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TECHNOLOGICAL REVOLUTIONS AND SPECULATIVE FINANCE: EVIDENCE FROM THE BRITISH BICYCLE MANIA

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Technological Revolutions and Speculative Finance: Evidence from the British Bicycle Mania

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Abstract

Technological revolutions are often accompanied by substantial stock price reversals, but previous literature has produced competing explanations for why this is the case. This paper brings new evidence to this debate using data from the innovation-driven British Bicycle Mania of 1895-1900, in which cycle share prices rose by over 200 per cent before collapsing by more than 75 per cent. These price patterns are not fully explained by fundamentals or by changes in the nature of risk associated with cycle shares. Instead, the evidence from the Bicycle Mania supports the hypothesis of Perez (2009), who argues that new technology, high short-term profits, and loose monetary conditions increase the level of speculative investment, 'decoupling' share prices from fundamentals.

Keywords: Technology, innovation, historical stock markets, asset price reversals.

JEL Codes: G19, N23, O39.

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1. Introduction

Recent research has noted that major technological breakthroughs are often accompanied by substantial asset price reversals, which have the potential to profoundly impact economies. However, the mechanism that leads from new technology to an asset price reversal is unclear. Shiller (2005, 2015) proposes that excitement over new technology and high initial profits leads to periods of irrationally high pricing, similar to those described in Galbraith (1994), Kindleberger (1978), and Minsky (1986; 1992). Within this framework, Perez (2009) suggests treating 'major technology bubbles' as a distinct category of asset price boom, defined as the point at which new technology stock prices 'decouple' from their underlying fundamentals. These hypotheses are contradicted, however, by research stressing the extent to which share prices during such episodes remain consistent with underlying fundamentals (Donaldson and Kamstra, 1996; Fama, 1991; Garber, 1989, 1990). In this area, Pástor and Veronesi (2006, 2009) develop a model in which a boom-bust pattern in new technology shares is the rational result of uncertainty surrounding the extent to which the technology will be adopted.

Evidence from previous technological booms is reasonably consistent with the predictions of both the speculative finance hypothesis advocated by Perez (2009), and with the time-varying uncertainty hypothesis advocated by Pástor and Veronesi (2009). Studies have thus arrived at opposite conclusions when studying the South Sea Bubble (Frehen et al., 2013; Kleer, 2015; Neal, 1990) and the dot-com boom of the 1990s (Pástor and Veronesi, 2006; Shiller, 2005). As a result, it is difficult to separate the extent to which technology-driven share price booms are explained by each dynamic.

This paper provides new evidence to this debate by evaluating a technology-driven boom and bust which has attracted almost no previous research: the British Bicycle Mania of 1895-1900. During this episode, a series of technological innovations rapidly increased the demand for bicycles, resulting in both a promotion boom and a substantial reversal in the prices of listed bicycle companies. However, there has been no in-depth economic analysis of share price movements during this episode. Data on share prices and fundamentals during the mania is therefore hand-collected from various sources order to empirically test the aforementioned hypotheses. The results are consistent with the hypothesis of a speculative technology bubble advocated by Perez (2009), but not with the time-varying risk hypothesis advocated by Pástor and Veronesi (2009).

The widely-reported asset price reversal in cycle shares is first quantified using prices gathered from a combination of the *Financial Times* and several local Birmingham newspapers, with these prices then collated into a daily market-capitalisation-weighted index. This index rises by over 200 per cent in early 1896, but loses 76 per cent of its peak value by the end of 1898, comfortably fulfilling the purely price-based criterion for an asset price bubble set out by Goetzmann (2015). In order to determine whether these prices departed from fundamental values, dividends are then collected from *Stock Exchange Yearbooks*. The consistency of prices with current and future dividends throughout this period is tested using a model which expresses the share price as a function of current dividends, the expected rate of return, and an implied rate of future dividend growth. The dividend growth rate implied by various assumed expected rates of return is then compared to the one and two-year observed rates of dividend growth. Even under the assumption of an unreasonably low expected rate of return, observed rates of dividend growth are substantially lower than those implied by cycle share prices. This suggests that prices were not consistent with short-term fundamentals.

The long-term performance of cycle firms is then investigated using the winding-up orders published in the *London Gazette* and BT31 files, which are held in the National Archives in London. 122 of the 141 cycle companies investigated either declared bankruptcy, were reconstructed, were wound up voluntarily, or were wound up for unknown reasons. The final traded share prices of these firms indicates that subscribers would generally have lost the vast majority of their initial investment. The profits accumulated by any long-term successes, the most notable of which was the Dunlop Company, are insufficient to offset these losses. The high level of cycle share prices in 1896 and 1897 is therefore not explained by the long-term performance of cycle firms.

The model of Pástor and Veronesi (2009) is then tested by comparing its predictions about the price, volatility and beta of 'new economy' stocks to those observed during the cycle mania. This hypothesis is consistent with the rapid growth in new technology observed directly before the cycle mania, as noted by Harrison (1969) and illustrated by the volume of cycle-related patents issued at this time. However, share prices reach a minimum much later than the Pástor-Veronesi (2009) model predicts, and the beta of the cycle share market does not significantly change over the course of the mania. Since the model's ability to explain the reversal depends on changes in the nature of risk associated with cycle shares, it cannot fully account for the price levels observed during 1896 and 1897.

The evidence from the cycle mania is instead consistent with the hypotheses advanced by Perez (2009) and Shiller (2005; 2015), who argue that asset price reversals occur when shares are bought in the expectation of future capital gains, rather than for the underlying company's profitability. This theory predicts that several features will be present during the asset price reversal: a rapid increase in the demand for new technology; high short-term capital gains, followed by a 'decoupling' of share prices from their underlying fundamentals; loose monetary conditions, which provide sufficient liquidity for a bubble to develop, whilst stimulating a 'reach for yield'; and qualitative accounts of speculative investment, in which investors buy shares with the intention of quickly re-selling them after prices rise.

This paper contributes to extant literature by providing an insight into the role of financial markets in the integration of new technology into an economy. Perez (2002, p.xviii) notes that while much has been written on the importance of financial markets to economies, and on the response of economies to innovation, relatively little research studies the relationship between innovation and financial markets (notable exceptions include: Eatwell (2004); Nicholas (2008); Pástor and Veronesi (2006, 2009); Perez (2002, 2009); and Saint-Paul (1992)). Perez (2009) identifies five major technology bubbles in canals, railways, steel, automobiles and oil, and information and digital communications. However, the pattern described, in which major innovations induce 'irrational' levels of investment as a result of high initial profits and excitement about the potential of the new technology, closely resembles the British bicycle mania. In contrast, the evidence from the cycle mania does not support the model of Pástor and Veronesi (2009).

This paper also contributes to the literature on asset price reversals by providing new evidence from an episode on which there is little previous research. Existing studies on the British bicycle industry in this era have focused on the effectiveness of British capital markets and the competitiveness of the cycle industry (Harrison, 1969, 1981; Millward, 1989; Lloyd-Jones and Lewis, 2000). Those dealing directly with the mania's financial element provide only narrative accounts of the fraudulent dealings of company promoters (Rubinstein, 1977; Stratmann, 2010). Whereas previous literature has often stressed the extent to which share prices remained consistent with fundamental values during famous manias (Campbell, 2012; Garber, 1990), this paper suggests that this was not the case for the cycle mania. This supports the findings of Galbraith (1994), Kindleberger (1978), and Shiller (2015), who argue that asset price reversals often contain a 'bubble' component, unexplained by economic fundamentals. The relative importance of the speculative feedback loop in driving the mania also supports the findings of Minsky (1992) and Wray (1991, 2008), who argue that asset price booms are primarily explicable by speculation.

The remainder of this paper is structured as follows. Section two constructs a narrative account of the mania from previous literature, and outlines the explanations for it provided by the contemporary financial press. Section three attempts to establish whether share price patterns were explicable by changes in fundamental values, as approximated by dividends and long-term firm performance. Section four examines the consistency of the mania with the dynamics identified by Pástor and Veronesi (2009) and Perez (2009). Section five summarises the main findings.

2. The Cycle Mania

The growth of the cycle industry between 1895 and 1900 had its origins in a series of technological innovations. The 'safety' design, diamond frame, and pneumatic tyre made for a much more comfortable ride, and the use of ball bearings and new processes for producing weldless steel tubes substantially increased British productive capacity (Harrison, 1969). The widespread adoption of the pneumatic tyre in 1895 resulted in a rapid increase in demand for bicycles, which existing producers struggled to meet (Rubinstein, 1977, p.51). There was thus a rapid increase in the number of registered cycle manufacturers in Britain: Harrison (1969) reports a fourfold increase between 1889 and 1897, with the majority based in the West Midlands (Millward, 1989). Rubinstein (1977) estimates that at the height of the boom in 1896, 750,000 bicycles were produced per year, and 1.5 million people cycled, at a time when the population of Britain was around 35 million.

The prevalent fashion for cycling was accompanied by a boom in the promotion of cycle manufacturing companies. The combined subscribed capital of cycle, tube and tyre companies floated in 1896 was over £17 million, around one eighth of the total value of all UK issues in that year, with another £7.7 million raised in 1897 (Harrison, 1981). The increase in the number and size of cycle companies floated at this time can be seen in Table 1, which shows the nominal capital of cycle, tube, tyre and motor corporations issued between 1895 and June 1897. The 29 companies issued in the first half of 1895 had a combined nominal capital of £540,000; the first half of 1896 saw 128 companies issued with a combined nominal capital of £15.5 million (although not all of these companies were fully subscribed).

<<<INSERT TABLE 1 HERE>>>

The largest cycle company to issue shares in this period was the Dunlop Company, which was floated in May 1896 for £5 million. This company was formed by combining the patents of some smaller firms with those of the Pneumatic Tyre Company, which was bought by promoters for £3 million in April 1896.[1] The nominal value of the Pneumatic Tyre Company had been only £300,000, and the profits earned by its shareholders as a result of its acquisition generated considerable excitement in the cycle share market. On April 22nd 1896, the *Financial Times* described the market as having 'gone mad' amid reports of increased activity and large increases in the price of several cycle shares.[2] This sentiment was repeated in an editorial the following week, which stated that 'cycle shares promise to become as inflated as the tyres'.[3]

The boom in cycle manufacturing did not last, and the industry went into recession after 1897. Millward (1989) estimates that in Birmingham, the focal point of the industry, 54 per cent of cycle companies that existed in 1896 were no longer in business by 1900. This decline is attributed by Harrison (1969) to the passing of a worldwide 'fashion' for bicycles, American competition, and the unwillingness of British companies to offer cheaper models of bicycle. It

[1] Nominal capital data is obtained from the *Stock Exchange Yearbooks* between 1895 and 1900. Details of the formation of the Dunlop Company are available from Stratmann (2010).
[2] *Financial Times*, 'The Cycle Trade Boom', 22nd April 1896.
[3] *Financial Times*, 'Cyclomania', 27th April 1896.

also appears to have been accompanied by a fall in the value of cycle shares, with the *Financial Times* reporting in July 1897 that 'cycle shares have depreciated considerably [since 1st May].'[4] The surviving British cycle firms did not recover until after 1906, when firms began to cut prices (Harrison, 1969). Long-term success was generally only achieved by companies which branched into related industries: tyres for other vehicles (Dunlop, Palmer), motorcycles (Rudge-Whitworth, Triumph), and motor cars (Rover, Riley). The notable exception is Raleigh, which became a globally successful bicycle firm only after being privately acquired during major financial difficulties in 1908 (Lloyd-Jones and Lewis, 2000).

