Leveraging the British Railway Mania: Derivatives for the Individual Investor

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Abstract

During the British Railway Mania of the 1840s the promotion and construction of new railways increased dramatically. These new projects were generally financed by shares with uncalled capital, which allowed investors to make payments on an instalment basis over a period of several years. There is evidence that these assets can be regarded as futures or options, implying that investors were purchasing highly leveraged derivatives. The leverage embedded in these assets multiplied both the positive returns during the boom, and the negative returns during the downturn. It also affected the payment schedule for investors as little capital was required initially, but the subsequent 'calls for capital' resulted in deleveraging.

JEL codes: G01, G11, G12, N23

The British Railway Mania of the 1840s was a period of rapid asset price growth which was followed by a market crash, and a sustained fall in prices. Analogous to the recent 'Housing Bubble', which was associated with an increase in the construction of new houses, the Railway Mania resulted in the promotion of many new railway lines. There were already about sixty railways in operation before 1843, but within just three years there were at least a further 1,000 new railway lines projected.

Most of the new lines issued shares with uncalled capital, which meant that the assets could be purchased on an instalment basis, with investors required to make a small initial deposit and enter a contract to make a series of regular payments in the future. This means that they bear some similarities to mortgages, and although the parallels are not exact, an examination of this instalment plan feature during the Railway Mania can provide some insight into the relationship between asset price booms and leverage.

This paper argues that the leverage which was produced by the structure of the assets resulted in two effects. Firstly it multiplied the returns of investors, leading to significantly higher returns during the boom, but higher losses during the downturn. Secondly, the payment terms affected investment, with the low initial deposit attracting investors but the subsequent deleveraging led to difficulties for shareholders.

These issues are analysed using a new and comprehensive dataset, consisting of daily share prices for all railway securities listed on the London Stock Exchange between 1843 and 1850. This paper begins by considering whether the partially paid shares listed at this time could be treated as either futures or options, both of which provide a leveraged position for investors. A cointegration analysis relating fully paid shares and partially paid instalment plan shares listed during the Railway Mania suggests that there was a spot-future relationship between these assets, implying that the partially paid shares can be modelled as futures. There is also

some evidence of partially paid shares being treated as call options, with a significantly higher default rate on payments in those situations where it would be optimal to avoid payment. If partially paid shares can be treated as derivatives, then it implies that the leverage which results from the use of derivatives could have been available to investors during the Railway Mania.

The implications of leverage during this period are then analysed, with a focus on the new railways which were promoted at this time. An important consequence of leverage was to multiply the returns which investors experienced. An analysis of first day returns suggests that subscribers to the IPOs of new railway companies, on average, could have doubled their investment if they sold their shares on the first day that they were listed on the market. Throughout the boom the market price was generally more than double the amount that investors had paid up in capital. However, this was largely due to the structure of the assets which gave investors exposure to price changes for only a small deposit. If investors had been required to pay the full cost of the asset immediately their returns would have been fairly modest, and the implied dividend rates which the new railways were expected to earn were not exceptionally high. The structure of the assets meant that during the downturn the losses experienced were also multiplied.

Another important feature of leverage was to affect the schedule which investors had to make their payments. During the boom investors had to deposit an average of less than 10 per cent of their total liability. This meant that although almost two hundred new railways had been listed on the market at the peak, capital had only been deposited which would have been equivalent to fully financing about twenty new companies. During construction there was substantial deleveraging when a large number of calls for capital were made, which resulted in price declines.

This analysis contributes to our understanding of the link between asset price reversals and leverage. It suggests that the widespread availability of leverage may be attractive during the boom, by multiplying positive returns and reducing the amount of capital which must be deposited, but it could produce difficulties during a downturn, by multiplying negative returns and enforcing deleveraging when payments are required. This may suggest that leverage is an important factor to consider when dealing with asset price booms.

This research also contributes to the existing literature which has examined the relationship between asset prices and leverage. Kindleberger (2000, p.14) has suggested that a boom can be fed by an expansion of bank credit. Bernanke and Gertler (2001) have discussed how an initial increase in asset prices can improve the collateral of investors, which increases borrowing, which can increase demand and prices further. Aoki et al. (2002) have examined the links between house prices, collateral and borrowing in the United Kingdom. Detken and Smets (2004) have found that real credit and money growth have been quite strong before and during booms in 18 countries since the 1970s.

This study also improves our understanding of the Railway Mania, which has been largely neglected by academic economists. This period has previously been mentioned in studies of the early railways, such as those by Simmons (1978), Jackman (1966) and Lewin (1968), in works focussing on manias and crises (Nairn, 2002, and Odlyzko, 2010), and in papers considering the history of accounting (Bryer, 1991, and McCartney and Arnold, 2003). However, there has been little detail provided on the new companies promoted at this time, on the assets which they issued, or on the role of leverage.

This paper is organised as follows. The next two sections give a brief overview of the Railway Mania, and of the data which has been used. The third section considers whether partially paid shares can be viewed as futures or options. The fourth section discusses the

relationship between leverage and returns, whilst the fifth section considers the impact of leverage on the payment schedule, with the final section being a brief conclusion.

1 Expansion during the British Railway Mania

The first modern railway, the Liverpool and Manchester, was promoted in 1824 and finally opened in 1830. Within the next decade about sixty other railways obtained Parliamentary authorisation, with most of these projects being promoted in a minor boom during 1836 and 1837. Whilst the economy was weak, and these railways were being constructed, share prices remained low and the promotion of new lines was subdued. However, between 1843 and August 1845, railway share prices rose rapidly, possibly because of a substantial increase in the dividends paid by the established railways, as suggested by Campbell (2010). A market index consisting of all railway shares, constructed by Campbell and Turner (2010), suggests that railway share prices increased by an average of 102 per cent in just under three years, as shown in Figure 1.

<< INSERT FIGURE 1 >>

As with some other periods of rapid asset price growth, such as the South Sea Bubble of 1720, the boom of 1825, and the Dot-Com Bubble of the 1990s, there was a substantial increase in the promotion of new companies during the Railway Mania, and the established railways also expanded rapidly. *The Times* estimated that there were 1,238 new railway projects in 1845 alone[1], a figure which itself understated the extent of promotion as 335 lines not on this list went on to petition Parliament[2]. The number of railway securities listed on the London Stock Exchange underestimates the extent of promotion, as only a small proportion ever achieved a listing, but the number of listed securities follows the pattern in prices with a lag, as shown in Figure 1.

[1] *The Times*, November 17, 1845, p.4
[2] *The Times*, January 14, 1846, p.6

Most of the new schemes issued partially paid shares with uncalled capital, which meant that investors paid a small deposit and would then make future payments when the process of construction required it. Shares issued during the Railway Mania, and throughout much of the eighteenth and nineteenth century, were quoted with a nominal value, a par value and the market price. The nominal value of the share was the total amount that original shareholders were initially liable to pay to the company. The par value of the share was the amount that shareholders had already paid to the company.

The difference between the nominal and par value reflected uncalled capital, which was the amount that shareholders were still liable to pay to the company. Uncalled capital could be used in several ways, with banks and insurance companies generally retaining it as a reserve, but the railways tended to call it up in regular instalments to finance the construction of their lines. Figure 2 illustrates the rapid increase in nominal value during the boom in railway shares, compared to a more gradual rise in par value. This reflects the issuance of the new securities which had only a small proportion of capital initially paid up.

<< INSERT FIGURE 2 >>

Concerns were raised by *The Times*[3] and the *Economist*[4] that the amount of railway promotion and construction would eventually result in difficulties for shareholders and the economy, as investors would face difficulties in paying the 'calls for capital', and investment would be diverted from other uses to the railways. Railway share prices fell by 18 per cent between mid-October and the end of November 1845 as the promotion of new railway schemes reached unprecedented levels.

[3] *The Times*, July 1, 1845, p.4
[4] *Economist*, October 4, 1845, p.950-953

Many of the railways promoted at the height of the boom never received Parliamentary authorisation, and others faced difficulties when they began to lay their line, but the extent of railway construction was still impressive. Estimates by Mitchell (1964) suggest that railway investment represented 5.7 per cent of GDP in 1846, 6.7 per cent in 1847, and 4.7 per cent in 1848. However, the extent of railway expansion proved to be unsustainable, with the size of investment being amongst a range of factors blamed by a Parliamentary Committee for the Commercial Crisis of 1847[5]. Concerns about overexpansion led several of the leading railways to announce they would not proceed with much of the planned construction in October 1848[6]. It was not until near the end of the decade that most of the remaining construction had been completed, and the new railways began to operate.

