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01 November 2021

Series edited by Philip T. Fliers and Louise Moss.
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Riding the Bubble or Taken for a Ride? Investors in the British Bicycle Mania

William Quinn^{1#} and John D. Turner¹

Abstract

Clientele-based theories explaining asset price bubbles are often difficult to test because the identities of investors cannot easily be tracked over time. This paper tests these theories using a hand-collected sample of 12,000 investors during an asset price reversal in the shares of British bicycle companies between 1895 and 1900. We find that informed investors reduced their holdings substantially during the crash, suggesting that they were riding the bubble. Those who performed worst were not typically the least informed groups, but gentlemen living near a stock exchange, who had the most time, money, and opportunity to engage in speculation.

Keywords: British financial history; financial bubbles.

JEL Classification: G01, N23

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1. Introduction

The aftermath of the dotcom boom and global housing market crash of 2008 has stimulated debate on the causes of asset price reversals, with recent literature proposing a wide range of competing theories.¹ Several theories are based on models that assume some heterogeneity in the experience, information, or acumen of investors. Brennan (2004) and Kindleberger (1978), for example, stress the role of naïve and inexperienced investors in driving prices beyond their fundamental values. Abreu and Brunnermeier (2002, 2003), however, argue that investors in overpriced stock may be arbitrageurs who hold the shares in the expectation of further price increases, before selling when prices peak.

The empirical validity of these arguments can be tested by observing the proportion of shares held by different groups of investors at various stages throughout an asset price reversal. However, obtaining a sufficiently detailed dataset of shareholder identities is often difficult. Several previous studies have focused on subsets of investors, which are not treated as representative of the overall body of investors. For example, Brunnermeier and Nagel (2004) focus on hedge funds, Temin and Voth (2004) investigate the holdings of one private bank, Campbell and Turner (2012) study only initial subscribers, and both Carlos and Neal (2006) and Frehen et al. (2013) limit their studies to holders of the stock of a single company. Other studies are limited by the level of information available on shareholders. For example, Greenwood and Nagel (2009) focus on variation between the holdings of different mutual fund managers, using age as a proxy for experience, and Griffin et al. (2011) use a full sample of investors, but can only distinguish between individuals and various types of institutional investor. This introduces a double-hypothesis problem, as institutional investors, while better

¹ Explanations include, for example, new technology (Pástor and Veronesi, 2006; Perez, 2009), easy credit conditions (Jordá et al., 2015), short sale restrictions (Ofek and Richardson, 2003; Schienkman and Xiong, 2003), and institutional agency problems (Allen and Gale, 1999).

informed, were also subject to a range of agency problems that were likely to affect their investment decisions.

This paper provides new evidence to this debate using a dataset of investors in the British Bicycle Mania of 1895-1900. Cycle company shares experienced a substantial price reversal in this period, almost trebling in value in the early months of 1896 before losing 73 per cent of their peak value by the end of 1898. This was accompanied by a promotion boom: between January 1896 and June 1897, 601 new cycle corporations were established (Quinn, 2019, p.276). The key advantage of studying this episode is that companies in this era were legally required to publish annually the names, occupations, addresses, and number of shares held by each shareholder. Since many of these registers have been preserved in archives, it is possible to construct a representative sample of investors in cycle shares with both longitudinal and cross-company variation.

Two separate datasets are obtained from the shareholder registers. The first consists of investors in 25 cycle, tube and tyre companies at two distinct points in time during the asset price reversal. The first time period chosen is prior to the crash, when the prices of cycle shares had not yet peaked. The second time period is during the crash, when share prices had peaked and were falling, but before they had reached their post-crash nadir. From each register, we record the occupation, address, and number of shares held by each investor. We also record whether the investor was a director of the company by checking their names against those listed in the *Stock Exchange Yearbook* and *Birch's Manual of Cycle Companies (1897)*. Excluding investors for which an occupation was not recorded, this results in a sample of 12,167 investors. The second dataset is obtained from transfer registers, which were compiled by a large minority of firms. These registers recorded the date on which any shares were sold from one investor to another, the number of shares sold, and the name, occupation, and address of the seller.

Relevant transfer registers were found for 13 companies, resulting in a dataset of 2,276 transfers.

Our shareholder data is used to establish the characteristics of investors during the mania, thereby testing the hypothesis that financial bubbles are driven by an influx of inexperienced investors (Kindleberger, 1978). Relative to the wider stock market, we find that cycle shares attracted a high level of investment from manufacturers, financiers, institutional investors and professional middle classes, and a low level of investment from gentlemen, women, and clergy. This suggests that cycle investors came from groups which previous research has associated with a preference for riskier investments, but not from groups associated with a low level of investment experience.

The paper then tests whether there is a systematic reduction in the number of shares held by informed investors over the course of the mania, which is a key prediction of the Abreu and Brunnermeier (2002) model. To this end, several binary proxies for information are created based on each investor's occupation and whether or not they were a director. The most conservative of these variables considers an investor as 'informed' if they were either a director in the company in which they held shares, or held a job in the cycle industry. We find that there was a notable reduction in the proportion of capital held by informed investors over the course of the mania. Using the most conservative definition of 'informed', this proportion falls from 33.7 per cent before the price crash to 25.3 per cent afterwards; using a broader definition, it falls from 56.9 per cent to 43.3 per cent. An alternative measure of informed is whether an investor lived near the office of the company in which they held shares (Fjesme et al., 2019). We find that the holdings of this group also fell over time.