What explanations did the contemporary press provide for rapid increases in the price of cycle shares? *The Economist* repeatedly argued that there was a strong element of gambling in the purchase of cycle shares, with 'rampant speculation' brought about by the aforementioned sale of the Pneumatic Tyre Company.[5] It is repeatedly claimed that many buyers of cycle shares did so in the hope of quickly selling the shares on at a small profit. Subsequent editorials were heavily critical of the methods used by cycle company promoters, with one article accusing promoters of being 'imbued with… a very robust faith in the gullibility of the average investor', a factor which has also been emphasised by Harrison (1981).[6] Another *Economist* article in May 1897 emphasised the role played at that stage by a lack of liquidity in the market, claiming that 'anybody wishing to buy cycle securities finds it extremely easy to get what he wants… holders… desiring to sell are told by their brokers that in nine cases out of ten there are no buyers about'.[7] The *Financial Times* was broadly in agreement, whilst also emphasising the effect of 'the prevalent feminine fashion for bicycle-riding' in driving demand.[8] *Money* noted that the vendors of the cycle firms overwhelmingly

[4] *Financial Times*, 'Cycle Shares & American Over-Production', 6th July 1897.
[5] *The Economist*, 'The "Boom" in Cycle Shares', 25th April 1896.
[6] *The Economist*, 'Cycle Company Promotion', 27th June 1896.
[7] *The Economist*, 'The Markets for Cycle Shares', 22nd May 1897.
[8] *Financial Times*, 'Cyclomania', 27th April 1896.

chose to take cash rather than shares in the new company, 'showing the faith these gentlemen have in their own concerns'.[9] The general picture presented by these newspapers is one in which rapid price rises attracted speculative money, resulting in prices rising above their fundamental values. These price levels were then maintained by a lack of liquidity in the market, slowing the market's corrective mechanism in 1897 and 1898.

3. Cycle Share Prices and Fundamentals

The narrative presented by the financial press contradicts Fama (1991), who argues that supposed 'bubbles' in share prices should be indistinguishable from rational time-varying returns. Previous studies of historical asset price reversals have often found that, contrary to contemporary reports of market irrationality, prices remained reasonably consistent with dividend payments (Campbell, 2012; Garber, 1990; Voth, 2003). This section uses data on daily share prices, dividends, and winding-up orders to assess whether cycle share prices remained consistent with fundamental values or experienced an asset price 'bubble'.

What constitutes an asset price bubble? Siegel (2003) argues that, in order to be classified as such, an event must fulfil two criteria. The first, in accordance with Kindleberger (1978, p.16), is that there is 'an upward price movement over an extended range that then implodes'. This criteria has been quantified by Goetzmann (2015), who categorises share price movements as a 'bubble' if there is a rise of more than 100 per cent over the course of either one or three years, and fall by at least 50 per cent, either in the following year or over the next five years. The second criteria, in accordance with Garber (2000, p.4), is that this price pattern is 'unexplainable based on… fundamentals'. Prices must at some point rise above the level implied by the profitability of underlying firms, not simply be the result of unforeseeable

[9] *Money*, 'Cycle Promotions', 20th June 1896.

changes in their circumstances. This section tests the consistency of each of these criteria with data from the Bicycle Mania.

3.1 Cycle Share Prices

Whether a substantial price reversal occurred is tested using cycle share prices hand-collected from contemporary newspapers, namely the *Birmingham Daily Post*, *Birmingham Daily Mail*, and *Financial Times*, between 1895 and 1898. The coverage of the *Financial Times* was most comprehensive, but only begins in April 1896, so a combination of the two Birmingham newspapers is used prior to then. In total, 143 cycle, tube or tyre companies had a share price listed at least once in one of these newspapers during this period: 96 producing bicycles, 24 producing tyres, and 23 producing tubes.[10] Summary statistics for these companies are shown in Table 2. As can be seen, there is considerable variation in the size of these companies, with nominal capitals ranging from £10,000 to £5 million. Data on par value was unavailable for three companies; of the remaining 140, 128 issued shares at £1, indicating that these companies were keen to attract as wide a range of investor as possible (Acheson et al., 2012; Jefferys, 1977).

<<<INSERT TABLE 2 HERE>>>

The daily share prices of these companies are then collated into an index, in order to track the level of cycle share prices during the period. In accordance with Le Bris and Hautcoeur (2010), this index is weighted by market capitalisation.[11] Market capitalisation is calculated by multiplying the price-par ratio of each firm by its subscribed capital, i.e:

[10] Eight general engineering companies that also produced bicycles and four motor companies are excluded. An index including these companies was also calculated, but any differences between the two indices were minimal, and this index is excluded for the sake of brevity.

[11] Price-weighted returns and equally-weighted log returns are also calculated as a robustness check, but the resulting indices are not notably different from one weighted by market capitalisation.

$$m_{i,t} = \frac{p_{i,t}}{\pi_i} * s_i \quad (1)$$

where π is the par value of firm i and s is its subscribed capital. A daily index return on cycle shares is then calculated using the formula:

$$R_t = \sum_{i=1}^{N} (w_{i,t} \times r_{i,t}) \quad (2)$$

with weighting $w_{i,t} = m_{i,t-1} / \sum_{i=1}^{N} m_{i,t-1}$ and

$$r_{i,t} = [(p_{i,t} - p_{i,t-1})]/[p_{i,t-1})]$$

where N is the number of stocks, p_i is the price of stock i at time t, and $m_{i,t-1}$ is the market capitalisation of firm i at time t-1.

The index at the first date, 2 September 1895, is set equal to 100. Each subsequent value of the index is calculated as:

$$I_t = I_{t-1} * (1 + R_t) \quad (3)$$

where I_t is the value of the index at time t and R_t is the return at time t.

The resulting cycle share index is shown in Figure 1. Its value increased by 261.5 per cent between January and May 1896, before declining modestly for the remainder of 1896. The first three months of 1897 show cycle share prices partially recovering, before a prolonged decrease for the remainder of 1897 and 1898. The value of the index falls from 276.2 at its peak in May 1896 to 65.6 at the end of 1898, a decrease of 76.3 per cent. This episode therefore comfortably fulfils the criteria for an asset price bubble set out by Goetzmann (2015), which requires a rise of only 100 per cent and a subsequent fall of 50 per cent.

<<<INSERT FIGURE 1 HERE>>>

<<<INSERT FIGURE 2 HERE>>>

One important issue when tracking an industry over such a volatile period is variation in the number of listed companies. This variation is shown graphically in Figure 2: at the end of 1895 less than ten companies were listed, 127 were listed by the summer of 1897, and by the end of 1898 only 65 remain. The change in the number of cycle shares presents a problem when tracking share prices, because the index does not account for the first-day returns of new additions. For example, if existing firms were valued highly relative to new firms, the price level implied by the index would be disproportionately high. To deal with this shortcoming, two other metrics to describe changes in the prices of cycle shares are calculated: the average price-par ratio of listed cycle firms, and their aggregate market capitalisation. The price-par ratio is calculated as:

$$\sigma_t = \frac{p_t}{\pi} \qquad (4)$$

where p_t is the price of the share at time t and π is its par value. This figure is a measure of how highly a share is valued relative to its face value, and thus has the advantage of accounting for first-day returns. It also provides a measure of the risk-adjusted return expected by investors, since dividends are paid in proportion to a share's par value.

Figure 3 shows the arithmetic mean of the price:par ratio for all listed cycle shares between September 1895 and December 1898. It is notable that the rapid increase in the number of incorporated cycle firms in early 1897 is not accompanied by a decrease in the average price-par ratio of listed firms. On the contrary, this ratio increases from 1.24 on January 1st 1896 to a peak of 1.41 on March 10th 1897. This suggests that investors expected the average risk-adjusted return on cycle shares to increase in this period, despite the corresponding increase in the number of companies. The average price of cycle shares relative to par was considerably lower than in March 1897 than in spring of the previous year, a fact which is not immediately apparent from the market-capitalisation weighted index. However, by this measure, prices still rise and fall on a large enough scale to meet the criteria of Goetzmann (2015).

<<<INSERT FIGURE 3 HERE>>>

Finally, Figure 4 shows the aggregate market capitalisation of all publicly-listed cycle firms between 1895 and 1898, calculated by multiplying the subscribed capital of each firm by its price-par ratio. This measure rises from around £2.5m in 1895 to a peak of £20.8m in April 1897. Thereafter, it steadily declines, reaching £5.4m in January 1899. This measure shows that while the average share price relative to par value peaked in spring 1896, the aggregate level of investment in the industry peaked in spring 1897. Once again, the extent of the rise and fall in the aggregate market value of these companies comfortably meets the criteria of Goetzmann (2015).

<<<INSERT FIGURE 4 HERE>>>

3.2 Cycle Company Fundamentals

The second criteria, that share prices were unexplainable by fundamentals, can be tested in numerous ways. One possibility is to track Tobin's Q, the ratio of share prices to tangible assets, over time (Smithers and Wright, 2000). The inconsistency and poor quality of accounting data during the cycle mania, however, makes this measure unreliable. Cycle firm accounts for 1897, which were obtained from Birch (1897), generally show a large proportion of intangible assets, such as patent rights, goodwill, or trademarks. In the case of the Dunlop Company, for example, this category accounted for £4.26 million of its £5.24 million assets. It is unclear how this number was reached, making any estimate of Q subject to substantial uncertainty. Similar problems arise when attempting to replicate the price-to-earnings ratio advocated by Campbell and Shiller (1998), as earnings figures were subject to unreliable estimates of depreciation.

This paper therefore follows Gordon (1959) and Shiller (1981) in assessing the value of stocks relative to current and future dividend payments. The major advantage of using dividend data is that it is not subject to the comparability and quality issues which affect data obtained from accounts, as any reported dividends had to be paid. On the other hand, firms could have reinvested profits, resulting in gains for investors that would only become clear in the long term. In order to deal with this issue, the winding up orders of cycle firms are also examined, providing an indicator of their long-term performance.

The dividends paid by each company during the sample period are obtained from *Stock Exchange Yearbooks* between 1895 and 1900. Ex-dividend dates are obtained from the *Financial Times*. Companies which went bankrupt are assumed to pay zero future dividend, and when a company is involved in a merger, the dividends of the merged company are used. When a company ceased business for another reason, its future dividends are treated as unknown. Companies for which data are not available, usually because they did not submit their accounts, are excluded from the analysis.

Figure 5 shows the average previous and subsequent dividend of cycle firms throughout 1895-1898. As reported by the *Stock Exchange Yearbook*, these dividends are expressed as a proportion of par value, as opposed to as a yield on the current market price. Dividend payments peak in May 1896, with the average next dividend of cycle firms reaching a level of 18 per cent. The dividend level remains relatively high, above 6 per cent, until March 1897, but falls to between 2 and 3 per cent during 1898, and 1.4 per cent during 1899.

<<<INSERT FIGURE 5 HERE>>>

To test whether cycle shares were priced consistently with dividends, a pricing model is required. The approach chosen is that of Voth (2003): calculating the dividend growth rate implied by the general level of share prices, and comparing this implied rate to the observed rate of dividend growth. This model is chosen because it is valid under very general assumptions, with the exception of an assumed expected interest rate, which can easily be varied to produce a range of plausible results.

The pricing model assumes a representative consumer who maximises the discounted value of future expected consumption, as in the consumption capital asset pricing model. The price level can therefore be expressed as a function of three factors: current dividends, expected dividend growth, and the expected return, which incorporates an appropriate risk premium. Assuming a constant rate of dividend growth g, and a constant expected return i, the price level p can be expressed as:

$$p=\frac{d_0(1+g)}{i-g} \quad (5)$$

Making g the subject, this formula becomes:

$$g=\frac{(pi-d_0)}{d_0+p} \quad (6)$$

Following Voth (2003), various estimates of i are used. The average dividend yield for the 125 largest British companies in 1898 was 3.93 per cent (Kennedy and Delargy, 2000, pp.54-56). This is almost definitely too low: Grossman (2002) identifies positive capital appreciation of between 1.31 and 2.84 per cent in this period, and the preference shares issued by cycle companies almost always promised an annual dividend of between 5 and 7 per cent.[12] The 3.93 per cent estimate is therefore used as a lower bound. Grossman (2002, p.140) calculates the average market-capitalisation-weighted total annual return on stocks between 1872 and 1913 as 6.39 per cent, and this is used as an alternative measure. Finally, an estimate assuming a value of 8 per cent is used, 8 per cent being the rate of dividends on ordinary shares

[12] The annual dividend on cycle company preference shares are obtained from the *Stock Exchange Yearbook*.

promised by the Dunlop Company upon its launch in May 1896.[13] This value is almost certainly too high: the Dunlop Company's shares were oversubscribed, going to market at a 25 per cent premium, which implied a dividend yield of 6.4 per cent. Furthermore, this was by far the largest listed cycle company, and it is possible that investors in smaller firms would have expected a greater return to compensate for a higher level of risk.