2 Data

Data on the number of shares in issue, the nominal value, the par value, and the market price of every railway security listed on the London Stock Exchange between 1843 and 1850 was obtained on a daily basis from the *Railway Times*. This newspaper was the leading railway periodical during this period, and although it was published weekly it contained tables which reported the daily share prices of each railway security. Data from each weekly table, containing an average of 242.1 securities for each of the 417 weeks in the sample, was computerised and each table was then merged to produce a comprehensive dataset. Due to the high number of listings and delistings the total number of securities included in the dataset is 868, representing 442 railway companies.

Preference shares (88 securities) and assets issued by railways outside Great Britain and Ireland (84 securities) were excluded. When some companies were first listed some of the data on the number of shares, nominal value or par value were not reported. In these cases the

[5] *Parliamentary Papers*, 1847-48, VIII, Pt. I, p.4 and Pt. III, p.3
[6] *Economist*, November 4, 1848, p.1241

next reported data was assumed to be correct for the missing period. If this data was not reported at any future period, the *Railway Shareholders' Manual* (Tuck, 1845) was used to obtain the missing details. There were 150 securities where data on either the number of shares or par value could not be ascertained.

Several additional variables were also included. The value of uncalled capital for each asset was calculated as the difference between the nominal value and the par value of that asset. Data on dividends, for the subset of companies which were also reported in the *Course of the Exchange (*a share list produced by a stockbroker) were also recorded. The risk-free rate was approximated as the yield on Government Consols, which was also obtained from the *Course of the Exchange*.

3 Embedded Leverage

The standard approach to obtaining a leveraged position in an asset is to obtain credit, possibly from a financial institution, and then use this to purchase the asset. However, leverage can also be produced by entering into a derivatives contract. Rather than borrowing the full amount at the start, there is an obligation to make future payments embedded within the asset. Investors have effectively borrowed the funds from the counterparty. By paying a small deposit, and making a commitment to future payments, it is possible to obtain exposure to the movements of the underlying asset.

In the following sections it is suggested that it may be appropriate to regard the partially paid shares issued during the Railway Mania as either futures or options. Consequently, the leverage which results from these asset classes may have been available to investors during this period.

3.1 Partially Paid Shares as Futures

The relationship between fully paid and partially paid shares can be illustrated by a no arbitrage argument. Investors should receive the same return from purchasing a fully paid up share, or from purchasing a partially paid up share and paying the remaining liability. Assuming that investors could not default on their liability, a partially paid share can be modelled as a future contract with a fixed payment in the future, and the fully paid share can be regarded as the underlying security. The relationship between the price of a future contract and an underlying security is given in Equation 1, as stated by Hull (2003, p.50), adjusted to account for dividends which can be expressed as a percentage of the future payment.

$$S = f + Ke^{(-r+q)t} \quad (1)$$

where: S = Price of underlying security

f = Price of future contract

K = Size of future payment

r = Risk-free interest rate

q = Dividend rate

Applying the relevant variables during the Railway Mania produces Equation 2. This functional form has also been proposed by Dale et al. (2005) in their analysis of the pricing of different issues of South Sea stock which had different par values.

$$P_{full} = P_{partial} + U_{partial}\ e^{(-r+q)t} \quad (2)$$

where: P = Price of asset

U = Uncalled capital

r = Risk-free interest rate

q = Dividend rate

To illustrate the implications of uncalled capital on the market price of an asset an example will be used of the relationship between two assets issued by the Great Western Railway (GWR), before a more comprehensive analysis of other companies. The GWR has been

chosen as it had both fully paid and partially paid shares listed on the market for almost the entire sample period, and longer than any other company. At the beginning of 1843 two 'GWR Half Shares' had a nominal value of £100, and a par value of £100, meaning that original subscribers were initially liable to pay up £100, and this full amount of £100 had already been called up. In 1843 the 'GWR Original Shares' had a nominal value of £100, and a par value of £65. This meant that shareholders had already paid the company a total of £65, but they were also liable to pay a further £35 at some time in the future. During the period between 1843 and 1850 the two 'GWR Half Shares' retain their par value of £100 throughout the period, but the par value of the 'GWR Original Shares' rise in a series of instalments from £65 to £100.

When only the market prices of the assets are compared the difference in prices appears to change over time, as suggested in Panel A of Figure 3. However, the previous discussion suggests that this is actually a comparison between the price of an ordinary share and a future contract. A fairer comparison would be between the fully paid 'GWR Half Shares' and the implied price of an equivalent fully paid 'GWR Original Share'. This implied price can be estimated using Equation 2, by adjusting the price of the partially paid 'GWR Original Share' to take account of uncalled capital. Once these adjustments have been made, for each day of the sample between 1843 and 1850, there appears to be a close relationship between the implied prices of the fully paid shares, as shown in Panel B of Figure 3.

<< INSERT FIGURE 3 >>

It is possible to introduce a more systematic analysis, which can be used to examine a wider sample of companies, by testing for cointegration. By using the Engle-Granger 2-step approach (Engle and Granger, 1987) it is possible to test if the difference between the two series is stationary. This involves regressing the level of price 1 on the level of price 2, and

testing the residual using the Augmented Dickey Fuller (ADF) test. If the ADF test is significant it is possible to reject the presence of a unit root and conclude that the two series are cointegrated. This test for cointegration has been carried out for the pair of GWR assets discussed above, and then repeated for all other qualifying pairs of assets. To be included in the analysis a pair of assets had to be issued by the same company, have the same *pro rata* dividend rights, and both be listed on the stock market for at least one year, and be traded on average at least once per week. Any assets which delisted and were then relisted with a different nominal or par value were excluded. The size of the ADF statistic, and its significance, for each cointegration test is shown in Table 1. The results suggest that when uncalled capital is accounted for, either as a separate variable or to produce a notional fully paid share, there is evidence of cointegration for almost every pair of assets.

<< INSERT TABLE 1 >>

The cointegrating vector has also been estimated for each of these asset pairs. A vector with a value of 1 would suggest that the partially paid share was priced, on average, the same as the fully paid share. A vector greater than 1 would suggest that the fully paid share may have been overpriced, and a vector below 1 may suggest the fully paid share was slightly underpriced. The cointegrating vector was estimated using Dynamic OLS, which includes past, present and future values of the change in X in the regression, as this is efficient in large samples as suggested by Stock and Watson (2003, p.557), with the results shown in Table 2. There appears to be a cointegrating vector close to 1 for most pairs of assets.

<< INSERT TABLE 2 >>

These results taken together, suggest that the no arbitrage relationship proposed in Equation 2 provides a good explanation of how shares with uncalled capital were priced. Using the most realistic assumptions of a discount rate (-r + q) between 0 per cent and 10 per cent shows a

strong pattern of cointegration, and a cointegrating vector close to 1. The only exceptions involved two assets issued by the York and North Midland (YNM) for Extensions and a Scarborough Branch which only cointegrate using a very high dividend rate. It is not clear from Tuck (1848) or company reports[7] whether these two exceptions had different dividend rights, but as they were both issued specifically for branch lines, it is possible that this was the case. These exceptions do not negate the general finding that investors were pricing partially paid shares as if they were future contracts, which meant that investors who purchased these assets were effectively purchasing leveraged futures.

3.2 Partially Paid Shares as Options

The discussion has thus far assumed that the contract which subscribers entered into to pay future instalments was a binding obligation. However, there has been the suggestion that it may be better to treat these assets as options, as the holder may have had the right, but not the obligation, to pay a future amount and obtain a fully paid share. Shea (2007b) has argued that this option to avoid future payments, and forfeit the partially paid share, was present during the South Sea Bubble and can explain why the prices of different partially paid shares diverged.

The relationship between the price of the partially paid share, the call option, and the fully paid share, the underlying security, can be shown from put-call parity, as shown in Equation 3. The fully paid share may be said to have price S, with the partially paid share having price c. The amount which an investor must pay to exercise the option and obtain a fully paid share is the size of the uncalled capital, which is the sum of future instalments due, and can be referred to as K.