The second prediction of the Abreu and Brunnermeier (2002) model is that arbitrageurs synchronize sales at the peak of the mania in order to effect a fall in the general price level.

This implies a disproportionate number of sales occurring at the point at which share prices peaked, which in the case of the cycle mania was in March 1897. Transfer data shows that the volume of sales in this month was high relative to the volume of sales in other months, consistent with the model.

Finally, we use a combination of holdings and transfer data to identify which investors were most likely to lose money during the bubble. The group which performed worst was gentlemen who lived near a stock exchange, a group which increased its holdings substantially despite accounting for a disproportionate number of sales. In other words, the biggest losers were men with considerable wealth, plenty of free time, and a convenient nearby stock exchange, who were very active traders during the mania. This finding contradicts popular anecdotes about financial bubbles which portray latecomers as members of the working class, such as shoeshine boys, busboys, or taxi drivers (Kindleberger, 1978). It is, however, consistent with the demographic profile of speculative day traders in modern markets, which typically skews old, wealthy, and male (Arthur and Delfabbro, 2017).

This paper makes two major contributions to the literature on bubbles. Firstly, it quantifies the extent to which an asset price reversal can be explained by arbitrageurs ‘riding the bubble’. Previous studies have documented specific instances of informed investors riding an asset price bubble, but because they do not use a representative sample of investors, they cannot estimate the scale on which it occurred (Abreu and Brunnermeier, 2003; Brunnermeier and Nagel, 2004; Temin and Voth, 2004). Other studies of investors have found that this dynamic was unlikely to have meaningfully contributed to historical asset price reversals (Carlos and Neal, 2006; Frehen et al., 2013). In contrast, we find that during the cycle mania, between 8 and 14 per cent of all issued cycle shares were transferred from informed investors to uninformed investors immediately before or during the crash. These results imply that models in which informed investors seek to ride a bubble, rather than immediately correcting

any observed mispricing, can explain a significant proportion of the price patterns observed during an asset price reversal.

Secondly, it provides new insights into the types of investors that gain or lose money during a bubble. While the most informed investors perform best, the least informed investors do not necessarily perform worst. The group most at risk of losing money is investors with no particular informational advantage or disadvantage, but whose circumstances make it easiest for them to be drawn into frequent trading in speculative assets.

2. The Bicycle Mania

In the 1880s and early 1890s, there were a series of technological innovations in the production of bicycles, most notably the pneumatic tyre, weldless steel tube, and diamond frame (Harrison, 1969).² The sharp improvement in the quality and cost of bicycles led to a rapid increase in demand, which came to a head in the ‘bicycle boom’ of 1895-1897. It is estimated that, at its peak, 750,000 bicycles were being produced annually, with 1.5 million people cycling out of a UK population of around 35 million (Rubinstein, 1977, p.51). The cycle industry went into recession after 1897, with Harrison (1969) attributing its decline to American competition, the over-capitalisation of many cycle firms, and bicycles going out of fashion.

The boom and bust observed in the cycle industry was mirrored by a reversal in the shares of cycle companies. Two events in April 1896 catalysed a rapid increase in the share prices of cycle companies. First, the Pneumatic Tyre Company was purchased for £3 million, ten times its nominal capital, and successfully recapitalised for £5 million as the Dunlop Pneumatic Tyre Company. At almost exactly the same time, the Beeston Pneumatic Tyre Company announced its intention to pay a dividend of 100 per cent for the year 1896. In

² For previous accounts of the cycle mania, see Harrison (1969, 1981), Rubinstein (1977), Millward (1989), Lloyd Jones and Lewis (2000), and Quinn and Turner (2020).

response, trading on the Birmingham Stock Exchange, where most cycle firms listed, was said to have ‘gone mad’.³ Prices appear to have been sustained until mid-1897, when financial newspapers were warning investors in cycle shares of an upcoming slump.⁴ Newspaper reports from 1898 suggest that the cycle share market had collapsed.⁵

Figure 1 shows the value of a cycle share index between September 1895 and December 1898. The index rose from a value of 88 in January 1896 to a peak of 250 in May of the same year, increasing by 184 per cent. Shares prices then decline throughout 1896, but experience a second boom in early 1897, which notably occurs at a time when dividends are falling. From mid-March 1897 onwards, prices continuously decline until the end of 1898: the index falls from 241 in March 1897 to 66 in January 1899, losing 73 per cent of its value. Quinn (2019) investigates whether these price movements constitute an asset price bubble, finding that the scale of the price movements is not justified by earnings, future dividends, idiosyncratic risk, or plausible future expectations. In any case, the contentious question of whether prices are consistent with fundamental values during a suspected bubble is orthogonal to the hypotheses explored in this paper.

<<<INSERT FIGURE 1 HERE>>>

The initial boom in cycle shares was taken advantage of by existing private cycle firms in order to go public at high capitalisations (Amini and Toms, 2018). The increase in the number of cycle firms can be seen in Figure 2, which tracks the number of cycle, tube or tyre firms with shares listed in the *Birmingham Daily Mail* or *Financial Times* between 1896 and 1898. While only 18 such firms traded in January of 1896, in August 1897 there were 123. In

³ *Financial Times*, ‘The Cycle Trade Boom’, 22nd April 1896.