The resulting implied dividend growth rates are shown in Figure 6. It can be seen that share prices implied high dividend growth until the summer of 1896, but from October 1896 onwards, implied dividend growth was almost exclusively negative, even at the highest assumed value of i. There is a notable large decrease in May 1896 resulting from the payment of a 100 per cent dividend by the Beeston Pneumatic Tyre Company. The story behind this dividend payment is documented by Stratmann (2010); it seems likely that E.T. Hooley, a promoter, paid the dividend from his own personal funds in a successful attempt to inflate the price of the company's shares. This payment was announced in the spring of 1896, and may have contributed to the rapid price increases experienced by the overall market for cycle shares at that time. Since Ponzi finance constitutes an important part of the alternative hypothesis of Minsky (1992), the Beeston Company is included in the analysis; however, the results are robust to its exclusion.

<<<INSERT FIGURE 6 HERE>>>

How realistic were these implied growth rates? The simplest way to answer this question is to compare these implied rates to the true rates of dividend growth observed in the industry. These observed rates are calculated on a one-year and two-year basis using the aforementioned dividend data. Using longer term data is unfeasible, because so many cycle

[13] *Financial Times*, 'Cyclomania', 27th April 1896.

companies did not survive beyond 1900. One-year dividend growth is defined as the percentage change in annual dividend payments from one year to the next, i.e.:

$$\gamma_{t,t+1} = \frac{d_{t+1} - d_t}{d_t} \tag{7}$$

For the purposes of calculating two-year growth rates, the effect of discounting can be assumed to be negligible, given the short time horizon and low risk-free rate in this period. Two-year dividend growth is therefore defined as the percentage change in dividends from the current year to the average of the two subsequent years, i.e.:

$$\gamma_{t,t+2} = \frac{((d_{t+1} + d_{t+2})/2) - d_t}{d_t} \tag{8}$$

The resulting time series are shown in Figure 7. Dividend growth rates are seen to be extremely high between January and May 1896, and extremely low from then onwards. Also notable is that two-year dividend growth was consistently lower than one-year growth, implying that the financial position of cycle firms continued to worsen until at least the end of 1900.

<<<INSERT FIGURE 7 HERE>>>

These rates are then subtracted from the implied dividend growth rates in order to estimate the difference between the expectation and reality of future dividends. These differences are shown graphically in Figures 8 and 9. All six series indicate that future dividend growth was underestimated between January and May 1896, which may explain why cycle share prices rapidly rose throughout the spring of that year. Thereafter, implied rates of dividend growth are generally higher than observed rates, often by a significant margin. Using the mid-range assumed value of i, share prices in May 1896 implied a rate of dividend growth 89 per cent higher than that observed over the subsequent two years. While prices were slightly more consistent with one-year dividend growth, the gap between the implied and observed level is still substantial.

<<<INSERT FIGURES 8 & 9 HERE>>>

Finally, it is necessary to briefly examine the long-term performance of cycle firms. Frehen et al. (2013) note that share prices during the South Sea Bubble, although high relative to immediate growth, appear reasonably consistent with the long-term performance of some underlying firms. To determine the extent to which this was the case for the cycle mania, the circumstances under which the majority of cycle companies became defunct are examined. Data on company winding-up orders, mergers, and reconstructions is obtained from BT31 files and the *London Gazette*, and summarised in Table 3. Table 3 also includes the average final share prices of each sub-group of companies, expressed as a proportion of par value, as reported in the *Financial Times*. A complete list of these companies is provided in Appendix Table 1.

<<<INSERT TABLE 3 HERE>>>

As Table 3 shows, 113 of 134 cycle companies for which data is available no longer existed in their original form in 1910. The final share prices of these companies suggest an average loss of 48.7 per cent on their initial par value, although this includes some firms which merged during the years 1896-1897, often at a large profit to shareholders. The most common reason that firms ceased to operate was bankruptcy, with the final share prices in these cases implying that shareholders were likely to lose the vast majority of the price paid at subscription. Companies which wound up voluntarily, reconstructed, or ceased business for unknown reasons also appear to have resulted in the loss of the majority of the initial investment. On average, the 21 companies which survived beyond 1910 were trading at just 42.2 per cent of par in December 1903, indicating substantial medium-term losses in these firms too. While some of these companies went on to become relatively successful, no realistic level of long-term profitability would have compensated investors for their losses on other cycle firms. It is therefore safe to conclude that investors in the cycle mania, excluding those who sold their shares during the mania, on average experienced substantial losses.

Is it possible that these losses were the result of changes to underlying factors that investors could not have foreseen? This question is impossible to provide a definitive answer to, but the aforementioned coverage of the financial press demonstrates the existence of a significant number of commentators who believed cycle shares to be overpriced. *The Economist*, for example, stated in February 1897 that 'a great many brokers… do their best to discourage the buying of most of the cycle issues, for the simple reasons that the particulars available are generally of a very vague character, and… the valuation placed upon the shares of freely discounts future profits'.[14] These concerns were repeated by both the *Financial Times* and *Money*; the only consistently dissenting voice was *Cycling Magazine.*[15] This is not necessarily proof that the crash could have been anticipated: it is possible that the financial press was simply inclined toward negativity in general. However, the qualitative evidence available does not support the contention that this collapse was unforeseeable.

4. Technology-based Explanations for the Cycle Mania

Since fundamentals do not appear to explain these price movements, it is necessary to search for an alternative explanation. Previous literature has advanced numerous mechanisms by which an asset price reversal can develop, many of which are summarised by Brunnermeier and Oehmke (2012). Since the cycle mania appears to have been closely linked with innovation, the hypotheses chosen to be tested are those which explicitly account for the effect of new technology. The first is that of Pástor and Veronesi (2009), who argue that the reversal

[14] *The Economist*, 'Cycle and Motor-Car Companies', 20th February 1897.
[15] *Financial Times*, 'Cycle Shares & American Over-Production', 6th July 1897; *Money*, 'Over-capitalisation in Cycles', 10th March 1897; *Cycling*, 'Financial', 27th November 1897.

is associated with changes in the nature of risk associated with new technology stock during a technological revolution. The second is that advanced by Perez (2009) and Shiller (2005; 2015), who argue that shares can temporarily become overpriced as a result of speculative investment, overconfidence in the profitability of new technology, and loose monetary conditions.

4.1 New Technology and Changes in the Nature of Associated Risk

Pástor and Veronesi (2009) propose a mechanism by which new technology can stimulate the development of a bubble-like pattern in share prices without irrational investor behaviour. The logic of the model is as follows. Prior to the large-scale adoption of a new technology, the risk associated with new-technology firms is idiosyncratic. As a result, the shares of these firms will command a risk premium. Whether the technology will be adopted is unknown *ex ante*, but as its use increases, positive cash flow news will cause share prices to increase. However, the adoption of the technology by the rest of the economy then causes the nature of risk associated with the shares to change from idiosyncratic to systemic. The risk premium therefore falls, resulting in a ‘bubble’ pattern in the share prices of new-technology firms.

A precondition of the Pástor-Veronesi model is significant technological innovation, with uncertainty regarding the scale of its adoption. The role of innovation in increasing demand for bicycles has been emphasised by Harrison (1969), and can be seen from the increase in the quantity of cycle-related patents issued in this period. Table 4 shows the number of British patents issued mentioning cycles, tyres, tires, bicycles, or velocipedes in their subject field between 1885 and 1896. At the peak of the cycle mania in 1896, this accounted for 4,269 patents, 14.8 per cent of all patents issued in that year. Uncertainty over the scale of adoption is evident from the responses of the contemporary press to the increase in demand for bicycles. The *Financial Times*, for example, expressed concerns over whether this demand would be maintained.[16] *The Economist* simply stated that 'it is impossible to say how long the rage for cycling will last'.[17]

<<<INSERT TABLE 4 HERE>>

The Pástor-Veronesi model's testable predictions require share price indices to be developed for both the 'old economy', consisting of existing firms which do not initially use the new technology, and the 'new economy', in this case cycle firms (Pástor and Veronesi, 2009, p.1453). A daily index of blue chip firms is therefore developed for the period 1895-1897. This index is weighted by market capitalisation and compiled using the same methodology as that of the daily cycle share index. It consists of the 30 largest firms by ordinary capital in 1898, as reported by Kennedy and Delargy (2000). The share prices of these companies are obtained from *The Times*. The constituent companies are listed in Appendix Table 2. The resulting index, alongside the cycle share index for the equivalent time period, is shown in Figure 10. Notably, the boom in cycle shares is not accompanied by a similar pattern in the price of blue-chip shares, and the two indices do not appear to be correlated.

<<<INSERT FIGURE 10 HERE>>>

In order to determine longer-term trends, monthly indices for both cycle shares and blue chip shares are calculated for the years 1895-1903. For simplicity, these indices are price-weighted, and returns are calculated as:

$$\text{Index return at time t:} \quad R_t = \sum_{i=1}^{N} (w_{i,t} \times r_{i,t}) \tag{9}$$

$$\text{with weighting } w_{i,t} = (p_{i,t-1}) / \sum_{i=1}^{N} (p_{i,t-1}) \quad \text{and}$$

$$r_{i,t} = [(p_{i,t} - p_{i,t-1})] / [p_{i,t-1})]$$

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[16] *Financial Times*, 'Cyclomania', 27th April 1896.
[17] *The Economist*, 'The "Boom" in Cycle Shares', 25th April 1896.

As in the previous calculations, indices at the first date, 2 September 1895, are set equal to 100, with each subsequent value calculated as:

$$I_t=I_{t-1}*(1+R_t) \qquad (10)$$

The resulting monthly indices are shown in Figure 11. Once again, the two indices do not appear to be correlated. These indices also show the lack of any substantial recovery in the cycle share market in the early 1900s.

<<<INSERT FIGURE 11 HERE>>>

What empirical predictions does the Pástor-Veronesi model make? The first is that the bubble in stock prices should be much stronger in the new economy than in the old economy, a criteria which, as Figures 10 and 11 show, is comfortably fulfilled for the cycle mania. The second is that stock prices in both economies should reach a minimum at the end of the revolution, defined as the point at which large-scale adoption becomes inevitable. Choosing this point is necessarily subjective, but the sales figures and narrative evidence quoted by Rubinstein (1977, p.51) suggest that bicycles were in widespread use by June 1896. Even allowing for some flexibility with this date, this criteria does not appear to have been fulfilled, because Figure 11 shows that cycle share prices did not reach a minimum until mid-1900.

The model also predicts that the new economy's volatility should exceed that of the old economy, rise sharply before the end of the revolution, and both volatilities should peak at the end of the revolution. In order to test these criteria, the 30-day volatility of both daily indices is computed. 30-day volatility is defined as the sample standard deviation of the previous 30 daily log returns of each index, i.e.:

$$\sigma_n=\sqrt{\frac{1}{29}\sum_i^{30}(u_{n-i}-\bar{u})^2} \qquad (11)$$

where

$$u_i = \ln\left(\frac{I_t}{I_{t-1}}\right)$$

and $\bar{u}$ is the mean of all values of u_i in the calculation.

The resulting volatilities are shown in Figure 12. The Pástor-Veronesi model predicts a much higher volatility in the new economy than in the old, and this is consistent with the cycle mania: the volatility of the cycle index ranges from 0.002 to 0.035, whereas the blue chip index volatility ranges from 0.001 to 0.004. These results are robust to adjustments for the number of firms in each index. Consistent with the Pástor-Veronesi model, volatility rises sharply in the spring of 1896, and peaks at the ‘end’ of the revolution in June 1896.

