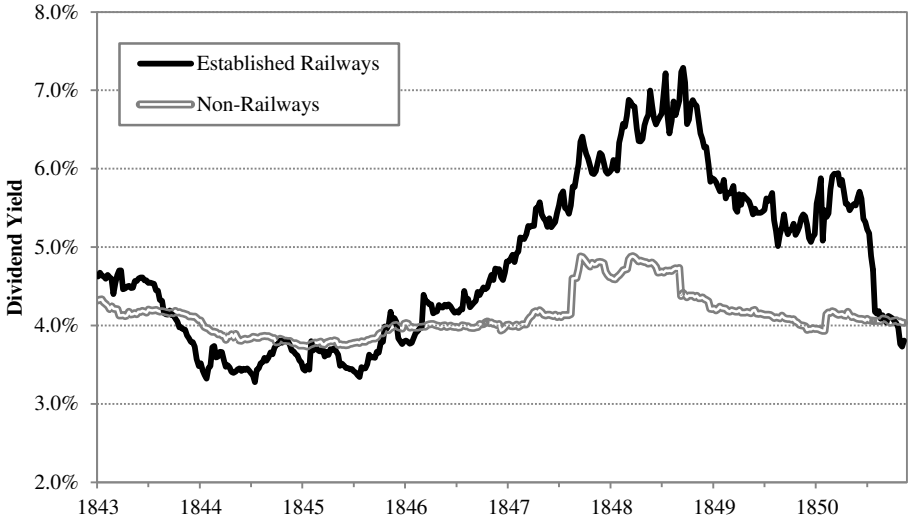
Notes: Source data for railway share prices from Railway Times (1843-50). Established railways include those railways which were operating before January 1843 for which share price and dividend data is available. Capital gains for each company weighted by market capitalisation to calculate weekly market return.

Figure 3: Industry Dividend/Par Ratio Amongst Established Railways and Non-Railways, 1843-50



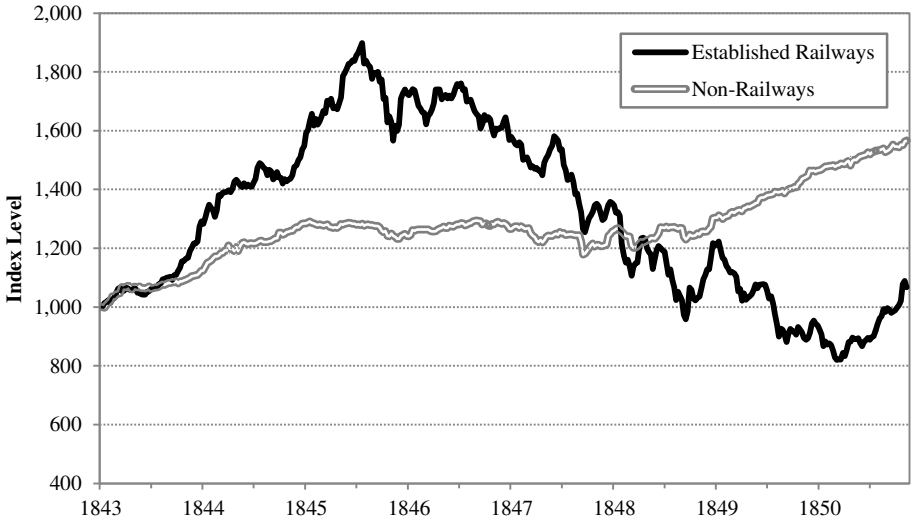
Notes: Source data from Course of the Exchange (1843-50) and Railway Times (1843-50). Railway industry dividend/par ratio calculated as total dividends paid by established railway companies as a percentage of total par value of established railway companies for which share price and dividend data is available. Non-railway industry dividend/par ratio calculated as total dividends paid by non-railway companies as a percentage of total par value of non-railway companies for which share price and dividend data is available.

Figure 4: Industry Dividend Yield of Established Railways and Non-Railways, 1843-50