⁴ *Financial Times*, ‘The Cycle Outlook’, 1st May 1897.

⁵ *Financial Times*, ‘The Slump in the Cycle Trade’, 15th June 1898.

spite of this, the general level of cycle shares rises for the first two months of 1897, reaching a peak on March 9th.

<<<INSERT FIGURE 2 HERE>>>

Data from this episode is used to test three hypotheses on financial bubbles. The first, suggested by Greenwood and Nagel (2009), Kindleberger (1978), Smith et al. (1988), and Vissing-Jorgensen (2003), argues that assets can become overvalued in the medium term because a large number of inexperienced or naïve investors enter the market. As a result, the proportion of capital controlled by arbitrageurs is insufficient to correct mispricing. If this were the case, a large proportion of shares during a mania would be held by investors from groups associated with low levels of experience and information. The second hypothesis, as formalised by Abreu and Brunnermeier (2002), is that informed investors prefer to hold ‘bubble’ stock until its price peaks, rather than immediately correct any mispricing. Since any one arbitrageur cannot correct mispricing alone, they will attempt to sell their shares simultaneously in response to a particular co-ordinating event. As a result, share prices experience a reversal. This model predicts a reduction in the number of informed investors over time, with sales concentrated at the point at which share prices peak. Finally, we explore the characteristics and trading behaviour of the investors who held shares after the crash, thereby losing most or all of their investment. There has been little work exploring the factors that determine who loses money during a bubble, but a plausible implication of bubble narratives based on naïve investors is that the biggest losers are the investors with the least information and experience.

3. Data

The data for this study is taken from the *Summaries of Capital and Shares* published annually by every publicly-traded company in this era, as required by the 1862 Companies Act. These documents listed the names, addresses, and occupations of shareholders in each company, alongside the number of shares held. Not every annual register for every company has been preserved in the archives, so it was only possible to obtain a sample of investors before and after the peak of the bubble for 25 cycle companies, just over a quarter of the actively-traded cycle firms quoted in the *Financial Times* in March 1897. The details of these companies are listed in Appendix Table 1. The preservation of these registers in the UK's National Archives appears to have been random, so this sample can be treated as representative of the overall market.

For each of these 25 companies, the occupations and addresses of shareholders are recorded at two points in time. The first point in time is either before or during the 'bubble' period, ranging from November 1894 to the beginning of April 1897. Although share prices in the overall cycle share market peaked in March 1897, the two companies whose initial shareholder register is from April 1897 were still trading at a price very close to their peak value at this time. The second shareholder register of each company is taken from a point in time during the crash, ranging from the end of April 1897 to November 1900.

The pre-peak and post-peak points in time, which are hereafter denoted as t_1 and t_2 respectively, provide cross-sections of investor occupations at different stages of the asset price reversal, giving an indication of the change in shareholder clienteles across time. Company-level summary statistics for this data are shown in Table 1. We can see that the average share price in this time falls from 109 per cent of par value to 37 per cent; in other words, on average these shares lost 66 per cent of their value between t_1 and t_2 .

<<<INSERT TABLE 1 HERE>>>

Figure 3 shows the dates on which the various shareholder records in our sample were published, alongside a monthly price-weighted cycle share index. Notably, the price level of cycle shares continued to fall until several months after the majority of t_2 summaries had been published. This suggests that shareholders at time t_2 would have undergone losses on their investment regardless of the precise point at which the shares were purchased.

<<<INSERT FIGURE 3 HERE>>>

The data for each company is aggregated, and observations where the occupation was either missing or unintelligible are removed. This results in a dataset of 5,118 and 7,049 shareholders at times t_1 and t_2 respectively, accounting for the ownership of around 1.6 million shares at t_1 and around 1.5 million at t_2 . These records provide a high level of detail on investor occupations: among the 12,167 individuals in the holdings data, there are 1,241 unique occupations listed. Few investor addresses were left blank or unintelligible, but at times only a city or postcode region was provided, rather than an exact address. Investors are therefore categorised according to the postcode region or city in which they lived, rather than by distance from a significant landmark, a measure which previous studies have used (Fjesme et al., 2019).

In order to account for potential changes in the occupations of individual shareholders, the full name of the ten largest shareholders in each company at time t_1 was also recorded. For some companies, more than ten shareholders were identified by name, because more than one investor held the tenth-most number of shares. This provided the identities of 273 investors, accounting for 83 per cent of the total capitalisation of these companies at t_1 . These identities were then looked up in the shareholder registers at time t_2 , in order to check whether their occupations had been reported differently. The listed occupations were found to be identical for 71 per cent of these large investors. For the remaining 29 per cent of observations, the occupation listed at time t_1 is treated as the investor's occupation at both points in time. The

exception to this was when no occupation was listed at time t_1 , in which case the occupation listed at time t_2 is treated as the investor's occupation throughout.

The names of the directors of each individual company were then collected from the *Stock Exchange Yearbooks* of 1896-1899. These names were looked up in the shareholder register of each company at both t_1 and t_2 , in order to determine whether there was a systematic change in the number of shares held by directors. Comparing the names listed in various editions of the *Stock Exchange Yearbook* indicates that company directors almost never changed between t_1 and t_2 , which is unsurprising given the relatively short length of time between shareholder registers. Directors typically accounted for a very low number of shareholders, but a significant proportion of shares: each company had between three and seven directors, but on average they held 26.5 per cent of the company's shares at time t_1 and 20.2 per cent at time t_2 .