<<<INSERT FIGURE 12 HERE>>>

The final predictions made by the Pástor-Veronesi model concern the beta of the new economy, which should rise sharply, peaking at the end of the revolution. Since shares for which risk is idiosyncratic command a premium, this would partly explain the rise and fall in cycle share prices. To test whether this was the case, two measures of beta are calculated: one using a rolling window of 100 days, and one using a rolling window of 30 months. Beta is defined as the coefficient of a regression of the cycle share return on the blue chip return, as in the equation:

$$y_t = \beta x_t + k \qquad (12)$$

where y_t is the return on the cycle share index at time t and x_t is the return on the blue chip index at time t. Figures 13 and 14 show the two measures of beta alongside two-standard-error confidence intervals.

<<<INSERT FIGURES 13 & 14 HERE>>>

As these figures show, the daily measure of beta is not significantly different from zero at any stage, and the monthly measure is only significantly above zero for two very brief periods in 1898 and 1903. Neither measure shows any similarity to the pattern predicted by the Pástor and Veronesi (2009) model, regardless of which date is chosen as the 'end' of the revolution. This represents a significant challenge to the ability of the model to explain the mania, as the bubble-like pattern in share prices is assumed to result from changes to the beta of cycle firms. Given that cycle firms' beta does not change, there is little support for this hypothesis.

4.2 Speculative Investment and Behavioural Effects

Having rejected the hypothesis of Pástor and Veronesi (2009), we are left with few potential explanations which do not contain some behavioural element. Garber (1990) suggests that, since this type of explanation is difficult to test directly, it should be treated as a 'non-explanation', to be resorted to only when all other possibilities are exhausted. This is a mischaracterisation; many recent behavioural theories of bubbles constitute clear, falsifiable hypotheses, and make a number of empirical predictions. This sub-section explores whether one such explanation, that of Perez (2009), is consistent with the evidence from the cycle mania. Perez (2009), building on the work of Shiller (2005; 2015), defines an asset price bubble as the point at which investors in a stock switch from buying shares for their fundamental value to buying shares in the hope of quick capital gains. The shares thus become objects of speculation, their prices 'decoupled' from the profitability of underlying firms.

The distinctive feature of Perez's (2009) work is the emphasis given to the effect of new technology. While her hypothesis is not wholly inconsistent with the dynamics identified by Pástor and Veronesi (2009), it also pinpoints two further mechanisms by which a technological revolution can lead to the decoupling of share prices from fundamentals. Firstly, share price increases could arise from the overconfidence of investors in the profit-making potential of new technologies (Perez, 2009, p.783). Shiller (2015) has described this confidence as ‘new-era thinking’, whereby some investors believe that the new technology will allow for permanently higher profits than were possible in the past. Secondly, existing new technology firms often experience a rapid increase in short-term profits as the technology becomes widely adopted. This initially stimulates high capital gains for new technology stocks, attracting speculative investors.

In addition to the presence of new technology, this theory predicts that financial markets will display three features. Firstly, there should be a sharp increase in the profits of existing firms that use the new technology, resulting in high short-term capital gains. This should then be followed by share prices ‘decoupling’ from fundamentals, rising above a value justified by the profitability of underlying firms. Secondly, since the price inflation is driven by speculative investment, it is more likely to occur when monetary conditions are loose and the yield on traditional assets is low. In these circumstances, investors may be inclined to search for alternative investments with a greater return, resulting in higher levels of speculation. Thirdly, the influx of speculative money into the new technology stocks is likely to be commented on by the financial press.

The consistency of the first prediction with data from the cycle mania can be seen in Figures 5, 8, and 9. The average annual cycle company dividend increased from below 4 per cent in 1895 to over 15 per cent in 1896. When excluding the Beeston Company’s unusual 100 per cent dividend from this calculation, the average dividend still peaks at over 12.5 per cent, indicating a genuine increase in the profitability of existing cycle firms. However, as has previously been discussed, the accompanying rise in cycle share prices was so substantial that they reached a level which implied an unrealistic level of future dividend growth. This is consistent with the hypothesis that share prices were no longer being priced according to the profitability of underlying firms.

In order to determine whether the return on traditional assets was unusually low, the yield on British consols and the Bank of England's minimum discount rate in the period 1866-1902 are obtained from Global Financial Data and the Bank of England respectively. British consols were widely considered to have been among the safest and most liquid assets in this period, and thus provide a good approximation of the risk-free rate of return. The minimum discount rate is a good indicator of how loose monetary conditions were. These measures are shown in Figure 15, with the years 1896 and 1897 highlighted. The yield on consols can be seen to have reached a minimum of below 2.5 per cent in spring of 1896, the point at which cycle share prices peaked. This also coincided with the end of a prolonged period in which the bank rate was 2 per cent, the lowest rate in the 1866-1906 time period. Since investors may be expected to respond this environment by seeking alternative investments, this is consistent with the hypothesis that the cycle mania was driven by an increase in speculation.

<<<INSERT FIGURE 15 HERE>>>

Finally, if many investments were being made for speculative purposes, it is likely that the financial press would comment on this phenomenon. This type of evidence is necessarily circumstantial, because it is impossible to know with any certainty the motivations of individual investors. It is, however, relevant that 'rampant speculation' was the explanation for the boom in cycle shares provided by the contemporary financial press. *The Economist* stated that many shares were bought 'in the hope of being able to realise their holdings at a profit after a little while', and that many subscribers 'had no intention of holding whatever they are allotted if they can secure a premium'.[18] The *Financial Times* attributed the boom to the 'harum-scarum

[18] *The Economist*, 'The "Boom" in Cycle Shares', 25th April 1896; *The Economist*, 'The Cycle Boom', 16th May 1896.

speculation' of 'avaricious speculators', comparing investing in cycle shares to gambling in Monte Carlo.[19] *Money* stated that 'while panics run in cycles, the present mania began with a run on cycles', and that there had been 'a great deal of wild speculation' in the cycle share market. They also highlighted the role of loose monetary conditions and a subsequent reach for yield, arguing that 'the investing public is suffering from too much wealth' and 'as interest has shrunk… he is in danger of putting his money into the first sink that offers'.[20]

The Perez (2009) hypothesis therefore appears to best explain the cycle mania. Alternative hypotheses, which stress the consistency of share prices with fundamentals, are rejected, and the specific features predicted by Perez (2009) are present. It is important to note that this hypothesis does not necessarily imply that all, or even a majority of investors, were in some way 'naïve' or 'irrational'. Previous literature has highlighted several reasons why informed investors may not immediately correct overpricing. They could, for example, have been short-sale constrained, as in the models of Ofek and Richardson (2003) and Schienkman and Xiong (2003), or they may have found it more profitable to 'ride' the bubble, as in the model of Abreu and Brunnermeier (2002, 2003). However, these mechanisms generally require the existence of some speculative, overconfident, or uninformed investors, and assume that share prices are temporarily inconsistent with fundamentals.

5. Conclusion

This paper investigates the causes of an asset-price reversal in British cycle shares in the years 1895-1900. I find that the price of cycle shares after spring 1896 is inconsistent with subsequent dividend growth, and investors in the mania who did not sell during the boom years generally suffered heavy losses. Contrary to the predictions of the Pástor and Veronesi (2009) model, the risk associated with cycle shares did not change from idiosyncratic to systemic during the

[19] *Financial Times*, 'The Cycle Market', 22nd May 1896.
[20] *Money*, 'The History of Panics', 30th May 1896.

reversal, implying that the risk dynamics which they argue explains technological asset price reversals did not apply to the Bicycle Mania. In terms of explaining the reversal, the evidence is found to be most consistent with the framework of Perez (2009), who argues that share price bubbles develop when high short-term profits in new technology stocks attract speculative money, leading to a decoupling of share prices from fundamental values.

A particularly interesting feature of this mania was the fact that a subset of firms adapted during the crash by moving into the newer technology, especially motor cars. Eatwell (2004) has argued that technology bubbles can have positive effects, as they are linked to high levels of investment in the most innovative sections of the economy; what is arguably 'irrational' from a financial perspective could be more rational than the alternative from the perspective of the public good. This would appear to apply particularly strongly to the cycle mania, which resulted in significant capital flowing to innovative companies without being accompanied by economy-wide instability.

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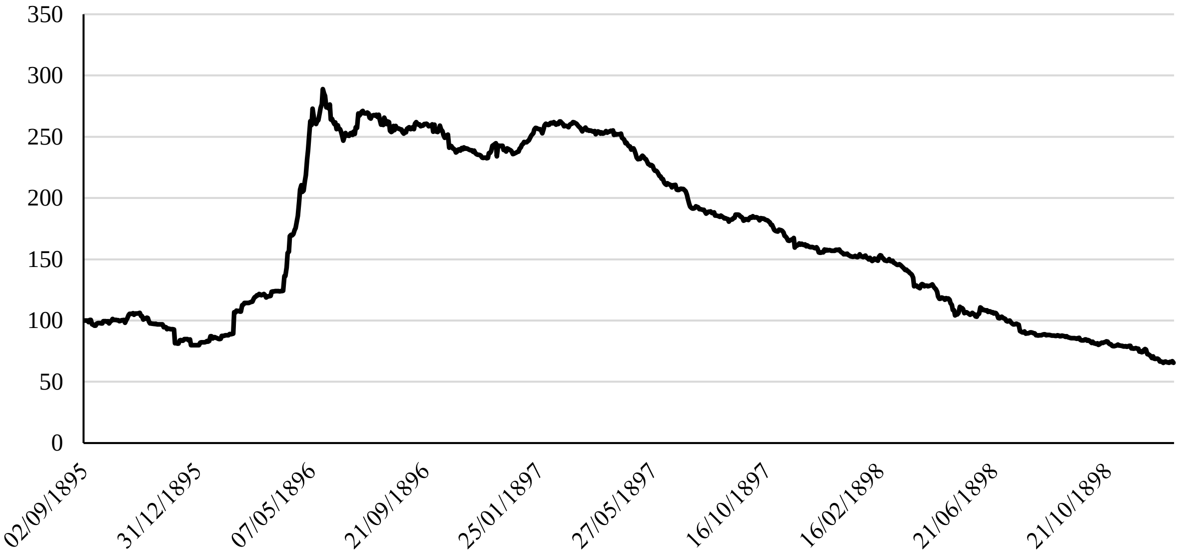
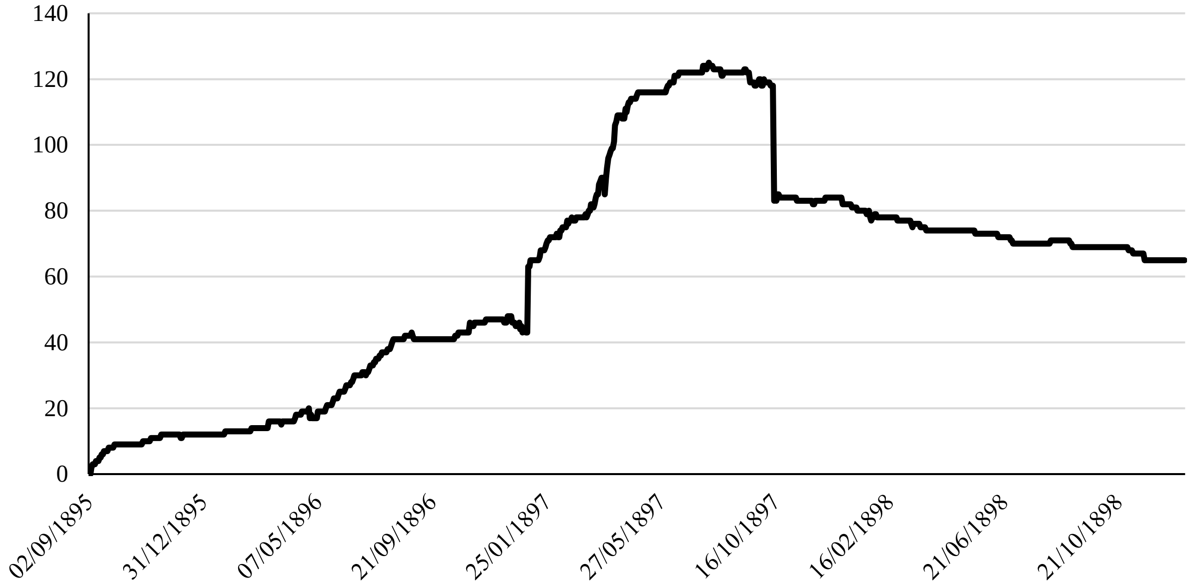
Figure 1: Market Cap-Weighted Daily Cycle Share Index, 1895-1898