[7] *Railway Times*, 1843-50

$$S = c + Ke^{-rt} - p \quad (3)$$

where: S = Price of underlying security

c = Price of call option

K = Size of future payment

r = Risk-free interest rate

q = Dividend rate

Applying the relevant variables during the Railway Mania would produce Equation 4. The difference in the implied price of a fully paid share when the partially paid share is treated as a future contract, and when it is treated as an option contract, is the put value.

$$P_{full} = P_{partial} + U_{partial}\ e^{(-r+q)t} - p \quad (4)$$

where: P = Price of asset

U = Uncalled capital

r = Risk-free interest rate

q = Dividend rate

p = Put Value

During the Railway Mania the legal framework for this issue was set down in the Companies' Clauses Consolidation Act[8]. This set standard clauses which companies could include in their constitutions. By this act a shareholder was to be given 21 days notice before an instalment was due. If the instalment was not paid on time the company could charge interest on the amount outstanding. If a shareholder had still failed to pay after two months, the company could sue the shareholder and attempt to recover the amount due with interest, or the directors could declare the share forfeited. At least another two months had to pass before the declaration of forfeiture could be confirmed at a general meeting, which would allow the company to sell the forfeited shares.

[8] *Parliamentary Papers*, 1845, II, p.226-227.

By suing shareholders the company could hope to obtain the full amount due, but they would have to pay legal expenses. By forfeiting the share these expenses could be avoided, and the company could sell the share in the secondary market. During the construction of the early railways (pre-1843), the practice of forfeiting shares seems to have been preferred by at least some of the companies. The Cheltenham and Great Western Railway had originally issued 7,500 shares, but by 1843 only 5,693 remained in issue, with the rest having been forfeited for non-payment of calls (MacDermot, 1964, p.83). In 1845 the *Economist*[9] noted that 'hitherto it has been the practice in the numerous cases where calls were not complied with, for the directors to declare the shares forfeited, and not to seek recourse back upon the original shareholders. In this way in one of the existing companies, no less than 8,000 out of the entire quantity of 12,000 shares, or two-thirds, were forfeited before the line was even begun.'

It should have been in the best interests of an investor to forfeit a share if the amount which the investor was required to pay was greater than the value of that share after that payment had been made. The default condition should therefore have been given by Equation 5.

$$S - K < 0 \tag{5}$$

where: S = Price of asset after payment of instalment

K = Size of instalment

By analysing data on the arrears outstanding on the instalments due on the shares of various railway companies, taken from *Parliamentary Papers* (1848, LXIII, p.275-442), it is possible to estimate whether investors chose to forfeit a partially paid share based on the criteria given in Equation 5. The data lists each instalment required on each asset for many of the railways. It states the amount that investors had paid on that instalment and the amount which was still outstanding in August 1848, when the data was collected. It does not distinguish between

[9] *Economist*, October 18, 1845, p.1013

those instalments in arrears which had already been forfeited, and those which had not. This complicates the analysis of whether an investor had definitely decided to forfeit the shares or whether they were delaying the payment decision until the company forced them to decide.

To overcome this difficulty it is possible to analyse various scenarios regarding when a decision of forfeiture was made. Alternative scenarios were considered which looked at whether companies enforced forfeiture if payment was not made after either two months, four months, one year or two years. Table 3 shows how many times the default condition was met under the various scenarios. According to the first scenario investors could have waited two months after the instalment was due, and decided on the deadline whether to pay the instalment. The criteria for default on a particular instalment was therefore whether the price of the asset, two months after the instalment due date, was less than the size of the instalment. Only those instalments where at least two months had passed could be included in the sample so only those instalments due before June 1848 were included. The other scenarios were analysed in a similar manner.

<< INSERT TABLE 3 >>

The results for the timeframe of 4 months, 1 year and 2 years suggest that there was a significantly higher default rate when it was in the best interests of investors to default. This would seem to suggest that some investors decided to pay or not, based on expected utility, rather than on ability to pay. However, the results imply that this was not universal. If the partially paid shares had been pure call options it would be expected that there would have been a zero default rate when the default criteria was not met, and 100 per cent when the criteria was met. Foote et al. (2008) find a similarly low default rate amongst home owners in the 1990s with negative equity. Although it may be inappropriate to assume that partially paid shares were pure call options, the difference in default rates depending on the default

criteria suggests that some investors did treat them this way, and would mean that some investors were purchasing leveraged options.

4 Multiplying Returns

A major effect of leverage is to multiply the returns which investors experience. This section will consider the impact which the leveraged nature of partially paid shares had for investors during the Railway Mania, initially examining first day returns before considering pricing throughout the period.

4.1 First Day Returns

Investors who subscribed to railway IPOs were asked to pay the par value of the share as a deposit. They would then be liable to pay calls up to the amount of the nominal value of the shares when the company requested it. An investor who subscribed to IPOs in the primary market and then sold those shares on the first day that they traded on the secondary market would receive a return given by Equation 6.

$$r_{partial} = \frac{P_{partial} - Z_{partial}}{Z_{partial}} \quad (6)$$

where: r = Return

P = Price

Z = Par Value

If investors had been required to pay the total cost of the asset immediately, rather than in instalments, their return can be calculated by Equation 7. The price of the fully paid share can be implied by adjusting the price of a partially paid share according to the futures pricing relationship given in Equation 2, or by the options pricing relationship given in Equation 4. The cost of the fully paid share can be implied by adjusting the par value to include the discounted sum of future calls.

$$r_{partial} = \frac{P_{full} - Z_{full}}{Z_{full}} \quad (7)$$

where: r = Return

P = Price

Z = Par Value

To analyse the impact of uncalled capital on the returns which subscribers to new companies could experience, the first day returns of 167 new railway companies listed on the London Stock Exchange between 1843 and 1850 are analysed. The criteria for inclusion in this analysis was that the asset had to be traded at least once, and full details of the nominal value, par value and the share price had to be available. Those securities where assets were subsequently relisted with changes in the amount of uncalled capital were excluded. Only the original security issued by any company was included to avoid multiple observations for each company.

The implied price of a fully paid share, assuming that the partially paid share was a future contract, was estimated using Equation 2 by adjusting the price of the future contract for the discounted sum of future payments. The risk-free rate was set as 3 per cent, which was close to the yield of Government Consols throughout the period, and as these new companies could not pay a dividend until they had completed construction and began operation, the dividend rate was set to 0 per cent. If an asset eventually became fully paid up during the sample period between 1843 and 1850 then the actual times when the instalments were due was used. If an asset delisted before becoming fully paid up then it was assumed that the instalments had been due in five equal payments within the next two years after the asset delisted. As the average time to becoming fully paid up was 3.2 years, and most assets were listed for at least several months before delisting, this seems to be a reasonable assumption.

To imply the price of a fully paid share, when the partially paid share was treated as an option contract, the Black-Scholes formula for a European call option (Black and Scholes, 1973) was used. The price of the underlying fully paid share was implied by using the partially paid share price as the call option price, and estimates of the risk-free rate, the time to exercise, the strike price and volatility. The risk-free rate was set to 3 per cent, as the yield on government Consols remained close to this rate throughout most of the period. The time to exercise was set to the difference between the current date and the time that the next call was due, plus one year, as the enforcement of forfeiture probably did not occur immediately, as discussed above. The strike price was equivalent to the remaining uncalled liability, adjusted to reflect the 5 per cent penalty interest which was imposed during the year between the instalment due date and the enforcement deadline. The median volatility of fully paid shares within the sample was 28 per cent. The volatility of partially paid shares plus the uncalled liability, which would have reflected the volatility of a fully paid share if the embedded put value was zero, was 27 per cent. For this analysis a volatility of 30 per cent is used.

It is obviously unrealistic to assume that investors in the 1840s could have implemented a pricing formula which was not published until the 1970s. However, the additional value of having the right, but not the obligation, to purchase an asset had been well understood for some time, with Murphy (2009) discussing the trading of options as far back as the 1690s. The use of the formula in this paper is to find an approximation of the impact of the right to default, rather than to obtain exact valuations.

In each instance the estimated return was adjusted by subtracting the market return on that day, to obtain the abnormal return. The difference between the returns which partially paid shares actually experienced, and the returns which would have been experienced if only fully paid shares had been issued, has also been calculated, as shown in Table 4.