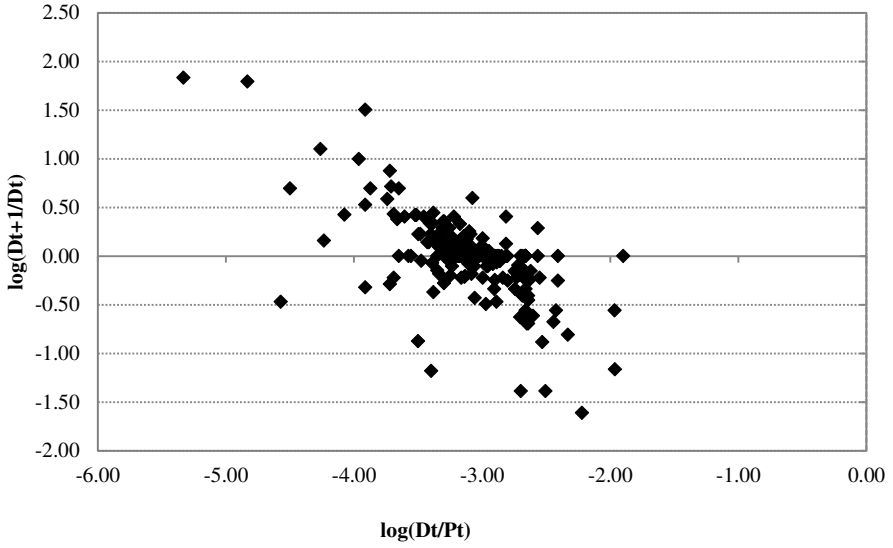
Notes: Source data from Course of the Exchange (1843-50) and Railway Times (1843-50). Railway industry dividend/price ratio calculated as total dividends paid by established railway companies as a percentage of total market capitalisation of established railway companies for which share price and dividend data is available. Non-railway industry dividend/price ratio calculated as total dividends paid by non-railway companies as a percentage of total market capitalisation of non-railway companies for which share price and dividend data is available.

Figure 5: Total Return Indices for Established Railways and Non-Railways, 1843-50



Notes: Source data from Course of the Exchange (1843-50) and Railway Times (1843-50). Half-yearly dividend assumed to be made in equal payments in each week. Total return, as measured by the sum of capital gains and dividends, for each company weighted by market capitalisation to produce market indices. Established railways index includes those railways which were operating before January 1843 for which share price and dividend data is available. Non-railways index includes the twenty largest non-railways by market capitalisation for which share price and dividend data is available.

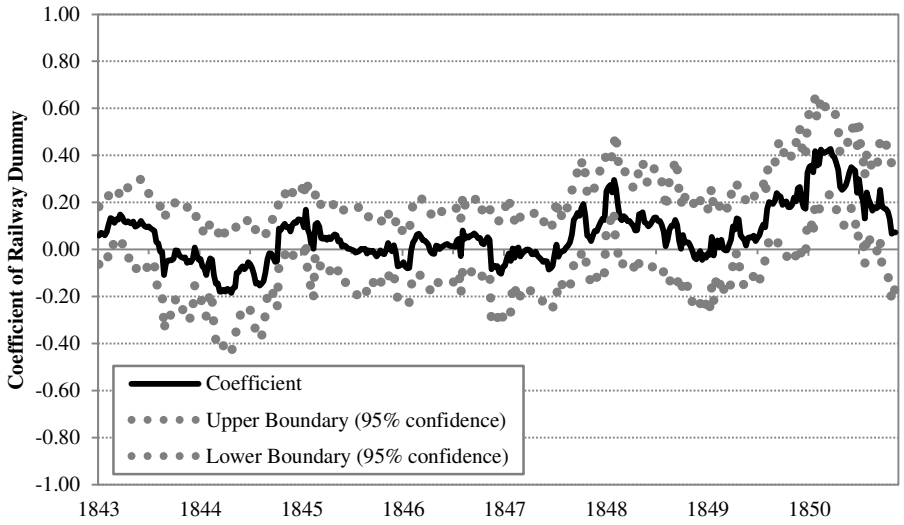
Figure 6: Correlation between Log of Dividend Yield and Dividend Growth between t and t + 1 year, for Railway Companies, 1843-50



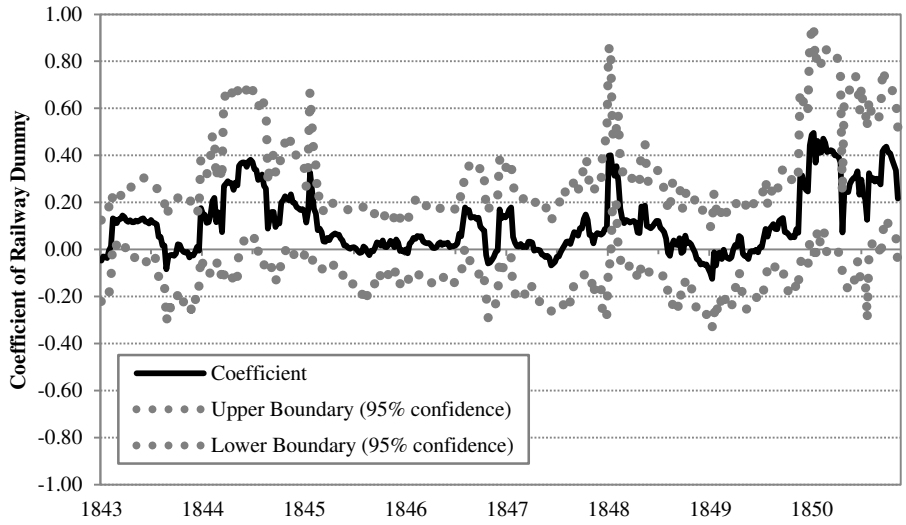
Notes: n=191, Correlation coefficient = -0.650. Source data from Course of the Exchange (1843-50) and Railway Times (1843-50). One observation shown per company at end of December in each year between 1843 and 1850.