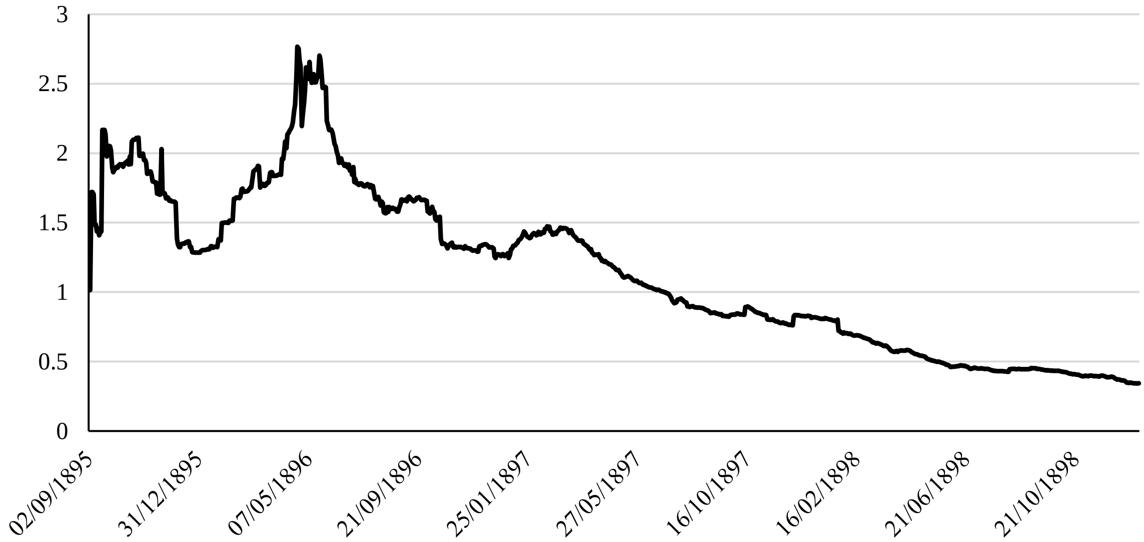
Sources: see text.

Figure 2: Number of Cycle Company Share Prices Listed in News Media, 1895-1898



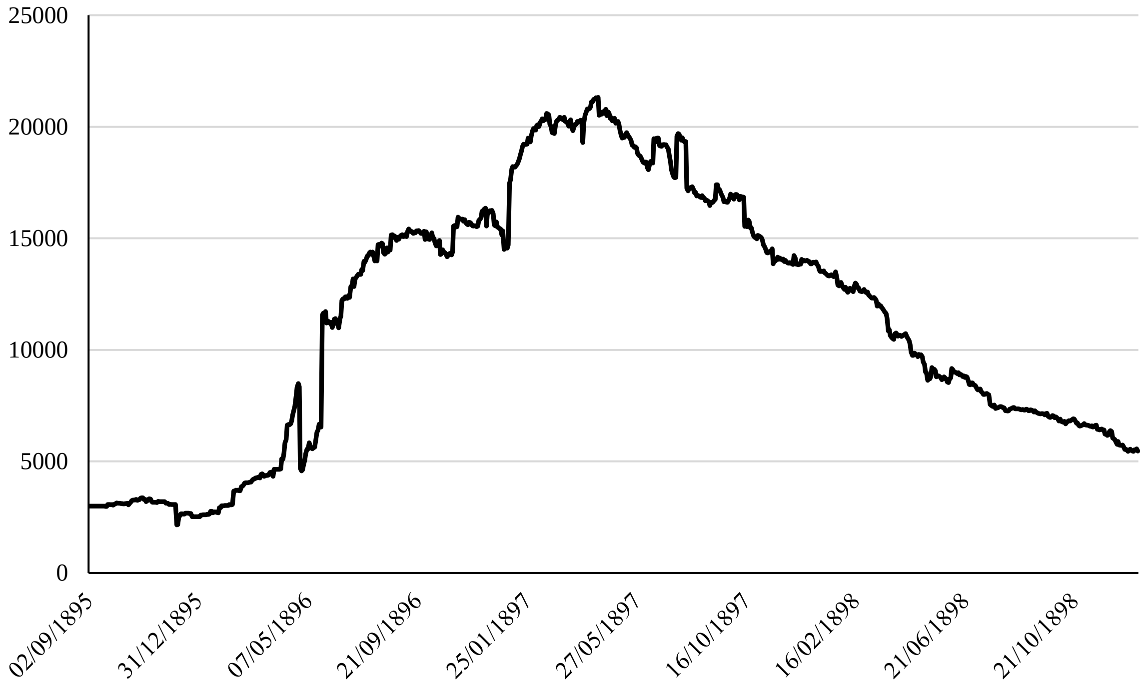
Sources: *Birmingham Daily Mail, Birmingham Daily Post, Financial Times*.
Notes: The large sudden increase and decrease of January 1897 and October 1897 result from changes to the *Financial Times* coverage. January 1897 marks the beginning of systematic reporting of non-trading cycle share prices, whereas October 1897 corresponds with the date at which unofficially listed companies were removed from the index. Unofficially listed companies generally had a low subscribed capital, and so, as can be seen from Figure 4, this incident had a very minor effect on aggregate market capitalisation (and, by extension, the index).

Figure 3: Average Price-par Ratio of Listed Cycle Firms, 1895-1898



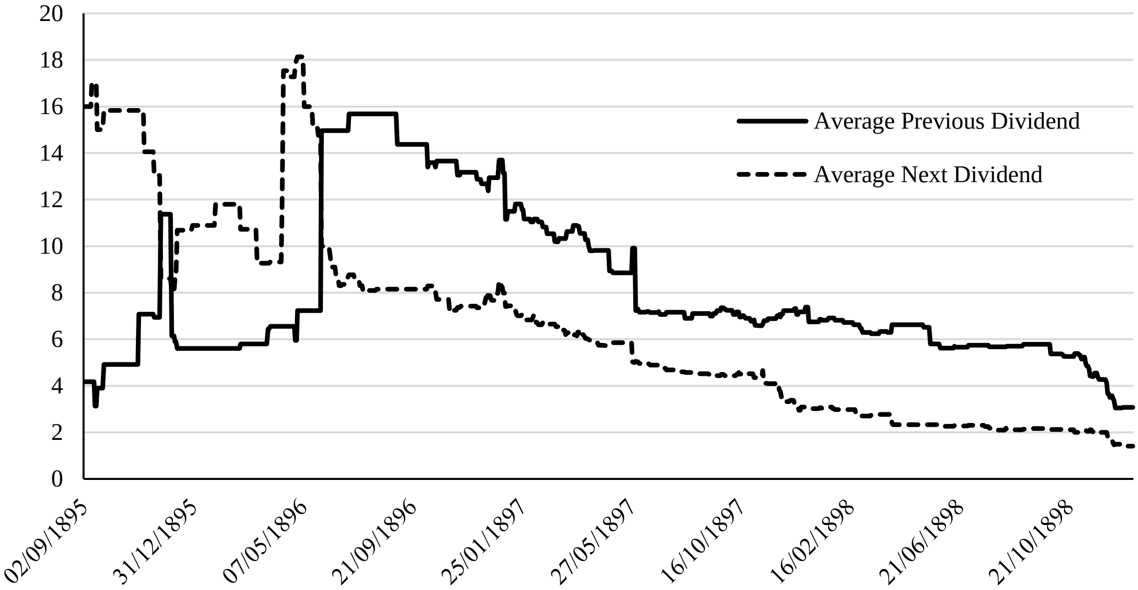
Sources: *Birmingham Daily Mail, Birmingham Daily Post, Financial Times*.

Figure 4: Total Market Capitalisation of Publicly Listed Cycle Firms (000's of Pounds), 1895-1898



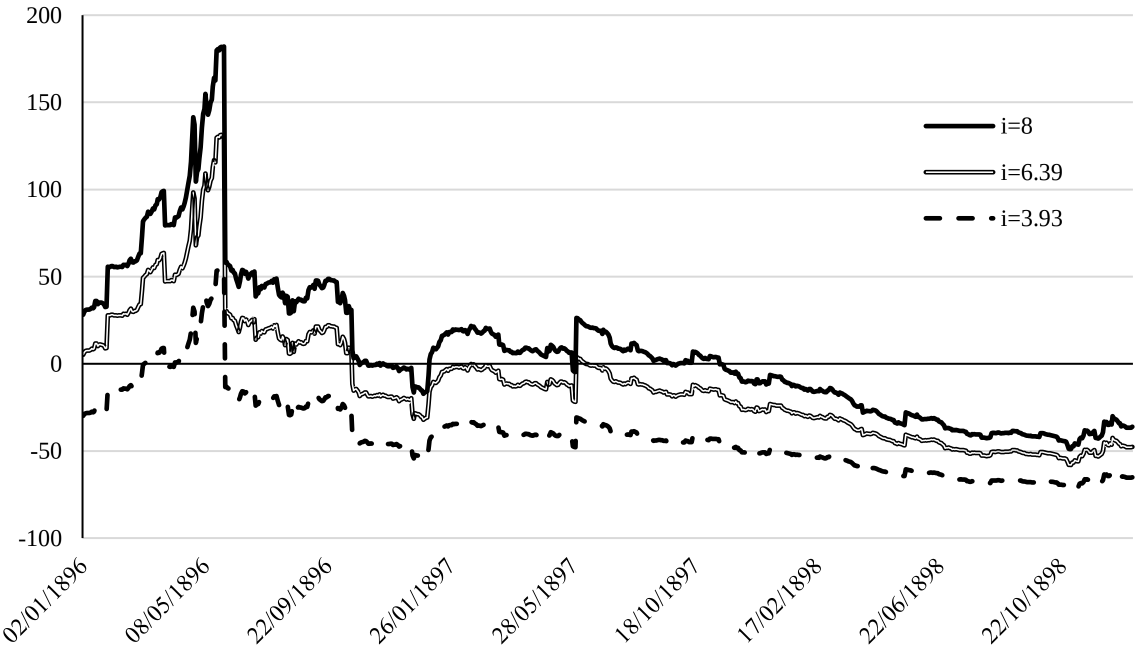
Sources: see text.

Figure 5: Average Cycle Company Dividends, 1895-1898 (%)



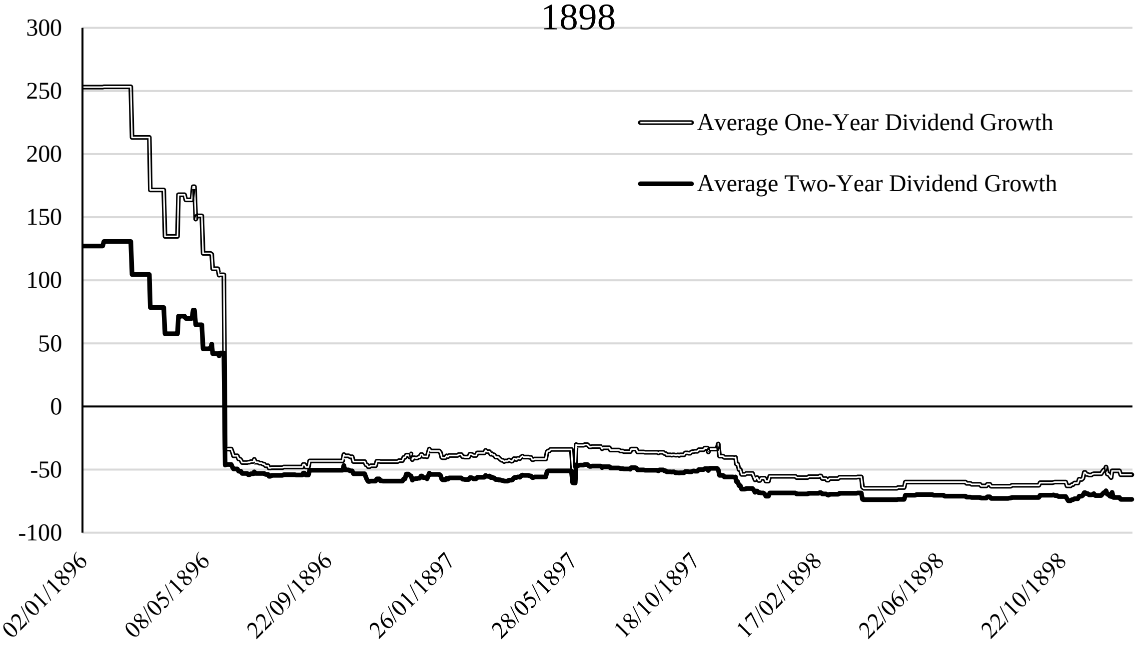
Sources: *Stock Exchange Yearbooks*, 1896-1900; *Financial Times*.