<< INSERT TABLE 4 >>

The size of the return which subscribers to new schemes could obtain during the boom was substantial, with a mean return of 76.2 per cent in 1844, and 106.7 per cent in 1845. This is consistent with commentary during the period, such as the remark by the *Railway Investment Guide* (1845, p.10) that 'it will be obvious that the party who has had certain shares allotted to him, which rise to a premium (as they almost invariably do, at least for a time) has the whole of that premium for his profit. By this means, persons possessing only sufficient capital to pay the deposit, may more than double it in a day'.

However, the returns which would have been experienced if only fully paid shares had been issued was just 5.5 per cent in 1844 and 7.1 per cent in 1845 if the partially paid share was regarded as a future contract, or -4.5 per cent in 1844 and -6.3 per cent in 1845 if the partially paid share was regarded as an option contract. The difference between the returns for partially paid shares and fully paid shares was substantial and significant during these years.

These results suggest that the first day returns for underlying ordinary shares were not particularly high, but the return which was experienced was considerable because the full premium was embedded in an asset on which only a small deposit was required. The impact of uncalled capital was to multiply the returns initially experienced by investors in new companies. Thus the dramatic returns which investors experienced at this time from investing in new companies were at least partially due to the effects of leverage.

4.2 Pricing throughout Mania

To estimate the impact on shareholder returns throughout the Mania a similar analysis can be repeated for each day of the sample period. If an investor subscribed to all new railway IPOs, and then paid all subsequent calls when they were due, their cost at any particular time can be calculated as the sum of the par values of all new companies. The market capitalisation at any

particular time reflected the price at which investors could sell their shares. Consequently, a simple measure for estimating the return to investors was the price/par ratio. A price/par ratio of 1 suggested that the current market price equalled the amount which had already been invested. A price/par ratio of 2 suggested that the original investors had made a 100 per cent return, whilst a price/par ratio of 0.5 suggested investors had lost 50 per cent of their original investment.

The average price/par ratios for the established railways and new railways were calculated for each day between 1844 and 1850, and are illustrated in Figure 4. The price/par ratio of the new companies reached a peak of 2.74, which meant that an investor who had subscribed to all the new companies would have earned a return of 174 per cent. The price for each equivalent fully paid share, when the partially paid share is considered as a future contract, has been calculated using Equation 2 for each day of the sample. Assumptions regarding the time when calls were due were the same as for the analysis of first day returns. Alternative scenarios for the discount rate have been employed, being -10 per cent, 0 per cent and +10 per cent. The implied total market capitalisation and the total par value for all of the new railways have been used to calculate the implied price/par ratio for the industry, for each day, and is shown in Panel A of Figure 4.

<< INSERT FIGURE 4 >>

The implied price of each equivalent fully paid share, when the partially paid share is treated as an option contract, has been calculated using the Black-Scholes formula (Black and Scholes, 1973), using the same assumptions as for the analysis of first day returns. To obtain a range of scenarios volatilities of 20 per cent, 30 per cent and 40 per cent were analysed. The implied total market capitalisation and total par values of all new railways were related to estimate the implied price/par ratio for the industry as shown in Panel B of Figure 4.

When partially paid shares are treated as a future contract the average price/par ratio of the equivalent fully paid shares of new railways reached a peak of between 1.12 and 1.18 depending on what assumptions are made about the discount rate. When partially paid shares are treated as option contracts, even at the market peak, the implied prices of fully paid shares of new companies were lower than their par value, meaning that they were at a discount. Unreported analysis also considers alternative scenarios for the timing of calls, and also implies prices of fully paid shares if the partially paid shares were treated as compound call options. In each instance the results suggest that the returns which investors would have experienced from investing in fully paid shares would have been relatively low, but due to the leveraged nature of the partially paid shares the returns which they actually experienced were substantial.

4.3 Relative Pricing of New Railways

These estimates of the prices of equivalent fully paid shares allow an estimation of whether the shares of new railways were priced consistently with other assets. As the new railways could not pay a dividend until they had finished construction and began operation, which generally took two to three years, it was not possible for investors to initially price them using their dividends. However, it is possible to use an approximation to calculate what dividend they would eventually have to achieve to produce a similar return to the non-railways and established railways. The dividend yield can be expressed in terms of the dividend/par ratio and price/par ratio, as shown in Equation 8.

$$Dividend\ Yield = \frac{Dividend/Par}{Price/Par} \tag{8}$$

The average price/par ratio of the new railways peaked at 1.16 if partially paid shares are treated as future contracts, assuming a 3 per cent discount rate. During 1845 the non-railways were trading at an average dividend yield of 4.5 per cent, so to achieve a similar yield the

new railways should have been producing a dividend/par ratio of 5.2 per cent. This is a lower bound estimate, as it does not take account of the much greater uncertainty surrounding the new railways, or the foregone dividends during the construction phase, but it provides an approximation for required performance. The dividend/par ratio of the established railways peaked at 7.2 per cent during the Mania. An analysis of the prospectuses of 85 new railways collected from advertisements in the *Railway Times* (1843-45) suggests that the promoters of these new railways encouraged investors to expect an average dividend/par ratio of 7.9 per cent. The lower bound estimate of the required dividend/par ratio to justify the price of the new railways was therefore much lower than either the established railways or the prospectuses of the new railways suggested was possible.

The factors which contributed to the decline in the dividends of the established railways also affected the new railways, and the average dividend/par ratio amongst those new railways which were actually constructed reached a peak of just 4.6 per cent in 1849, and fell to 1.9 per cent by the end of 1850. Given the actual performance which was eventually achieved, the new railways provided a low return, but given the information available at the time the new railways were not obviously overpriced, even at the market peak.

5 Payment Schedule

The previous section focused on the effect which leverage has on returns, but the impact on the schedule with which investors must make their payments may also be important. Rather than paying the full amount initially, the use of leverage makes it possible to pay a small initial deposit and then make a series of payments in the future. The difference between the amount that investors were liable to pay, the nominal value, and the amount which they had paid so far, the par value, is reported in Table 5 for the end of each year. Only companies

where the details of both the nominal and par values are available are included in the analysis.

<< INSERT TABLE 5 >>

It can be seen from Table 5 that the total nominal value of new railways at the end of 1844 was £39.6m, and at the end of was £158.0m. In contrast, the total par value of these new railways was just £3.7m in 1844, and £15.6m in 1845, which means that during the boom in prices and promotions investors had been asked to pay up less than 10 per cent of their total liability. This implies that although 44 new railway companies had been listed by the end of 1844, investors had only provided enough capital to fully finance 4.1 companies. By the end of 1845, when 186 new railway companies were listed, investors had provided enough capital to entirely finance just 18.5 companies.

The ability to obtain exposure to the price movements of assets without having to immediately find the total capital required may have contributed to the number of new railways promoted at this time, and to the enthusiasm with which investors subscribed to the new schemes. The Economist (April 5, 1845, p.310) noted that 'it is one of their peculiar characteristics but yet not less ultimately dangerous and deceptive on that account, that from the delay of procuring the act and getting it into operation the period when the main bulk of capital is required is remote from that when the greatest excitement and speculation exists, and no immediate check is therefore experienced by calls of capital.'

When payments were eventually demanded, the resulting deleveraging may have contributed to a decline in prices. Investors were required to make regular and sizeable payments on their partially paid shares during the construction phase, especially between 1846 and 1848, as shown in Figure 5. The extent of the capital required was substantial, with railway

construction accounting for an estimated 5.7 per cent of GDP in 1846, 6.7 per cent in 1847 and 4.7 per cent in 1848 (Mitchell, 1964).

<< INSERT FIGURE 5 >>

When investors were required to make a payment on an instalment they had several choices. The simplest method was to use cash from their portfolio but they may have had liquidity constraints, making this very difficult. They could attempt to borrow from a financial institution but during the downturn, and particularly during the Commercial Crisis of 1847, this could only be done at a high rate of interest. They could effectively borrow from the railway company by delaying their payment of the instalment which would lead to a penalty interest rate of 5 per cent per annum, but this was only available for a limited period of time, with the railways only required to offer this alternative for two months after an instalment was due[10]. They may also have had the option of avoiding payment, which led to forfeiture of the asset but, as previously discussed, this would only be optimal in a limited number of occasions and may have been an ambiguous right. This left them with two commonly used alternatives. They could sell the asset on which the liability was due, or sell another asset to raise cash which could be used to pay the liability. The impact of both of these alternatives was to increase the supply, and lower the price, of railway shares.