A minority of companies also recorded any sales made by investors since the previous summary had been published, and the dates on which these sales occurred. Records covering the relevant time period were found for 13 cycle companies, resulting in a sample of 2,276 transfers involving 558,559 shares. The dates of these transfers range from May 1896 to December 1898. For each transfer, we record the occupation of the investor selling shares, the number of shares sold, and the date on which the shares were sold. The companies in the sample, numbers of transfers and shares sold, and date ranges of transfers are listed in Table 2. These companies appear to be representative of the overall cycle share market, with each experiencing a fall in its share price after the spring of 1897.

<<<INSERT TABLE 2 HERE>>>

The market price of the shares on the date of each transfer, as listed in the *Financial Times*, is also recorded, and summarised in Table 3. Prices were not always quoted, and so this

data was only available for 1,958 out of 2,276 transfers. The summaries of capital and shares were selected specifically to document trades that occurred while cycle share prices were relatively high, so this cannot be treated as a representative sample of all trades in cycle shares throughout the period. There is, however, notable variation in the prices at which transactions occurred: some were sold for a price 86 per cent greater than the IPO subscription price, while others were sold for 96 per cent less.

<<<INSERT TABLE 3 HERE>>>

4. Who invested in cycle shares?

This section investigates whether cycle share investors came from groups associated with inexperience, thereby testing the contention of Kindleberger (1978) that bubbles are driven by an influx of naïve investors. In order to determine the characteristics of investors in the cycle mania, the occupations of shareholders in cycle companies are compared with those who held shares in the general stock market in the 1890s, as reported by Acheson et al. (2017). The shareholders are categorised by occupation according to the groups used by Acheson et al. (2017), and the proportion of capital contributed to cycle companies by each group is compared to the capital contributed to the overall share market.

The Acheson et al. (2017) sample provides a robust comparison because its data is taken from the same source, and so the reporting of investor occupations is likely to have been very similar to that of the cycle company sample. Occupation is an imperfect proxy for the characteristics of investors, and there is likely to have been substantial variation in the experience levels and risk preferences of investors within a particular occupational group. However, it is notable that previous research has consistently shown systematic trends in the

investments preferred by each occupation (Acheson et al., 2017; Rutterford and Maltby, 2006; Rutterford et al., 2011). Acheson et al. (2017), for example, find that gentlemen overwhelmingly invested in large firms, whereas businessmen preferred smaller, more regional businesses. Financiers and institutional investors tended to prefer speculative assets, particularly in foreign companies, whereas women and the middle classes exhibited a preference for safer assets.

Table 4 summarises the occupations of investors of cycle companies at times t_1 and t_2 alongside the occupations of investors in the overall stock market. It is notable how few of the initial shareholders in cycle companies came from groups traditionally thought of as inexperienced. Clergy, for example, were often characterised by contemporaries as the least experienced investors (Campbell and Turner, 2012; Maltby and Rutterford, 2006). However, this group contributed only 0.2 per cent of cycle company capital at t_1 , compared to 1.7 per cent of capital in the general stock-market sample. Women were also significantly less likely to hold cycle shares than shares in the general stock market, although the contemporary characterisation of women as naïve investors is unlikely to have been accurate (Rutterford et al., 2011; Acheson et al., 2021). The proportion of cycle shares held by gentlemen is also relatively low, with only 16 per cent of capital contributed at t_1 , as compared to 43.4 per cent in the overall stock market. A potential explanation for this is that cycle shares were seen as a relatively risky investment, and these groups were associated with a high level of risk aversion. Conversely, occupational groups associated with riskier investments were much more likely to hold cycle shares than they were shares in other companies. Businessmen, institutional investors, and financiers, who Acheson et al. (2017) identify as preferring more speculative investments, contributed a combined 46.5 per cent of capital to cycle firms, as opposed to just 20.5 per cent in the general sample. The proportion of capital held by insiders appears to have been similar to that of other sectors in the economy. 25.7 per cent of the total capital contributed

at time t_1 was from company directors; Braggion and Moore (2013) find that directors between 1890 and 1909 held 26.4 per cent of shares on average.

<<<INSERT TABLE 4 HERE>>>

The shareholder records therefore do not suggest that initial cycle share investors were particularly naïve or poorly informed relative to the average investor. Relatively large numbers of investors came from groups associated with a preference for riskier and more speculative investments, but not from groups that had less investment experience. However, it is notable that the proportion of capital contributed by some of these groups changed over time. Gentlemen increased their holdings from 16.0 per cent of capital at time t_1 to 27.7 per cent at time t_2 , with women and financiers also increasing their stakes in cycle firms. Conversely, company directors reduced their holdings considerably, from 25.7 per cent of capital at time t_1 to 18.7 per cent at time t_2 . Since company directors would have been among the most well-informed investors, this suggests the possibility of informed investors successfully speculating in cycle shares, or ‘riding’ the bubble. The following section explores the extent to which this occurred.