Figure 6: Implied Dividend Growth Rate of Cycle Firms (%), 1896-1898



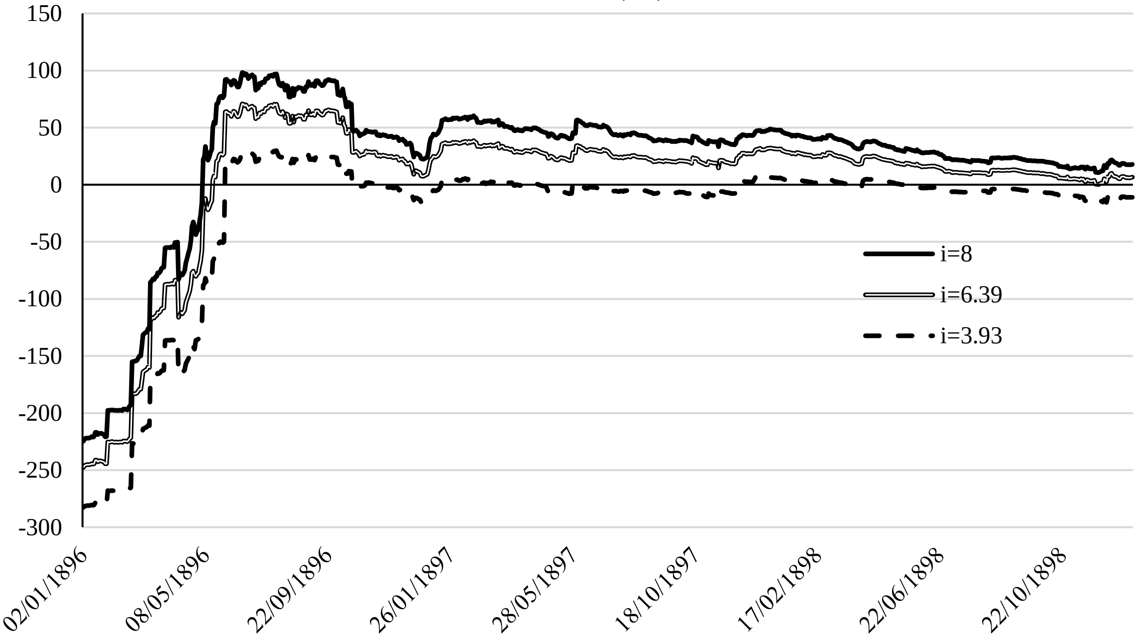
Sources: see text.
Notes: i is the assumed expected return on cycle shares.

Figure 7: Dividend Growth Rate of Cycle Firms (%), 1896-1898



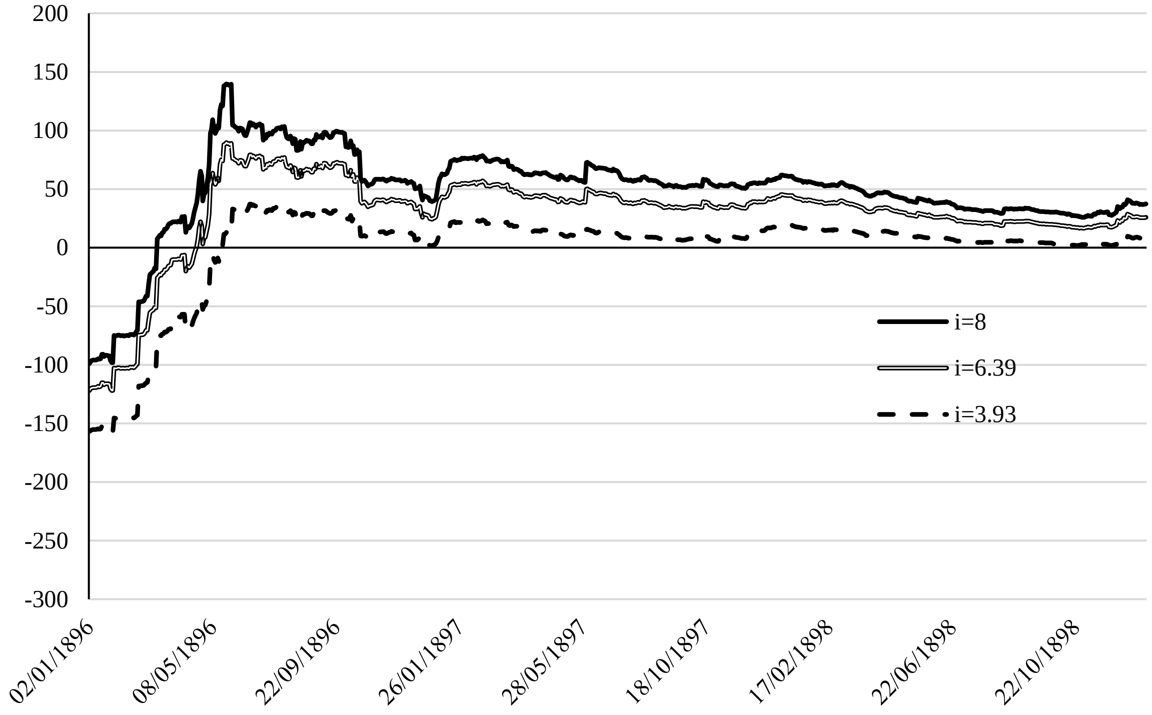
Sources: see text.

Figure 8: Implied Dividend Growth Minus Observed One-Year Dividend Growth (%), 1896-1898



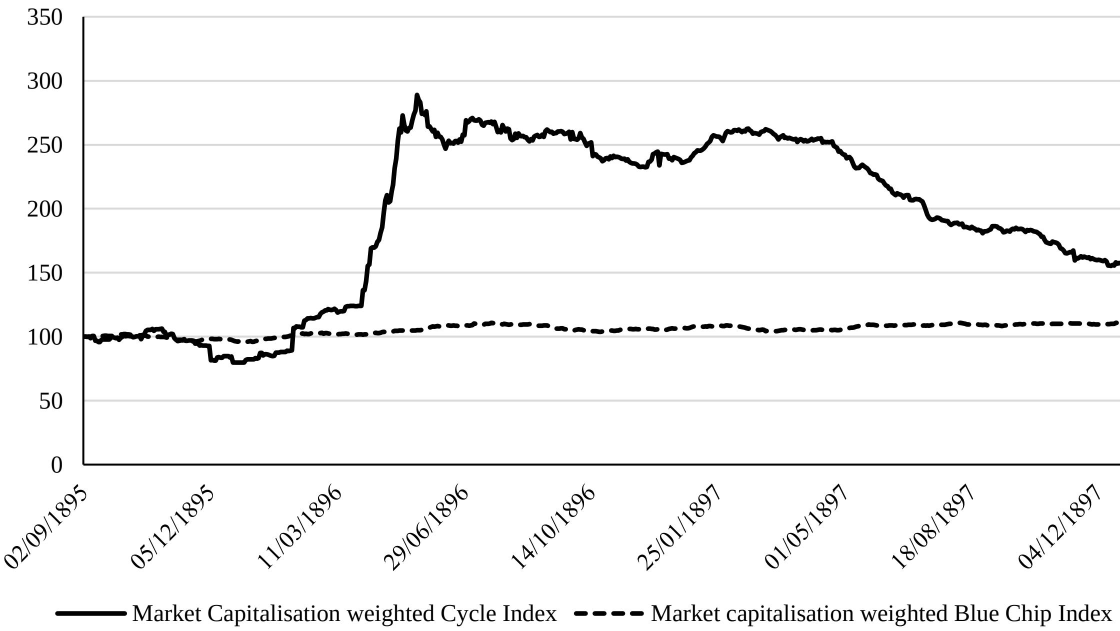
Sources: see text.

Figure 9: Implied Dividend Growth Minus Observed Two-Year Dividend Growth (%), 1896-1898



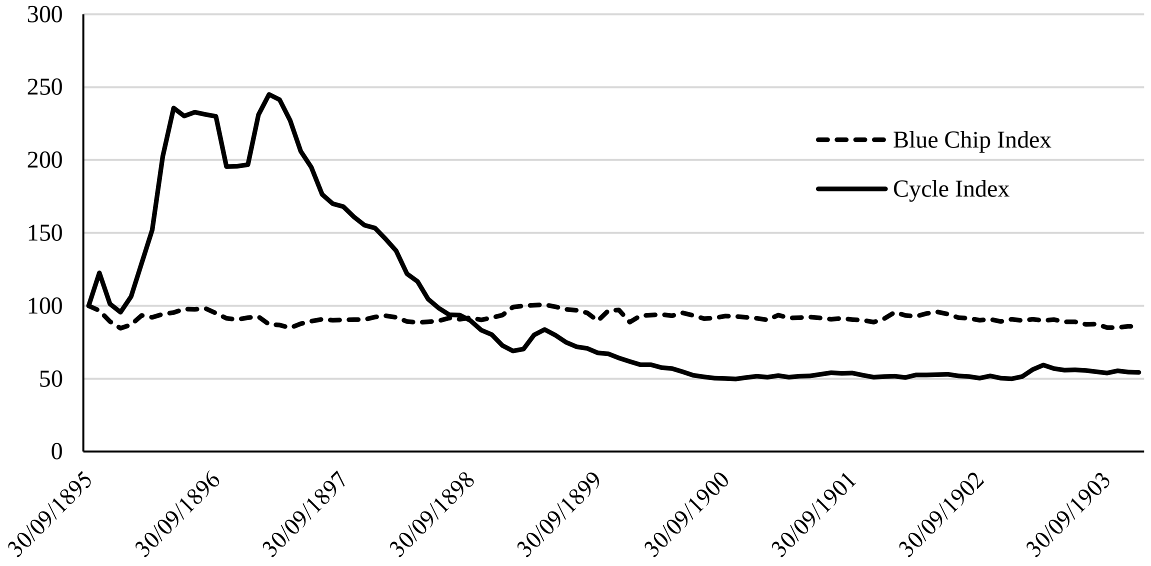
Sources: see text.