The Times had issued warnings at the height of the Mania about the extent and impact of future calls for capital. They said 'soon or late the day will come when an untold proportion of this year's scripholders will be doubly pressed, no longer able to suffer the sums they have already paid to remain buried in the earthworks of an unfinished line, much less to pay up the quick recurring calls of the company'[11]. The *Economist*[12] noted that 'every fresh call that was

[10] *Parliamentary Papers*, 1845, II, p.226-227.
[11] *The Times*, July 30, 1845
[12] *Economist*, October 21, 1848, p.1187

made upon exhausted shareholders was attended by one of two effects – either the shares themselves upon which the call had been made were sold in order to avoid payment, or some other shares were sold in order to raise the money for that purpose. There was constantly an increasing number of sellers, and a constantly diminishing number of buyers.' This led to the result that 'lines in course of construction in place of increasing in price as more and more capital became invested in them, have after each new call fallen about as much as they should have risen.'

To estimate the impact which these calls for capital had on prices, 971 changes in capital were analysed as shown in Table 6. When a company issued a call, its return during that week was calculated, with the abnormal return being calculated as the company return minus the market return. If an asset was not traded in the week during which the call was made the calculation was carried out for the week that it was next traded.

<< INSERT TABLE 6 >>

A regression was then conducted, with the abnormal return as the dependent variable, and just a constant with no independent variables. The coefficient of the constant reveals the average abnormal return, whilst the standard error can be used to calculate whether the average abnormal return was significantly greater than zero. This process was repeated for the sample as a whole, and for each year individually. It was then extended to incorporate a longer sample window, with both three weeks and five weeks being considered. The three week window included one week prior to the event, the week of the event and one week after the event. The five week window included two weeks prior to the event, the week of the event, and two weeks after the event. In these cases the cumulative abnormal return for each event was calculated and used in the regressions as the dependent variable.

An analysis of all 971 calls for capital between 1843 and 1850 suggests that a share had an average abnormal return of -9.7 per cent in the week that a call was made on it, as shown in Table 8. If a three week period is analysed, there was an average abnormal return of -8.4 per cent, and if a five week period is considered, there was an average abnormal return of -4.7 per cent. The most likely reason for the falls in prices was investors selling some shares to pay the instalments on others. The extent of these declines, and the number of calls which were made, suggest that this exercised a considerable downward pressure on prices during this period. This implies that the process of deleveraging contributed to the decline in prices during the downturn.

6 Conclusion

Using an extensive dataset of daily data this paper has analysed the pricing of assets with uncalled capital during the British Railway Mania. It began by establishing that partially paid assets may be regarded as either futures or options. This implies that investors who purchased these assets were effectively purchasing highly leveraged derivatives.

The first impact of this leverage was to multiply the returns to investors. First day returns for the partially paid shares were significantly higher than the returns which investors would have received if they had only been able to purchase fully paid shares. The returns to investors in new railways were substantially greater throughout the boom due to the leverage embedded in the assets, but during the downturn negative returns were also multiplied. Once the effects of leverage have been accounted for, the implied prices of new companies were not unjustifiably high, even at the peak in prices.

The second impact of leverage was to affect the payment schedule which investors faced. Investors could subscribe to shares in new companies for a small deposit, but were required to make a series of payments in the future. This meant that although almost two hundred new

railways had been listed on the market at its peak, enough capital had been provided to finance only about twenty of them. When payments were subsequently required, the resulting deleveraging was associated with price declines.

These results suggest that leverage may have contributed to both the initial rises, and subsequent declines, in asset prices during the Railway Mania. This could imply that leverage is a factor which regulators should consider when attempting to maintain financial stability. It may appear to be attractive during a boom, but it can lead to problems in a downturn.

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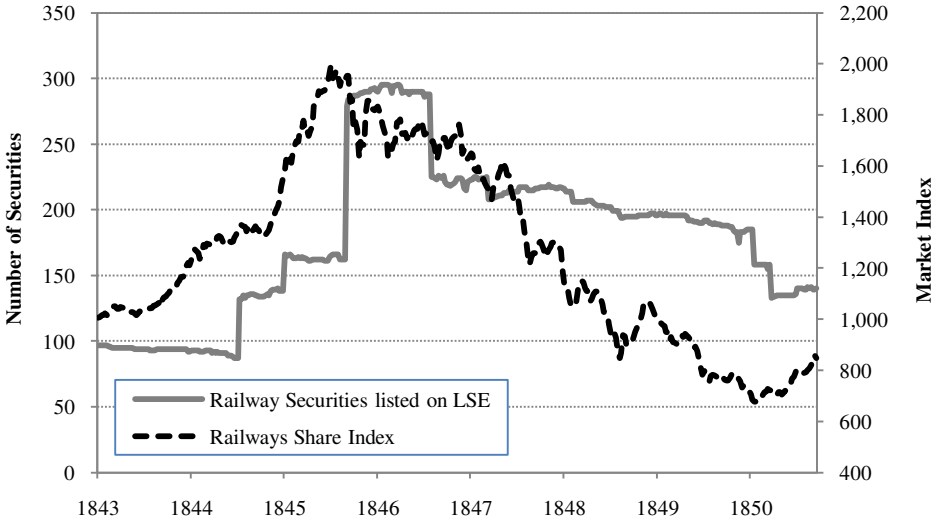
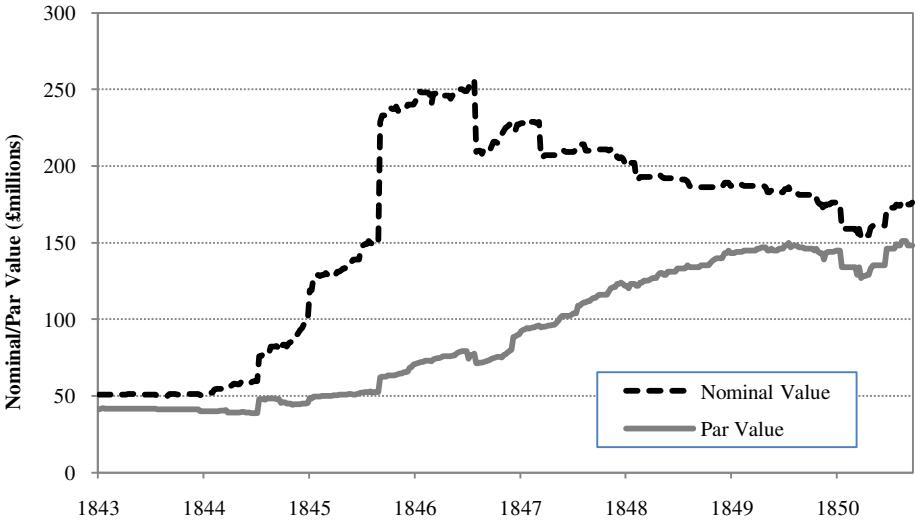
Figure 1: Number of Railway Securities Listed on LSE, and Railway Share Index 1843-50



Notes: Railway share index and number of securities listed on London Stock Exchange calculated from weekly share price tables in *Railway Times* (1843-50). Market index constructed from market returns, which have been calculated by weighting the returns of the component companies by their market capitalisation at the start of the day.

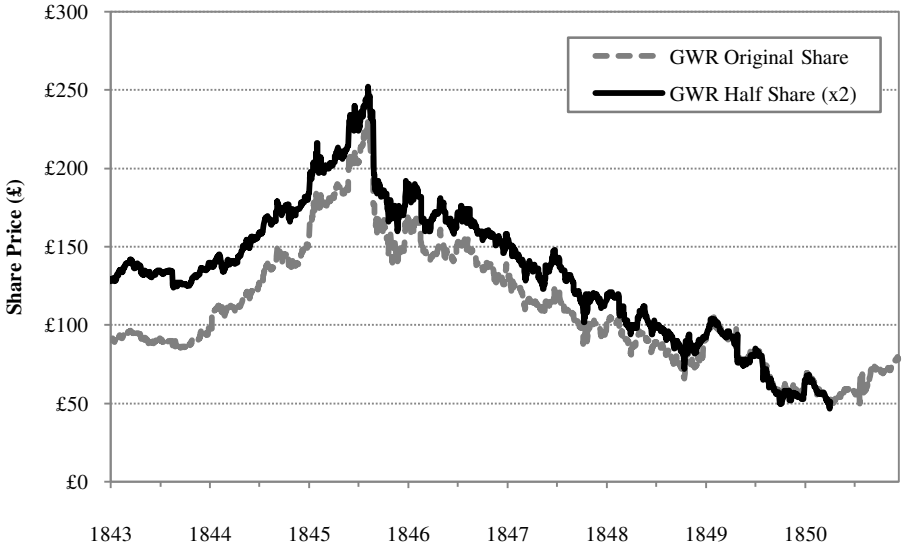
Figure 2: Total Par Value and Nominal Value of Railway Shares Listed on LSE, 1843-50



Notes: Nominal Value and Par Value for each company listed on London Stock Exchange obtained from weekly share price tables in *Railway Times* (1843-50). Industry Nominal and Par Values calculated by summing individual companies.