5. Did informed investors ride the bubble?

Abreu and Brunnermeier (2002, 2003) argue that during a bubble, informed investors know that assets are overvalued, but cannot correct the mispricing individually. As a result, they must account for the risk that the market will become more overpriced after they sell their shares, a risk that is termed ‘synchronization risk’. The solution to this problem is to hold the overpriced stock until some co-ordinating event occurs, at which point a large number of informed investors sell simultaneously. An asset price reversal can therefore occur within a rational

expectations framework. Informal variations of this theory were often referenced during the mania, referred to by the financial press as ‘speculating for the rise’ (or ‘stag’ investment when the shares were bought at IPO). *The Economist*, for example, noted in May 1896 that ‘it goes without saying that those who have applied for the [cycle] shares are mainly... people... who have no intention of holding whatever they are allotted if they can secure a premium.’⁶ Notably, however, the *Financial Times* and *The Economist* were both of the opinion that this was an ineffective and risky investment strategy.⁷

This model makes two predictions which can be tested using the shareholder data in the *Summaries of Capital and Shares*. Firstly, informed investors should decrease their holdings over the course of the mania. The number of informed investors should therefore be relatively high in the period preceding the crash, but significantly lower during and after the crash. Secondly, sales are co-ordinated by informed investors at a particular point in time, in order to ensure that mispricing is corrected. This implies that sales of cycle shares, particularly among those from groups with better information, would be concentrated at the point at which share prices peak.

The prediction that informed investors decrease their holdings during the mania is tested using the holdings data. Determining which investors should be classed as informed requires some subjective judgement, and so we repeat this analysis four times, using four different binary definitions of ‘informed’. The first, most conservative definition of ‘informed’ includes only company directors and cycle industry insiders. Company directors in this era had no legal restrictions on their ability to trade based on insider information, and the tendency of directors to sell shares immediately prior to a fall in price has been documented by Braggion and Moore (2013). Fjesme et al. (2019) find that investors at this time made better investment

⁶ *The Economist*, ‘The Cycle Boom’, 16th May 1896.

⁷ *Financial Times*, ‘The Cycle Market’, 22nd May 1896; *The Economist*, ‘The Cycle Boom’, 16th May 1896.

decisions with respect to the industry where they worked. This was likely to be the case in the cycle industry, where workers would also have had access to insider information in the form of production orders, which provided an indicator of future profitability prior to the publication of financial data.

The second definition of informed is broadened to include stockbrokers. Stockbrokers would not generally have had direct information on individual cycle firms, but would have had considerable experience of pricing stocks. They were also well-placed to judge supply and demand for cycle shares: *The Economist* reported in May 1897 that brokers were often commenting on the disparity between the number of investors attempting to sell cycle shares and the number of investors attempting to buy.⁸ The third definition of informed also includes those in upper management positions and company secretaries. There is likely to have been considerable variation in the level of information held by members of this group, but since it includes many investors with considerable business experience, as well as those holding management positions in other cycle firms, on average these investors are likely to have been relatively well informed.

The fourth definition of informed is much broader, incorporating all of the above groups plus institutional investors and those who worked in finance, law, journalism, or government. Some members of these groups may have had some inside information; for example, some institutional investors, such as the Accles Arms Manufacturing Co., appear to have been closely linked with cycle company promoters or directors.⁹ The category of government employees includes some Members of Parliament, who could have benefitted from political connections.

⁸ *The Economist*, 'Markets for Cycle Shares', 22nd May 1897.

⁹ *Money*, 'Companies to be Avoided', June 16th 1896.

Those working in finance, law or journalism may have been more likely to encounter the sceptical coverage of the cycle share market in the financial press.

A change in the holdings of informed investors can manifest itself in the data in two ways: a reduction in the number of shareholders from that group, and a change in the average size of their holding. On average, the shareholder base of these companies grew more dispersed over time, with the total number of shareholders increasing from 5,118 to 7,049 between t_1 and t_2 . We therefore also examine whether there was a change in the proportion of informed investors. For illustrative purposes, we also note the change in the number of shares held and the proportion of capital contributed.

The statistical significance of the difference between the t_1 and t_2 investor cohorts can be estimated by modelling whether an investor was informed or not as a binomial distribution, then using Pearson's chi-squared test to determine whether this probability was the same at t_1 as at t_2 . This provides an estimate of the probability that the observed change in the proportion of informed shareholders occurred due to random variation. Formally, the null hypothesis of:

$$P_{i, t=1} = P_{i, t=2} \quad (1)$$

is tested against the two-sided alternative:

$$P_{i, t=1} \neq P_{i, t=2} \quad (2)$$

where i represents the definition of 'informed' used for the test and $P_{i, t=1}$ and $P_{i, t=2}$ are the proportion of informed investors in samples t_1 and t_2 respectively. The test statistic is:

$$\chi^2 = \sum_{j=1}^4 \frac{(O_j - E_j)^2}{E_j} \quad (3)$$

where O_j equates to the number of observations of type j , with each j representing a particular combination of the time of the observation, t , and whether the investor is informed using

definition i . E_j is the proportion of investors in the pooled sample that are informed by definition i . This test statistic asymptotically approaches the chi-squared distribution with one degree of freedom, and is thus appropriate given the size of our sample (Rao and Scott, 1981).