Figure 7: Impact of Railway Dummy on Log of Dividend Yield from Repeated Weekly Cross-sectional Regressions Controlling for Two Years of Dividend Growth, 1843-50

Panel A: Using Beta based on Market Portfolio of Non-Railways



Panel B: Using Beta based on Market Portfolio of Non-Railways and Railways



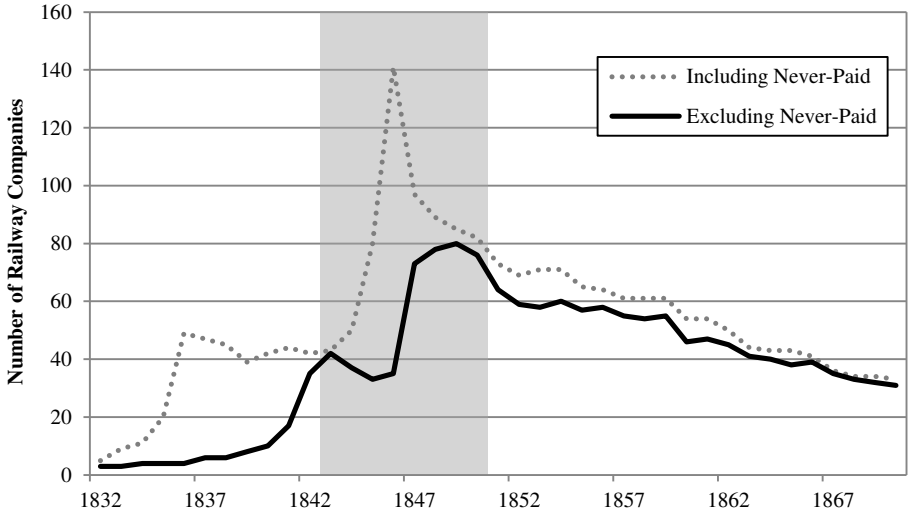
Notes: A regression estimating Equation 2 is calculated for each week of the sample. Dividend growth from variables from t to t+1, and from t+1 to t+2 included in regression. Value of the coefficient represents the value of β_4 from Equation 2 in any given week, with a 95 per cent confidence interval constructed using robust standard errors. δ=Log of Dividend Yield, Δd=Dividend Growth, B=Beta, S=Size, R=Railway Dummy.

For week = t

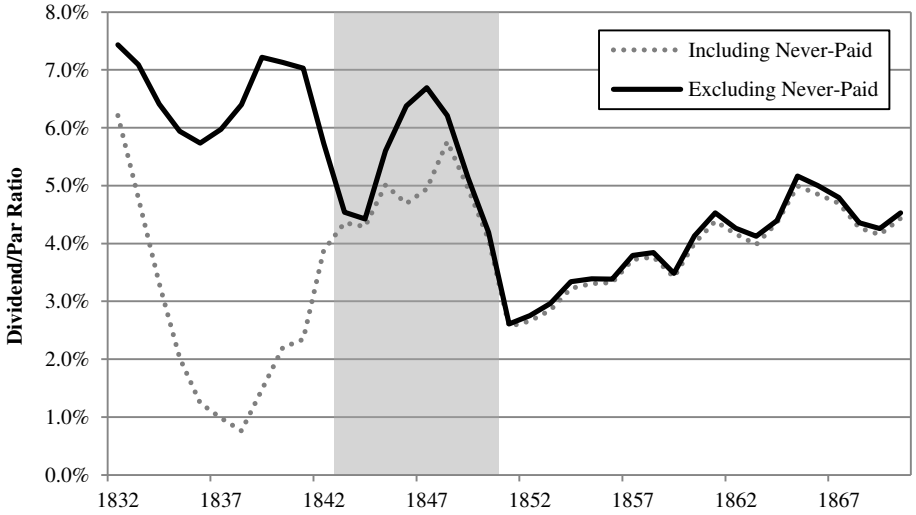
$$\delta_{i,t} = \beta_0 + \beta_1 E_t\left(\Delta d_{i,t+n}\right) + \beta_2 B_{i,t} + \beta_3 S_{i,t} + \beta_4 R_i + \varepsilon \quad (2)$$