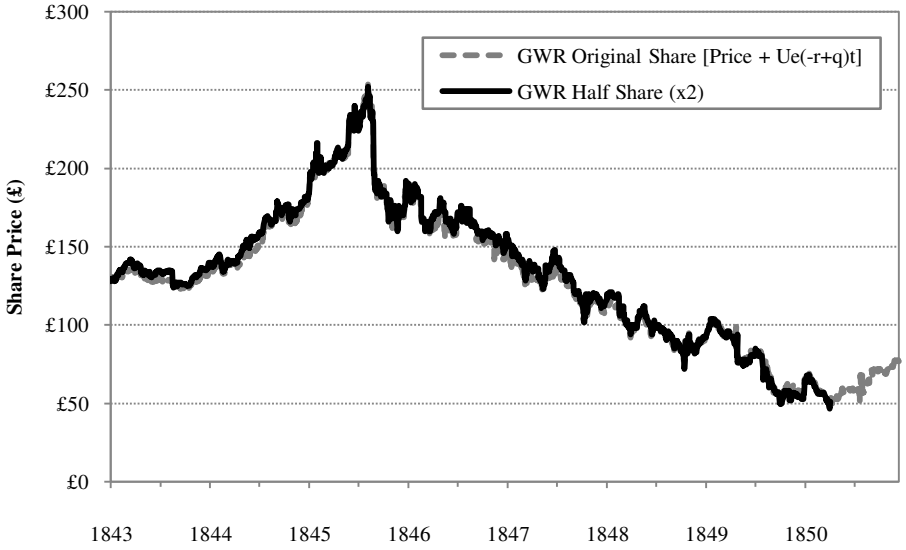
Figure 3: Daily Share Prices of a GWR Full Share and Two Half Shares, 1843-50

Panel A: Prices Observed in Market



Notes: Share prices obtained on a daily basis from weekly share price tables in *Railway Times* (1843-50).

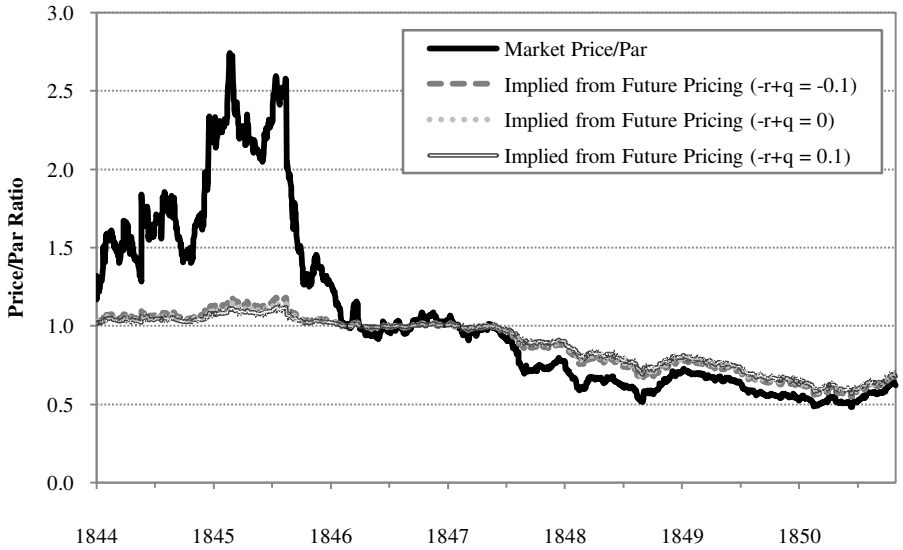
Panel B: Prices Adjusted for Uncalled Capital Discounted at Actual Risk-Free and Dividend Rates



Notes: Share prices and par values obtained from weekly share price tables in *Railway Times* (1843-50). Implied price of a GWR original share calculated using Equation 2.

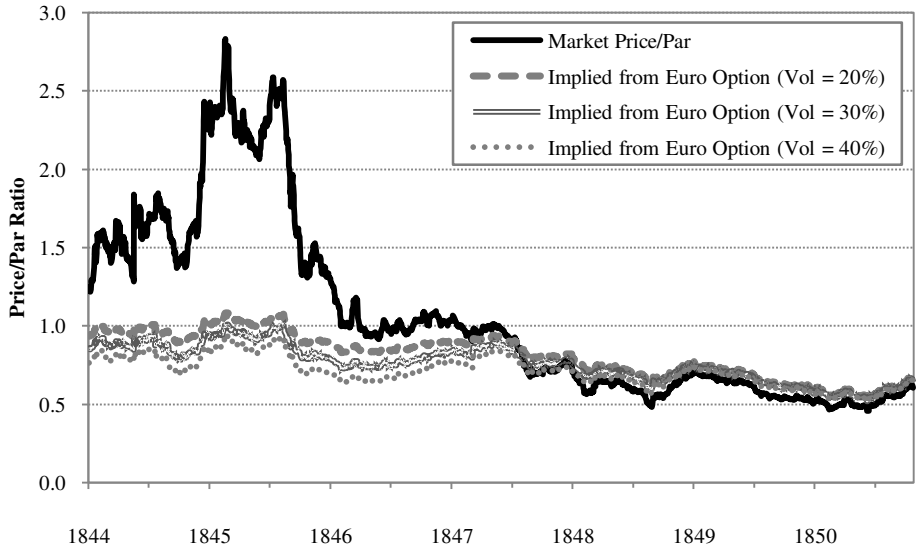
Figure 4: Price/Par Ratio of New Railways, 1844-50

Panel A: Shares Treated as Futures, using Alternative Scenarios of Discount Rate



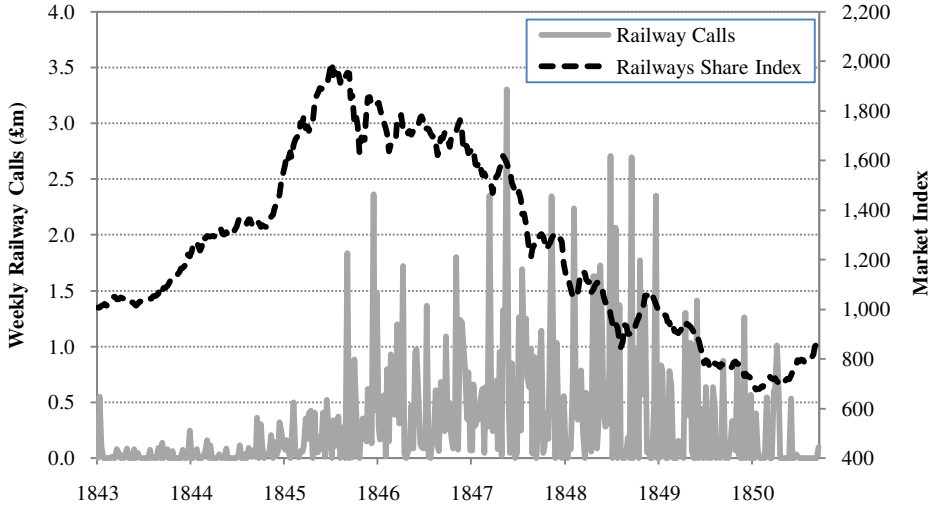
Notes: Share prices and par values for individual companies obtained from weekly share price tables in *Railway Times* (1843-50). Implied market capitalisation and par value calculated for individual new railways, promoted after 1843, using alternative scenarios of the interest and dividend rates. Implied price/par ratio of all new railways calculated as implied total market price/total cost.