The changes in the holdings of informed investors between t_1 and t_2 are shown in Table 5. All four definitions of ‘informed’ show a reduction in the proportion of informed investors, the average number of shares held by informed investors, and the proportion of capital contributed by informed investors. For each definition, the reduction in the proportion of informed investors is statistically significant at the 1 per cent level. The effect sizes vary depending on which measure is used, with the number of shares held by informed investors falling by between 161,000 and 263,000 between t_1 and t_2 . The reduction in the proportion of capital contributed ranges from 8.4 to 13.6 per cent, indicating that a substantial proportion of initial investment was from informed investors who exited the market either immediately prior to or during the crash. The high number of shares sold by informed investors is consistent with the model of Abreu and Brunnermeier (2002), and the scale on which this occurred indicates that these dynamics could explain a significant part of the asset price reversal.

<<<INSERT TABLE 5 HERE>>>

An alternative measure of information is the proximity of an investor to the office of the company in which they hold shares. Fjesme et al. (2019) find that investors who lived near the company office in this era made better investments at the IPO stage, and it is reasonable to expect that this advantage would continue after the company was listed. Living near a company office also made it more convenient to buy shares at the IPO stage than on secondary markets, making it less likely that these investors would enter the market when prices were peaking. We also test for a change in the proportion of investors living near a stock exchange. While this may have conferred some information benefit on investors, it also would have made it more

convenient to buy on secondary markets, increasing the risk of entering the market at the peak. Although the UK had several provincial stock exchanges at this time (Rogers et al., 2020), the vast majority of trade in cycle shares occurred in London or Birmingham. Investors are therefore treated as living near a stock exchange if they lived in the postcode regions B, EC, or WC. Finally, we use interaction terms to examine the effect of, for example, living near both a company office and a stock exchange.

The results of this analysis are shown in Table 6. The shareholder base grew more dispersed overall between t_1 and t_2 , so the number of overall shareholders increased by 46.7%. The number of investors living near the company's office increased at a lower rate, so the proportion of investors from this group fell slightly, indicating that these investors performed better than average. There was also a large reduction in the proportion of capital they held. In contrast, there was a large expansion in the number of shareholders based beside a stock exchange, particularly among those who did not also live near the company office. The number of shareholders in this group rose by 165.7% during the bubble. If there was any informational advantage to living near a stock exchange, it was clearly offset by the increased risk of entering the market when prices were falling.

<<<INSERT TABLE 6 HERE>>>

Overall, these results suggest a statistically significant decrease in the number of informed investors, a key prediction of the Abreu and Brunnermeier (2002) model. A second prediction of this model is that sales are synchronized at a particular point in time, in order to ensure that the quantity of shares sold is sufficient to correct overpricing. As a result, sales should be concentrated at the point in time at which share prices peak. In order to test whether this occurred during the cycle mania, it is first necessary to identify the point at which share prices peaked. As Figure 1 shows, cycle shares peaked in both May 1896 and March 1897.

However, since the high price level in March 1897 involved significantly more companies, it is treated as the peak of the mania. If the Abreu and Brunnermeier (2002) model is accurate, then there should have been a disproportionate amount of sales occurring at this time.

This prediction is tested using the aforementioned transfer data, which recorded the dates on which 2,276 transfers occurred, and the identity of the seller. A ‘proportionate’ number of sales is defined as the number predicted under the assumption that all sales are randomly distributed across each company’s individual sample period. This sample period is defined as the range of dates between the first and last reported transfer in each company’s *Summary of Capital and Shares*. The number of months in this range for each company i is defined as T_i . For each company i and month m , the expected number of transfers is then defined as:

$$E(X)_{m,i} = \frac{Y_i}{T_i} * \frac{d_{i,m}}{d_m} \quad (7)$$

where Y_i is the total number of transfers for company i over the entire sample, $d_{i,m}$ is the number of days in month i covered by the range T_i , and d_m is the total number of days in month m . These values are then summed for each month m , in the equation:

$$E(X)_m = \sum_{i=1}^{I^3} E(X)_{m,i} \quad (8)$$

$E(X)_m$ is therefore the expected total number of share transfers which would have taken place in month m if transfers were randomly distributed. The unconditional number of expected transfers in a given month follows a Poisson process, and so the variance of this estimate is also equal to $E(X)_m$.

Figure 4 graphs the expected number of shares sold in each month, with 95 per cent confidence intervals, against the observed number of shares sold, i.e., X_m . This analysis shows that the number of transfers was disproportionately high in March 1897, the month in which share prices peaked. This provides evidence in favour of Abreu and Brunnermeier’s (2002)

hypothesis: investors appear to have co-ordinated sales at a particular point in time, in order to ensure that sales were sufficient to cause a reversal in share prices. The co-ordinating mechanism, Abreu and Brunnermeier (2003) suggest, is often a particular event, which subsequently moves share prices more than its impact on fundamentals would suggest. In the case of the cycle mania, the co-ordinating event might have been the publication of an article in *Money*, a leading financial periodical, advising investors to sell shares in cycle firms.¹⁰

<<<INSERT FIGURE 4 HERE>>>

Figure 5 repeats this methodology using the total number of shares sold, as opposed to the total number of sales. The complexity of this process makes generating variances impossible under realistic assumptions, but it can be seen to closely track the number of transfers, with a similar spike in the volume of shares sold in March 1897. This indicates that there is no systematic variation in the number of shares involved in each transfer across time, confirming the validity of the results shown in Figure 4. The exception to this pattern is in November 1897, when the number of shares sold spikes as a result of 52,170 shares being sold in a single transfer.