Figure 10: Daily Cycle Share and Blue-Chip Indices, 1895-1897



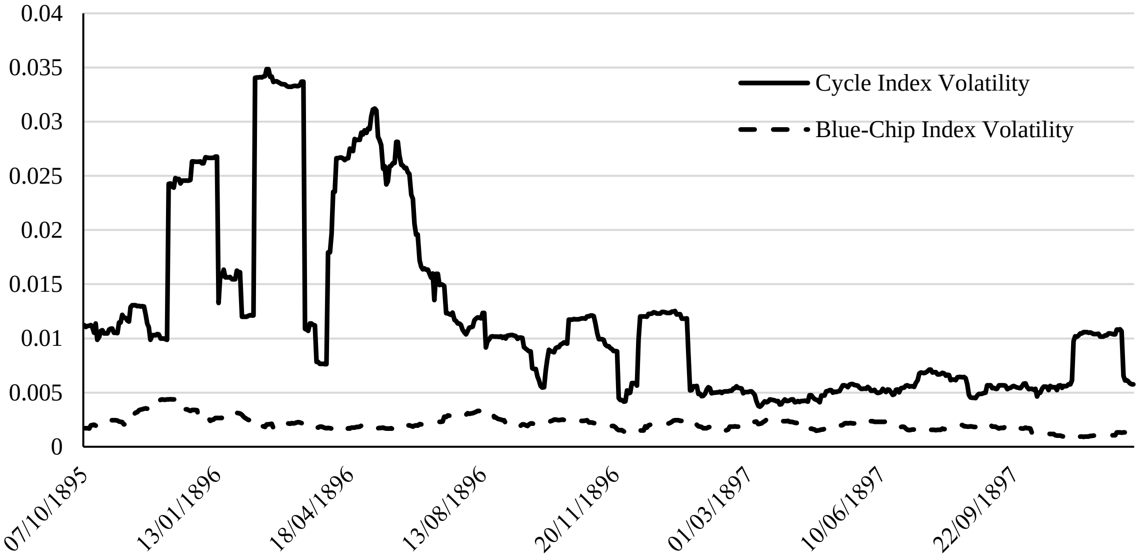
Sources: *Birmingham Daily Mail, Birmingham Daily Post, Financial Times, The Times.*

Figure 11: Monthly Cycle Share and Blue-Chip Indices, 1895-1903



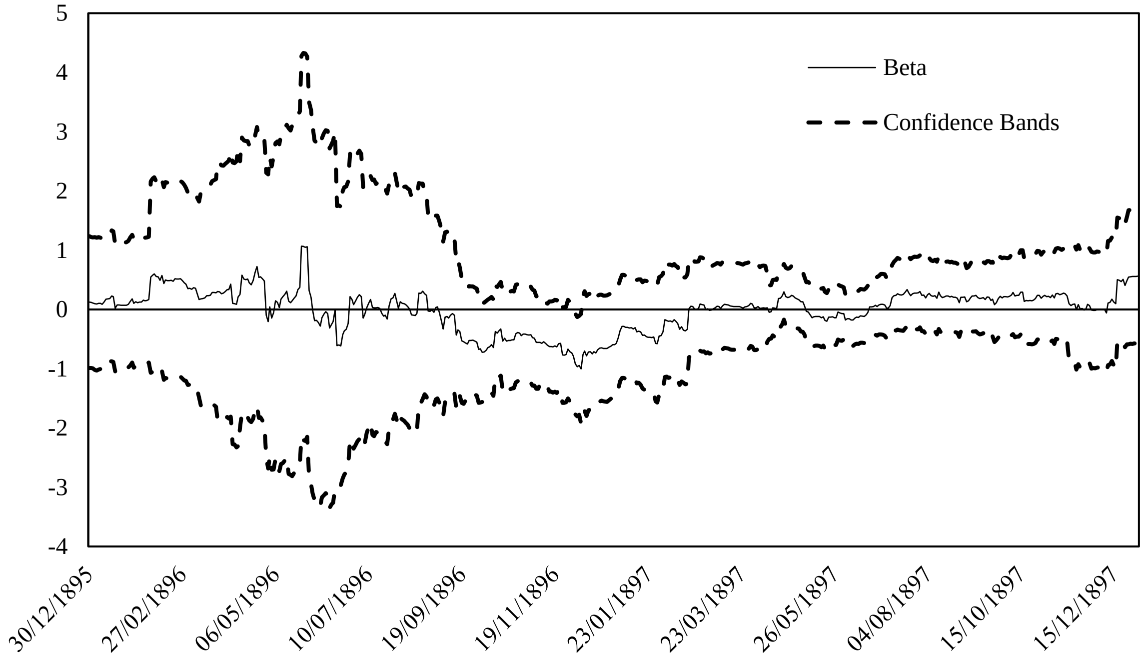
Sources: *Birmingham Daily Mail, Birmingham Daily Post, Financial Times, Global Financial Data.*

Figure 12: 30-day Volatility of Cycle and Blue-Chip Indices, 1895-1897



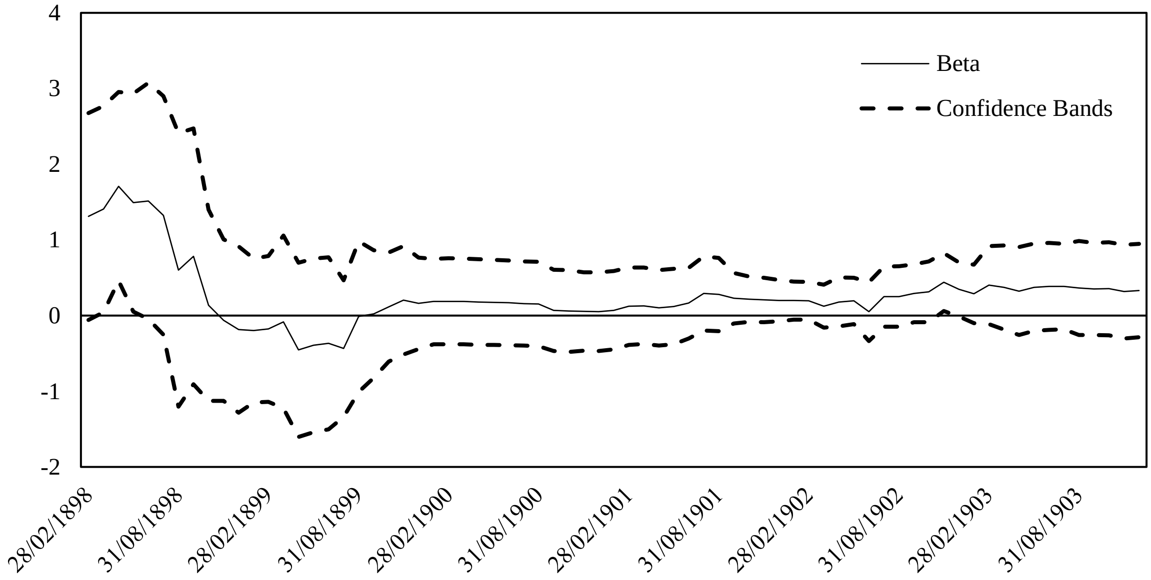
Sources: see text.

Figure 13: Daily Cycle Firm Beta, 1896-1897



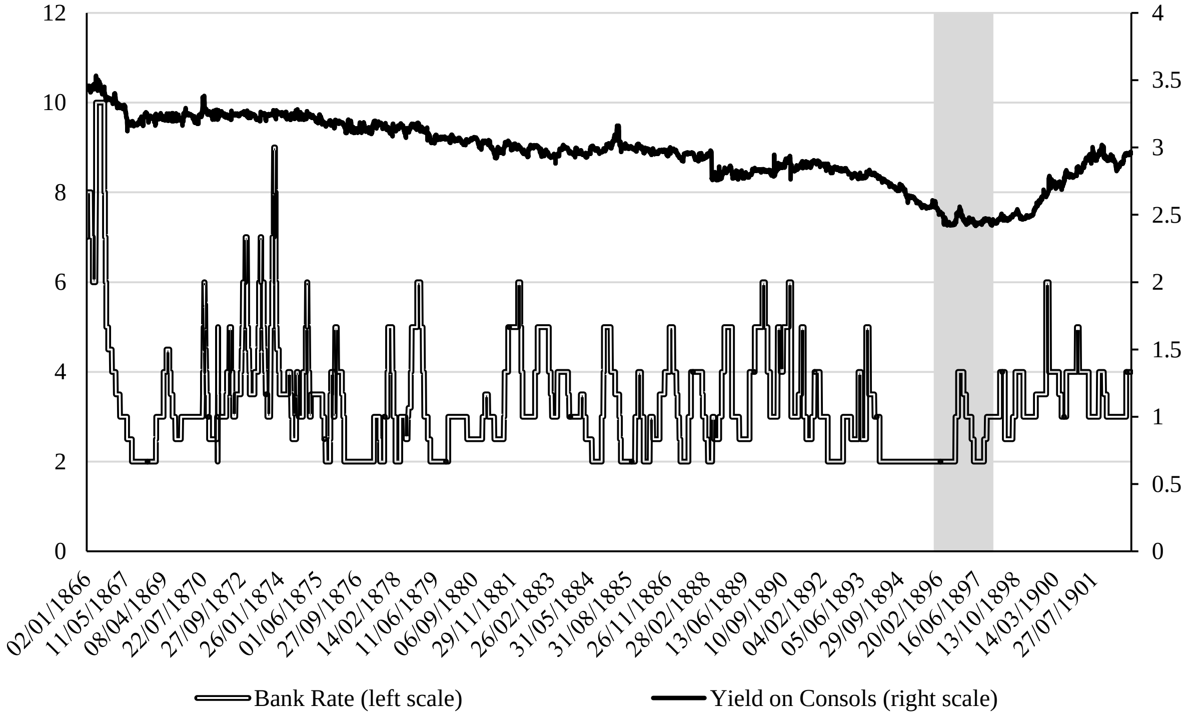
Sources: see text.

Figure 14: Monthly Cycle Firm Beta, 1898-1903



Sources: see text.

Figure 15: Bank of England Minimum Discount Rate and Yield on British Consols, 1866-1902



Sources: *Global Financial Data, Bank of England.*

Table 1: Cycle Corporation Establishment, January 1895- June 1897

		No. of Companies Established	Average Nominal Capital (thousands of £)	Total Nominal Capital (thousands of £)
1895	Q1	17	21.03	357.5
	Q2	12	15.21	182.5
	Q3	15	108.27	1,624.0
	Q4	26	56.77	1,476.1
1896	Q1	34	48.27	1,641.1
	Q2	94	147.31	13,847.2
	Q3	96	55.38	5,316.6
	Q4	139	46.44	6,454.6
1897	Q1	156	47.24	7,370.0
	Q2	82	58.09	4,763.6
Total		**671**	**64.13**	**43,033.2**

Source: Birch (1897).

Table 2: Summary Statistics for Companies in Sample

	Average	Std. Dev	Min	Max	N
Nominal Capital (000's of pounds)	180.5	440.9	10	5000	143
Subscribed Capital (000's of pounds)	159.5	409.0	2.61	4547	143
Par Value (pounds)	1.244	0.9888	0.25	5	140

Source: *Stock Exchange Yearbooks*, 1895-1900, BT31 Files.

Table 3: Cycle Company Dissolutions

Reason for Winding Up	**No. of Companies**	**Average Final Share Price**
Bankruptcy	43	0.039
Voluntary	32	0.441
Reconstructed	27	0.416
Merger	17	2.758
Unknown	20	0.206
Year of Winding Up	**No. of Companies**	**Average Final Share Price**
Before 1900	55	0.800
1900-1910	58	0.168
After 1910	21	0.422*
Unknown	5	-
Shares not Allotted	2	-
All Companies	**141**	**0.512**

Source: *London Gazette*, BT31 Files, *Financial Times*. *indicates the share price as of December 1903 (not included in average calculation).

Table 4: Cycle Industry Patents, 1885-1896

Year	Number of Cycle/Tyre-Related Patents	Total Patents Issued	Percentage of Patents relating to Cycles/Tyres
1885	258	22,667	1.1
1886	248	23,757	1.0
1887	297	30,748	1.0
1888	267	25,398	1.1
1889	357	26,519	1.3
1890	595	26,877	2.2
1891	964	28,735	3.4
1892	1,402	29,814	4.7
1893	2,607	31,585	8.3
1894	2,192	33,704	6.5
1895	2,038	33,258	6.1
1896	4,269	28,919	14.8

Source: Cradle of Inventions. Cycle/Tyre-Related Patents are defined as those including any of the following words in their subject fields: cycle/cycles, bicycle/bicycles, tyre/tyres/tire/tires, velocipede/velocipedes.