Figure 8: Dividends Paid by Railway Companies, 1832-70

Panel A: Number of Railway Companies



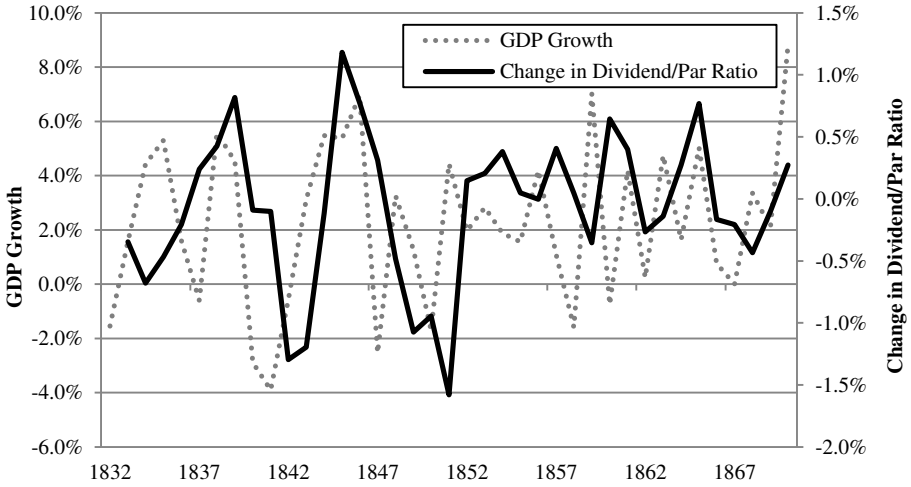
Panel B: Average Dividend/Par Ratio of Railways



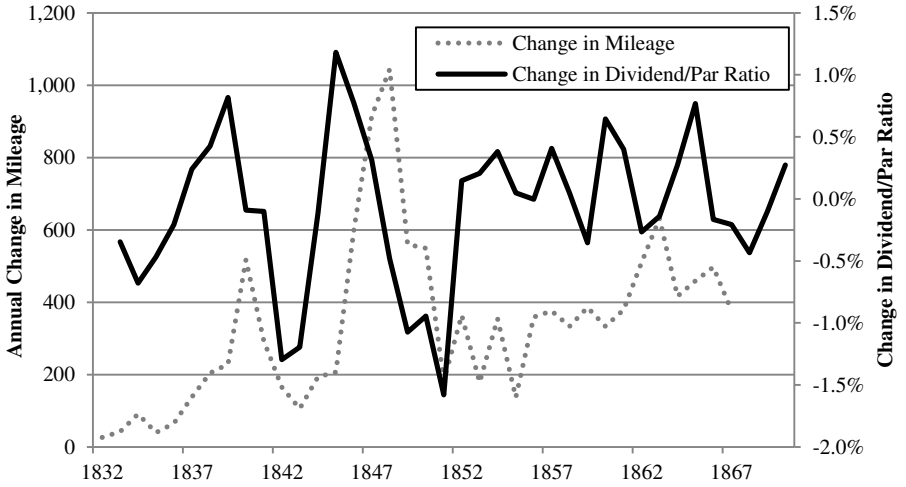
Notes: Source data on dividends from *Course of the Exchange* and *Railway Times*. Railway industry dividend/par ratio calculated as total dividends paid on ordinary shares by railway companies as a percentage of total par value of railway companies for which dividend data is available. One observation per year. 'Including Never-Paid' reports results for all railway companies including those which have never previously paid a dividend. 'Excluding Never-paid' reports results for all railway companies excluding those which have never previously paid a dividend. Shaded area illustrates the period 1843-50 on which the rest of the paper is based. The sample begins in 1832, with the first dividend payment by the first major railway, the Liverpool and Manchester. Two minor lines, the Stockton and Darlington and the Forest of Dean were also paying dividends at this time.

Figure 9: Changes in Dividends, GDP Growth and Railway Mileage Open, 1832-70

Panel A: Change in Dividends and GDP Growth



Panel B: Change in Dividends and Mileage Open



Notes: Source data on dividends from *Course of the Exchange* and *Railway Times*. Railway industry dividend/par ratio calculated as total dividends paid by railway companies as a percentage of total par value of railway companies for which dividend data is available, excluding those which have never previously paid a dividend. The change in the dividend/par ratio is calculated as the change since the previous year. GDP growth using constant prices calculated from Mitchell (2003, pp.905-907), and Change in Mileage calculated from Mitchell (2003, pp.674) . Granger Causality tests indicate that GDP growth Granger-Causes changes in dividends at 1% significance, and Change in Mileage Granger-Causes changes in dividends at 5% significance, when lags are selected using the Akaike Information Criteria.