<<<INSERT FIGURE 5 HERE>>>

6. Who lost money in the bubble?

This section uses the combined occupation, location, and transfer data to identify the characteristics of investors who lost money during the bubble. In order to measure the extent of trading activity among different groups, we begin by restricting the sample of shareholders to the 10 cycle companies that are both included in the main sample and recorded transfers. This results in a sample of 9,134 shareholders, 7,708 of whom provided an occupation. The

¹⁰ *Money*, 'The Cycle Boom', 27th March 1897.

patterns of ownership within this sub-sample are broadly similar to those observed in the full sample. The transfer data of three companies that were not included in the main sample is also omitted, resulting in a sample of 1,927 transfers conducted by 1,568 unique individuals. For these companies we have a record of ownership pre-crash, a record of sales, and a record of ownership post-crash.

The transfer data provides useful context for understanding why certain groups lost money during the bubble. As Griffin et al. (2011) note, a given group of investors can lose money during a bubble in two ways. Firstly, they can supply fewer shares when prices are at their peak; in other words, they are less likely to ride the bubble. Secondly, they can demand more shares when prices are high, thereby being more likely to buy at the worst possible time. Since the transfer data does not include the identity of buyers, demand is unobservable. However, it can be deduced by comparing the change in ownership to the number of sales. For example, an occupational group that sold a large number of shares but still increased its ownership must have demanded an even greater number of shares, likely because of new entrants from the same group.

The results for occupational groups are shown in Table 7. The group that conducted the most sales was gentlemen and nobility – also the group that increased its ownership of cycle shares by the most during the bubble. This indicates that this group performed poorly in aggregate because it was extremely active in secondary markets at a time when cycle share prices were close to their peak. Although they were more likely to sell than any other group, they were also much more likely to buy, suggesting that this group engaged in substantial speculative investment. While a significant minority may have been successful, many more would have lost money. Notably, groups that might be characterised as low-information, such as clergy or tradesmen, do not perform particularly badly.

<<<INSERT TABLE 7 HERE>>>

Table 8 performs a similar analysis for investors in various locations. It can be seen that, like gentlemen, investors based near a stock exchange increased their holdings despite being very active sellers. If anything, this group would have had better information than the average investor, suggesting that the worst-performing investors do not appear to be any less informed than average. The final row examines gentlemen who lived near a stock exchange in order to identify any interaction effects. This group accounted for only 1.57 per cent of shareholders at time t_1 . Based on the sample trend, in the absence of interaction effects, this group would be expected to account for 11.01 per cent of transfers and 4.49 per cent of shareholders at time t_2 . However, it accounted for 18.07 per cent of transfers and 8.22 per cent of t_2 shareholders, suggesting a positive interaction effect. The combination of being a gentleman and living near a stock exchange made it much more likely that an investor would become an active trader and end up holding cycle shares after the crash.

<<<INSERT TABLE 8 HERE>>>

These results instead suggest that poor performance in a bubble is associated with greater opportunity to invest at a bad time. The defining characteristic of gentlemen was that they had enough money that they did not need to work, and as a result, they had sufficient time and money to trade speculative stocks. Investors in general, and gentlemen in particular, were much more likely to be drawn into the market if they lived near a stock exchange, as this made frequently trading cycle shares much more convenient. While narratives of bubbles often emphasise the role of naïve investors, the investors most at risk during the cycle mania were not necessarily the least experienced. Rather they were those whose circumstances made it easy for them to invest in an asset in which they held no particular expertise.

6. Conclusion

This paper uses a unique dataset on holders of British cycle shares during the asset price reversal of 1896-1900 to examine who profits and who loses during a bubble. Three main conclusions are reached. Firstly, consistent with the work of Campbell and Turner (2012) and Carlos and Neal (2006), the bubble was not driven by extremely inexperienced or naïve investors. Instead, investors in cycle shares tended to come disproportionately from groups associated with a preference for relatively risky investments. Secondly, we find evidence in favour of the dynamics identified by Abreu and Brunnermeier (2002), in which arbitrageurs face a synchronization risk that limits their ability to correct mispricing. Company directors, cycle industry insiders, and those based near the company's office all systematically reduced their holdings during the crash. Transfers were disproportionately concentrated in the month of March 1897, when share prices peaked, consistent with the prediction of Abreu and Brunnermeier (2002) that investors co-ordinate their exit in order to ensure that mispricing is corrected.

Thirdly, we provide new insights into which investors lose money during a bubble. The investors left holding cycle shares that were almost worthless after 1897 were predominantly gentlemen based near a stock exchange who were active on secondary markets. Rather than being those with the least information or investment acuity, these were investors with the time, money, and opportunity to trade frequently during the mania. For policymakers, identifying which investors this describes today could be the key to determining who is most at risk of losing money on speculative assets.

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Table 1: Company-Level Summary Statistics for Holdings
Data

	Average	Std. Dev	Max	Min
	t_1			
Share price (% of par)	1.09	0.20	1.5	0.75
No. of Shareholders	281	305	1,290	18
Subscribed Capital (£)	73,418	66,871	249,837	4,291
	t_2			
Share price (% of par)	0.37	0.30	1.06	0.05
No. of Shareholders	399	468	2,068	24
Subscribed Capital (£)	70,003	65,330	250,000	4,500

Sources: Share prices obtained from the *Financial Times*; Number of Shareholders and Subscribed Capital obtained from *Summaries of Capital and Shares*.