Appendix Table 1: Constituents of Cycle Firm Index

Company	Year of Establishment	Peak Share Price (% of par)	Year of Winding Up	Final Share Price (% of par)*	Reason for Winding Up
Accles	1896	1.00	1899	0.03	Bankruptcy
Amalgamated Tyre	1897	0.58	1899	0.00	Bankruptcy
Anglo-Bavarian Steel Balls	Unknown	1.50	1900	0.04	Voluntary
Anglo-French Pneumatic	Unknown	1.13	1897	0.94	Voluntary
Anglo-Swedish	1896	1.28	1899	0.08	Bankruptcy
Appleby (Alfred)	1897	1.04	1901	0.06	Bankruptcy
Appleby (Joseph)	1896	1.28	1904	Unknown	Bankruptcy
Austral Agency	1896	1.75	1899	Unknown	Bankruptcy
Badminton	1897	1.25	1898	0.05	Bankruptcy
Bagots	1896	5.56	1902	Unknown	Voluntary
Bagshawes	1897	Unknown	1901	Unknown	Bankruptcy
Bards	1896	1.98	1902	0.09	Bankruptcy
Bayliss-Thomas	1896	1.35	1905	0.01	Bankruptcy
Beeston	1895	7.75	1897	1.38	Voluntary
Beeston Tyre Rims	1895	0.88	1898	0.13	Voluntary
Belle Vale	1896	1.70	1900	Unknown	Bankruptcy
Birmingham Pneumatic	1896	2.50	1910	0.05	Bankruptcy
Boudard-Peveril Gear	1894	0.08	1901	Unknown	Unknown
Bown (pref shares)	1893	2.25	1900	0.01	Bankruptcy
Brampton Bros	1897	1.10	1935	0.63*	Voluntary
Bretts	1897	0.98	1898	0.10	Reconstructed
British Tube	1895	4.10	1904	0.20	Voluntary
Brookes	1896	1.44	1899	0.03	Bankruptcy
Brooks (J.B.)	1896	1.25	1953	1.05*	Merger
Brown Brothers	1897	1.18	1960	0.99*	Unknown
Casswell	1896	1.13	1924	0.19*	Voluntary
Claremont	1896	1.25	1898	0.03	Voluntary
Climax Tube	1896	2.13	1897	2.13	Merger
Clipper	1897	0.94	1904	0.61	Voluntary
Components Tube	1897	1.11	1900	0.08	Voluntary
Concentric Tubes	1896	1.88	1898	0.01	Bankruptcy
Coventry Cross	1896	2.30	1899	0.18	Reconstructed
Coventry Motor	1896	3.25	1908	Unknown	Bankruptcy
Coventry Stamping	1897	1.08	1897	0.88	Voluntary
Credenda Tubes	Unknown	2.03	1897	2.03	Merger
Cycle Components	Unknown	5.00	1932	0.23*	Bankruptcy
Cycle Tubes	1896	1.31	1901	0.09	Bankruptcy
Detachable Tyres	1894	1.38	1900	Unknown	Bankruptcy
Diamond Components	1897	0.00	1902	0.30	Voluntary
Dunlop	1896	1.29	1985	0.30*	Merger
Dunlop (J.B.) Fittings	1896	1.15	1902	0.13	Unknown
Dunlop France	1896	1.08	1909	1.53	Merger
Eadie Chains	1896	1.34	1897	Unknown	Reconstructed
Elswick	1896	0.98	1900	0.05	Voluntary
Empire	1896	1.33	1898	0.05	Bankruptcy
Endurance Tubes	1896	1.15	1898	0.04	Bankruptcy
Fairbanks Rim	1896	0.88	1899	0.30	Voluntary
Gilbert, Hoare and Co.	Unknown	1.13	1902	Unknown	Unknown
Gladiators	Unknown	1.55	1901	0.04	Reconstructed
Grappler	1893	2.88	1899	0.10	Reconstructed
Griffiths	Unknown	4.20	Unknown	Unknown	Unknown
Halls, R. F.	1897	1.34	1899	0.43	Reconstructed
Hampton	1896	0.65	1899	0.10	Bankruptcy
Hanman’s	1897	0.94	1904	Unknown	Bankruptcy

Company	Year of Establishment	Peak Share Price (% of par)	Year of Winding Up	Final Share Price (% of par)*	Reason for Winding Up
Hawkers'	1897	1.31	1933	Unknown	Voluntary
Hearl and Tonks	1897	0.90	1899	0.40	Reconstructed
Hudson Brothers	1897	1.05	1905	0.10	Voluntary
Hughes Johnson Stamping	1897	0.95	1970	0.20*	Unknown
Humber and Co.	Unknown	4.20	1900	0.65*	Merger
Humber and Goddard	1896	0.65	1899	0.25	Voluntary
Humber Cycle	1895	1.55	1900	0.09	Reconstructed
James	1897	2.50	1966	0.18*	Unknown
Jewel	1897	0.88	1902	Unknown	Unknown
Jointless Rim	1893	3.15	1897	2.68	Reconstructed
Jointless Rim (New)	1897	0.99	1901	0.04	Reconstructed
Larue Air-Tight	1896	0.55	1900	Unknown	Unknown
Lloyd W.A.	1896	1.34	1906	0.02	Bankruptcy
Metallic Tube	1896	1.30	1926	0.09*	Merger
Middlemore and Lamplugh	1896	0.81	1900	0.45	Reconstructed
Midwinter	1897	1.18	1905	Unknown	Unknown
Miller, H. and Co.	1896	1.25	Unknown	0.43	Unknown
Morgan's Chain	1897	1.10	1899	0.90	Reconstructed
Mutual, Ltd.	1895	1.45	1898	0.50	Voluntary
New Beeston	1895	1.00	1897	0.40	Reconstructed
New Beeston Rim and Components	1895	0.95	1899	0.04	Reconstructed
New Brotherton	1897	1.00	1923	0.14*	Reconstructed
New Buckingham and Adams	1897	1.39	1899	0.04	Bankruptcy
New Centaur	1897	1.19	1910	0.05	Merger
New Cooper Fittings	1897	1.16	1899	0.04	Bankruptcy
New Enfield	1896	1.69	1906	0.87	Reconstructed
New Hudson	1896	2.21	1899	0.50	Voluntary
New Premier	1896	1.08	1920	0.03*	Merger
New Rapid	1897	0.98	1906	0.03	Unknown
New Seddon	1896	1.10	1899	0.05	Reconstructed
New Townend	1896	1.30	1903	0.11	Reconstructed
New Triumph	1897	1.40	1956	0.25*	Merger
New Turner and Wadeley	1897	1.00	1899	Unknown	Bankruptcy
New Vanguard	Unknown	1.40	1901	Unknown	Bankruptcy
New Victoria of Scotland	1896	0.80	1899	Unknown	Reconstructed
Non-Collapsible	1896	1.13	1906	Unknown	Bankruptcy
North European	1897	1.00	1909	Unknown	Unknown
Oriental Tube	Unknown	0.69	Unknown	Unknown	Unknown
Ormonde	1897	0.86	1900	0.01	Bankruptcy
Osmond	1897	2.83	1897	0.65	Voluntary
Palmer Tyre	1895	4.50	1939	1.20*	Merger
Perfecta Tubes	1896	2.00	1905	0.01	Bankruptcy
Pneumatic Tyre	1892	12.50	1896	12.50	Merger
Premier Cycle	1892	5.80	1896	Unknown	Voluntary
Presto Gear Case	Unknown	1.95	1914	Unknown	Voluntary
Preston-Davies	1896	0.68	1901	0.04	Voluntary
Puncture-Proof	1895	1.66	1898	0.18	Merger
Quadrant (pref shares)	1895	1.04	1908	0.25	Unknown
Quinton Cycle	1891	1.61	1896	1.61	Merger
Raglan	1896	1.31	1909	0.02	Bankruptcy
Raleigh	1896	1.86	1899	0.05	Reconstructed
Raleigh (old company)	1891	1.99	1896	1.90	Reconstructed

Company	Year of Establishment	Peak Share Price (% of par)	Year of Winding Up	Final Share Price (% of par)*	Reason for Winding Up
Referee Automatic-Cycle Pump	1892	1.25	1903	Unknown	Unknown
Reliance	1897	1.43	1898	0.03	Bankruptcy
Reuben Chambers	Unknown	1.13	1902	Unknown	Bankruptcy
Richard's Beau Ideal	1896	1.19	1913	Unknown	Bankruptcy
Riley	1896	1.49	1938	0.25*	Merger
Robinson and Price	1896	1.50	1904	0.02	Bankruptcy
Rose Tubes	1896	3.04	1904	0.03	Bankruptcy
Rosser Brake	1896	1.04	1898	Unknown	Unknown
Rover	1896	1.34	1967	0.06*	Merger
Rubber Tyre	1896	1.75	1901	0.79	Voluntary
Rudge-Whitworth	1894	1.36	1939	1.39*	Reconstructed
Sanspareil	1896	1.28	1899	0.80	Voluntary
Scott's Standard	1896	1.30	1897	0.70	Voluntary
Self-Sealers	1895	1.75	1899	Unknown	Bankruptcy
Simpson’s Chain	1895	1.03	1898	0.02	Bankruptcy
Singer's	1896	1.13	1903	0.05	Reconstructed
Smith's Stamping	1896	2.90	1938	0.10*	Reconstructed
Standard Tube	1897	1.09	1898	0.18	Voluntary
Star	1896	1.63	1915	0.10*	Unknown
Star Tube	1896	13.50	1897	2.05	Merger
Starley	1896	1.83	1899	0.06	Bankruptcy
Stiefels Tubes	1896	2.93	1900	0.06	Voluntary
Swift's	1896	1.25	1901	0.11	Reconstructed
Sydney Lee and Co.	1896	1.25	Unknown	Unknown	Unknown
Trent	1896	0.93	1900	0.06	Bankruptcy
Trigwell	Unknown	1.06	1898	Unknown	Bankruptcy
Truffault	1896	0.55	1898	0.18	Reconstructed
Tubeless Tire	1896	1.90	1900	0.01	Voluntary
Tubes Limited	1897	1.02	1906	0.01	Reconstructed
Turner's Pneumatic	Unknown	3.56	1897	1.94	Voluntary
Warwicks	Unknown	1.63	Unknown	Unknown	Unknown
Wearwell	1896	1.10	1910	Unknown	Bankruptcy
Woodley	1896	1.85	1902	0.04	Voluntary
Mean	-	1.77	-	0.50	

Source: *London Gazette*, BT31 Files, *Financial Times*, *Stock Exchange Yearbook.* *indicates the share price at the end of 1903 for companies where a final share price was unavailable. Reasons for winding up are those provided in the firm’s BT31 file or in the *London Gazette*.

Appendix Table 2: Constituents of Blue-Chip Index

Company	**Industry**	**Ordinary Share Capital in 1898 (Thousands of £)**
London and North Western	Rail	81,525
Midland	Rail	61,366
Bank of England	Bank	50,863
North-Eastern	Rail	49,541
Great Western	Rail	40,559
London and South Western	Rail	26,811
Caledonian	Rail	24,803
Lancashire and Yorkshire	Rail	24,614
Great Northern	Rail	21,376
De Beers	Mine	21,323
J&P Coats	Misc	18,000
Gas Light and Coke	Misc	17,443
South-Eastern	Rail	15,375
Great Northern of Ireland	Rail	15,204
Great Eastern	Rail	15,182
London, Brighton & South Coast	Rail	15,110
Guinness	Brew	14,750
National Provincial Bank of England	Bank	14,383
Bank of Ireland	Bank	11,550
Armstrong, Whitworth & Co.	Iron	10,232
North British	Rail	10,202
London and County Banking	Bank	10,100
Rand Mines	Mine	9,815
Metropolitan	Rail	9,296
Rio Tinto	Mine	8,450
London & Westminster	Bank	8,050
Lloyds Bank Limited	Bank	8,033
Imperial Continental Gas	Misc	7,961
South Metropolitan	Misc	7,771
Glasgow and South Western	Rail	7,302

Source: Kennedy and Delargy (2000)