Panel B: Shares Treated as European Call Options, using Alternative Scenarios of Expected Volatility



Notes: Share prices and par values for individual companies obtained from weekly share price tables in *Railway Times* (1843-50). When treated as a future the implied price/par ratio calculated as total price/total cost using an interest rate of 3 per cent and dividend rate of 0 per cent to discount uncalled capital. When treated as an option the price of a partially paid share is assumed to be the price of a European call option. The time to exercise was set to the difference between the current date and the time that the next call was due, plus one year, as the enforcement of forfeiture probably did not occur immediately. The strike price was equivalent to the remaining uncalled liability, adjusted to reflect the 5 per cent penalty interest which was imposed during the year between the instalment due date and the enforcement deadline. To obtain a range of scenarios volatilities of 20 per cent, 30 per cent and 40 per cent are shown. The Black-Scholes equation (Black and Scholes, 1973) was used to imply the price of an underlying fully paid share for each company. Total market capitalisation and par value of all new railways was calculated for each day by summing all new railways' implied market capitalisations and par values. Implied price/par ratio of all new railways calculated as implied total price/total cost.

Figure 5: Weekly Railways Calls and Railway Share Index 1843-50



Notes: Railway share index and volume of calls calculated from weekly share price tables in *Railway Times* (1843-50).

Table 1: Augmented Dickey-Fuller (ADF) Tests of Residual from Estimated Cointegrating Relationships between Fully Paid and Partially Paid Shares of Established Railway Companies

		Variables Included in Cointegrating Relationship																					
		$Y = Price_F$ $X_1 = Price_P$		$Y = Price_F$ $X_1= Price_P$ $X_2 = Uncalled_P$		$Y = Price_F$ $X_1 = Price_P$ $X_2 = Uncalled_P$ $X_3 = R_f$ $X_4 = Div$		$Y = Price_F$ $X_1 = Price_P + Ue^{(-r+q)t}$, where (-r+q) is equal to:															
Fully Paid Share ($Y = Price_F$)	**Partially Paid Share ($X = Price_P$)**							**Actual**		**-50%**		**-10%**		**0%**		**10%**		**50%**		**Obs**			
Edinburgh and Glasgow	Half Shares	-1.60		-4.78	***	-5.33	***	-4.33	***	-2.57		-3.59	**	-4.13	***	-4.72	***	-3.02		1,186			
Great Western Half Share	Full Shares	-3.82	**	-16.36	***	-16.82	***	-14.50	***	-5.11	***	-8.67	***	-13.21	***	-12.04	***	-2.22		2,284			
Great Western Half Share	Fifth Shares	-3.79	**	-17.83	***	-18.26	***	-15.93	***	-5.18	***	-10.09	***	-14.21	***	-17.20	***	-4.49	***	2,270			
Great Western Half Share	Sixth Shares	-1.13		-9.83	***	-10.18	***	-8.90	***	-4.37	***	-6.78	***	-8.29	***	-9.75	***	-4.01	***	1,119			
Great Western Half Share	Quarter Shares	-2.38		-13.28	***	-13.18	***	-11.91	***	-5.17	***	-9.31	***	-11.61	***	-11.23	***	-3.79	**	1,379			
London and North Western	New Shares	-0.87		-7.52	***	-8.64	***	-8.17	***	-1.04		-2.94		-6.18	***	-6.11	***	-2.62		1,050			
London and North Western	Fifth Shares	-1.27		-9.07	***	-10.79	***	-6.11	***	-1.15		-5.69	***	-7.07	***	-4.07	***	-2.49		1,359			
London and North Western	Quarter Shares	-1.47		-6.25	***	-6.55	***	-5.03	***	-4.08	***	-4.74	***	-4.91	***	-5.04	***	-4.02	***	537			
Midland	Half Shares	-1.43		-5.03	***	-5.72	***	-4.34	***	-1.93		-3.35	*	-4.23	***	-4.02	***	-1.95		1,284			
Midland	New Shares	-2.02		-8.84	***	-9.24	***	-8.45	***	-2.13		-5.67	***	-8.27	***	-6.65	***	-3.32	*	989			
York and Newcastle	New Shares	-2.70		-6.85	***	-6.79	***	-6.37	***	-4.69	***	-6.65	***	-6.65	***	-6.07	***	-4.21	***	327			
York, Newcastle and Berwick	Extension No. 1 Shares	-2.51		-12.00	***	-12.04	***	-9.92	***	-4.32	***	-7.04	***	-9.04	***	-10.55	***	-3.90	**	1,008			
York, Newcastle and Berwick	Extension No. 2 Shares	-1.93		-6.90	***	-7.58	***	-5.19	***	-1.72		-3.47	**	-4.70	***	-5.23	***	-2.90		438			
York and North Midland	Half Shares	-4.95	***	-14.35	***	-14.51	***	-12.30	***	-8.71	***	-10.86	***	-11.67	***	-12.59	***	-13.73	***	1,279			
York and North Midland	E&W Riding Shares	-0.89		-5.94	***	-7.86	***	-3.82	**	-2.38		-2.95		-3.31	*	-4.20	***	-4.32	***	1,035			
York and North Midland	Extension Shares	-1.54		-4.97	***	-7.40	***	-2.61		-0.90		-1.42		-2.00		-2.95		-4.09	***	886			
York and North Midland	Scarborough Branch Shares	-3.31	*	-4.27	**	-4.31	*	-2.90		-3.12		-2.96		-2.92		-2.90		-4.50	***	870			

Notes: Daily share prices and par values obtained from weekly share price tables in *Railway Times* (1843-50). Engle-Granger 2-step procedure (Engle and Granger, 1987) used to test for cointegration between a partially paid share and equivalent fully paid share for a particular established railway. When a partially paid share had a nominal value which was a fraction of a full share then the calculation was based on the relationship between a fully paid share and N partially paid shares, where N is the number of partially paid shares which would be equivalent to one fully paid share. Alternative specifications of the cointegrating relationship were tested. ADF test of the residuals from the cointegrating relationship are shown. Critical values for the ADF test of residuals given in Stock and Watson (2003, p.557). A significant ADF test rejects the presence of a unit root in the residual and suggests that the variables cointegrate. Significance shown by *** p<0.01, ** p<0.05, * p<0.1.

Table 2: Cointegrating Vector from Estimated Cointegrating Relationships between Fully Paid and Partially Paid Shares of Established Railway Companies

		Variables Included in Cointegrating Relationship									
		$Y = Price_F$ $X_1 = Price_P$	$Y = Price_F$ $X_1 = Price_P$ $X_2 = Uncalled_P$	$Y = Price_F$ $X_1 = Price_P$ $X_2 = Uncalled_P$ $X_3 = R_f$ $X_4 = Div$	$Y = Price_F$ $X_1 = Price_P + Ue^{(-r+q)t}$, where (-r+q) is equal to:						
Fully Paid Share ($Y = Price_F$)	**Partially Paid Share ($X = Price_P$)**				**Actual**	**-50%**	**-10%**	**0%**	**10%**	**50%**	**Obs**
Edinburgh and Glasgow	Half Shares	1.51	0.93	0.79	1.00	1.43	1.18	1.05	0.90	0.36	1,186
Great Western Half Share	Full Shares	1.12	1.01	0.99	1.02	1.12	1.07	1.04	0.99	0.32	2,284
Great Western Half Share	Fifth Shares	0.87	1.00	0.96	1.00	0.97	1.00	1.00	1.00	0.90	2,270
Great Western Half Share	Sixth Shares	-0.17	1.04	1.07	1.18	1.83	1.42	1.26	1.07	0.34	1,119
Great Western Half Share	Quarter Shares	1.94	1.09	1.06	1.16	1.95	1.39	1.23	1.06	0.48	1,379
London and North Western	New Shares	1.20	1.46	1.12	1.22	1.32	2.03	1.54	1.03	0.17	1,050
London and North Western	Fifth Shares	0.99	1.10	0.98	0.87	1.59	1.40	1.05	0.72	0.12	1,359
London and North Western	Quarter Shares	-0.11	1.01	0.76	1.17	1.42	1.28	1.22	1.14	0.65	537
Midland	Half Shares	0.09	1.22	0.96	1.37	2.72	1.93	1.48	1.06	0.18	1,284
Midland	New Shares	-0.46	1.11	1.09	1.12	0.88	1.32	1.18	0.99	0.39	989
York and Newcastle	New Shares	-0.01	0.96	0.92	0.90	1.35	1.17	1.01	0.83	0.27	327
York, Newcastle and Berwick	Extension No. 1 Shares	1.58	1.22	1.19	1.25	1.64	1.44	1.32	1.16	0.40	1,008
York, Newcastle and Berwick	Extension No. 2 Shares	-0.12	1.25	0.96	1.39	0.54	1.49	1.47	1.27	0.40	438
York and North Midland	Half Shares	0.66	0.89	0.87	0.89	0.80	0.86	0.88	0.90	0.97	1,279
York and North Midland	E&W Riding Shares	-0.62	0.98	0.54	1.46	1.01	1.51	1.51	1.43	0.88	1,035
York and North Midland	Extension Shares	-0.32	0.50	0.47	0.83	-0.10	0.35	0.62	0.91	0.57	886
York and North Midland	Scarborough Branch Shares	-0.15	0.43	0.46	-0.07	-0.24	-0.18	-0.13	-0.03	0.89	870
	Average	0.47	1.01	0.89	1.04	1.19	1.22	1.10	0.97	0.49	
	Average (without YNM)	0.65	1.11	0.99	1.13	1.44	1.39	1.22	1.02	0.38	

Notes: Daily share prices and par values obtained from weekly share price tables in *Railway Times* (1843-50). Engle-Granger 2-step procedure (Engle and Granger, 1987) used to test for cointegration between a partially paid share and equivalent fully paid share for a particular established railway. When a partially paid share had a nominal value which was a fraction of a full share then the calculation was based on the relationship between a fully paid share and N partially paid shares, where N is the number of partially paid shares which would be equivalent to one fully paid share. Alternative specifications of the cointegrating relationship were tested. Cointegrating vector from the first step of regression is shown.

Table 3: Forfeiture Rates on Railway Share Instalments, using Alternative Scenarios for Deadline on Payment

Time between Instalment Due Date and Deadline for Payment	N	Criteria Met		Forfeiture Rate		Difference in Forfeiture Rates		SE of Difference
		S-K>=0	S-K<0	S-K>=0	S-K<0			
2 Months	225	214	11	10.5%	13.6%	3.2%		(4.1%)
4 Months	221	197	24	8.5%	19.0%	10.5%	***	(2.4%)
1 Year	163	132	31	5.5%	14.8%	9.3%	***	(1.8%)
2 Years	74	52	22	2.7%	6.3%	3.5%	**	(1.7%)

Notes: It would have been better for the investor to forfeit the partially paid share when $S - K < 0$, where S is the price of a fully paid share and K is the instalment due. Share prices and par values obtained from *Railway Times* (1843-50). Forfeiture rates calculated from data on arrears on calls for capital published in *Parliamentary Papers* (1848, LXIII, p.275-442), assuming that any arrears which were still outstanding after the deadline had been forfeited.

Table 4: New Railways' First Day Abnormal Returns

			Return on Partially Paid Shares			Return on Fully Paid Shares if Partially Paid Shares Treated as Futures						Return on Fully Paid Shares if Partially Paid Shares Treated as Options					
Year	N	Average Paid up (%)	Mean	SE of mean		Mean	SE of mean		Mean Difference between Partial and Full	SE of Mean Difference between Partial and Full		Mean	SE of mean		Mean Difference between Partial and Full	SE of Mean Difference between Partial and Full	
1844	38	10.2%	76.2%	(17.4%)	***	5.5%	(1.9%)	***	70.8%	(15.7%)	***	-4.5%	2.9%		80.8%	14.9%	***
1845	79	6.2%	106.7%	(13.1%)	***	7.1%	(0.9%)	***	99.6%	(12.3%)	***	-6.3%	2.0%	***	113.0%	11.5%	***
1846	40	15.8%	1.9%	(9.9%)		3.4%	(2.2%)		-1.4%	(8.7%)		-9.1%	3.9%	**	11.0%	7.4%	
1847	9	20.0%	8.3%	(20.7%)		1.3%	(4.9%)		7.0%	(17.0%)		-3.3%	7.1%		11.7%	15.4%	
1848	1	10.0%	37.3%	.		3.8%	.		33.5%	.		-8.5%	.		45.8%	.	
Total	167	10.2%	69.0%	(8.5%)	***	5.5%	(0.9%)	***	63.5%	(7.9%)	***	-6.4%	1.5%		75.4%	7.4%	

Notes: Daily share prices and par values obtained from weekly share price tables in *Railway Times* (1843-50). First day actual returns calculated using Equation 6. Returns for implied fully paid up shares calculated using Equation 7. In this scenario the risk-free rate of 3 per cent was used to discount the value of future instalments to their present value. Abnormal returns calculated by subtracting the market return on the day when first traded from actual and nominal returns. Significance shown by *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Total Nominal and Par Values of New Railways, 1844-50

	Dec 27, 1844	Dec 26, 1845	Dec 25, 1846	Dec 31, 1847	Dec 29, 1848	Dec 28, 1849	Dec 27, 1850
Total for All New Railways							
Nominal Value (£m)	39.6	158.0	129.0	94.4	79.0	78.8	69.4
Par Value (£m)	3.7	15.6	24.8	36.0	48.5	57.0	53.9
Average for New Railways							
Nominal Value (£m)	0.9	0.8	1.1	1.2	1.1	1.2	1.2
Par Value (£m)	0.1	0.1	0.2	0.4	0.7	0.8	0.9
Number of New Railway Companies							
Listed on LSE	44.0	186.0	112.0	81.0	69.0	68.0	60.0
Listed if All Securities Fully Paid up and Total Par Value Remained Constant	4.1	18.5	21.6	30.9	42.4	49.2	46.6
Par/Nominal Ratio	9.2%	9.9%	19.2%	38.1%	61.4%	72.3%	77.7%

Notes: Nominal Value and Par Value for each company listed on London Stock Exchange obtained from weekly share price tables in *Railway Times* (1843-50). Industry Nominal and Par Values calculated by summing individual companies. Average values obtained by dividing totals by number of new companies listed. Estimates for number of companies which would have been listed if all securities had been fully paid up, and total par value remained constant, estimated by dividing total par value by average nominal value. Par/Nominal Ratio calculate by dividing total par value by nominal value.

Table 6: Event Study on Company Returns when Calls for Capital Were Issued

		One Week			Three Weeks			Five Weeks		
Year	**Number of calls**	**Mean**	**SE of mean**		**Mean**	**SE of mean**		**Mean**	**SE of mean**	
1843	22	-4.2%	(2.5%)		-0.7%	(3.5%)		2.4%	(3.0%)	
1844	36	-4.6%	(2.1%)	**	-2.5%	(3.5%)		4.8%	(4.8%)	
1845	110	-4.1%	(1.6%)	**	-2.4%	(1.7%)		-1.3%	(2.2%)	
1846	197	-7.4%	(1.9%)	***	-6.0%	(2.1%)	***	-3.9%	(2.2%)	*
1847	218	-9.1%	(1.2%)	***	-7.9%	(1.5%)	***	-6.2%	(1.7%)	***
1848	182	-16.1%	(1.8%)	***	-14.3%	(2.1%)	***	-6.5%	(3.4%)	*
1849	149	-11.9%	(2.3%)	***	-11.4%	(2.3%)	***	-6.9%	(2.6%)	***
1850	57	-10.9%	(3.8%)	***	-10.4%	(3.6%)	***	-6.1%	(6.1%)	
Overall	971	-9.7%	(0.7%)	***	-8.4%	(0.8%)	***	-4.7%	(1.1%)	***

Notes: Share prices and par values obtained from weekly share price tables in *Railway Times* (1843-1850). Time of call defined as the week on which paid up value of the share changes in the share list. If company does not trade during the week a call is made, the fair value estimate is calculated as (previous price + size of call). The return is calculated for the next week in which the share is traded. One week return is the return during the week in which the call is made, three week return also includes previous week and subsequent week, five week return includes the two previous weeks and two subsequent weeks. Significance shown by *** p<0.01, ** p<0.05, * p<0.1, testing if the mean return is significantly different from 0.