Notes: t_1 and t_2 are from time periods before and after the peak in cycle share prices.

Table 2: Company Level Summary Statistics for Transfer Data

Company	Transfers	Shares Sold	First Transfer	Last Transfer
Accles	129	88,759	11/01/1898	11/11/1898
Appleby (Joseph)	52	9,247	05/05/1896	07/07/1897
Belle Vale	77	13,600	03/03/1897	21/02/1898
Claremont	96	14,938	05/11/1896	01/01/1898
Concentric Tubes	401	50,208	10/09/1896	10/10/1897
Endurance Tubes	337	74,244	09/09/1896	07/12/1897
Midwinter	50	12,172	04/05/1897	30/06/1897
Mutual, Ltd.	40	22,638	18/09/1896	12/12/1897
New Hudson	133	8,929	05/05/1897	12/12/1898
New Rapid	172	38,372	29/06/1897	17/11/1897
Raleigh	387	56,470	05/11/1896	16/12/1897
Simpson's Chain	385	200,105	08/01/1897	22/11/1897
Truffault	16	4,605	11/11/1896	15/10/1897
Total	2,276	594,287	05/05/1896	12/12/1898

Source: National Archives, Summaries of Capital and Shares

Table 3: Summary of Transfers

	Transfers	Shares	Average Price Per Transfer (£)	Average Price Per Share (£)	Maximum Price (£)	Minimum Price (£)
At or Above Par	1,046	143,743	1.32	1.27	1.86	1.00
Below Par	912	362,949	0.46	0.30	0.99	0.04
Unknown Price	318	87,595	-	-	-	-
Total	2,276	594,287	0.92	0.58	1.86	0.04

Sources: Share prices obtained from the *Financial Times*, transfers obtained from National Archives, Summaries of Capital and Shares.

Table 4: Proportion of Capital Contributed by Occupational Groups

	Cycle Companies t ₁	Cycle Companies t ₂	General Sample
Business-Manufacturing	21.3	20.0	5.9
Business-Merchant	8.3	6.7	9.5
Business-Retail	1.2	1.5	1.8
Businessmen	30.8	28.2	17.2
Institutional	10.0	7.7	1.2
Finance-Other Finance	3.7	5.3	1.5
Finance-Stockbroker	2.0	1.5	0.6
Financiers	5.7	6.7	2.1
Middle-Legal Profession	3.8	3.8	4.2
Middle-Clergy	0.2	0.3	1.7
Middle-Professional	19.0	12.0	4.6
Middle-White Collar	3.1	1.0	1.6
Middle Classes	26.1	17.2	12.1
Gentlemen	16.0	27.7	43.4
Women-Married	2.5	3.1	2.3
Women-Spinster	1.0	1.5	5.8
Women-Widow	0.7	1.2	5.1
Women	4.3	5.9	13.2
Working-Skilled	5.5	4.9	0.5
Working-Unskilled	0.4	0.2	0.0
Working Classes	5.9	5.1	0.5
Agriculture	0.3	0.4	1.5
Military	0.9	1.2	2.1
Executor/Trust	-	-	4.7
Unknown (Males)	-	-	2.0
Total	100	100	100
Company Directors	25.7	18.7	26.4*

Sources: National Archives, Summaries of Capital and Shares; Acheson et al (2017); Braggion and Moore (2013). *indicates the average proportion of capital contributed by directors to the companies in Braggion and Moore's (2013) sample. Company directors also listed an occupation, and so the analysis of their capital contribution is conducted separately.

Table 5: Changes in Informed Investor Holdings during the Cycle Mania

Measure of Informed	Shareholders t ₁	Shareholders t ₂	% Informed Investors t ₁	% Informed Investors t ₂	Shares held t ₁	Shares held t ₂	% Capital Contributed t ₁	% Capital Contributed t ₂
A	255	223	4.98	3.16**	541,083	379,821	33.70	25.30
B	313	320	6.12	4.54**	562,428	394,235	35.03	26.26
C	581	572	11.35	8.11**	659,653	456,211	41.09	30.38
D	1,133	1,235	34.82	26.50**	913,418	649,841	56.90	43.28
All investors	5118	7049	-	-	1,605,378	1,501,490	100	100

Source: National Archives, Summaries of Capital and Shares.

Notes: A=Company directors and cycle industry workers; B= All of those included in A plus stockbrokers; C=All of those included in B plus upper management and secretaries; D= All of those included in C plus institutional investors, finance industry workers, legal workers, journalists and government workers. * and ** indicate the significance of Pearson chi-squared tests for a change in the proportion of informed investors at a 5% and 1% level respectively.

Table 6. Cycle Shares Held by Location.

Location Category	Shareholders t1	Shareholders t2	Percentage Change	Shares Held t1	Shares Held t2	Percentage change
Beside Stock Exchange	1,523	2,758**	81.1	818,452	813,806	-0.6
Beside Company Office	1,614	2,233*	38.4	847,252	719,786	-15.0
Beside Exchange AND Beside Company Office	1,053	1,509	43.3	547,205	476,977	-12.8
Beside Exchange but NOT Beside Company Office	470	1,249**	165.7	271,247	336,829	24.2
Beside Company Office but NOT Beside Exchange	561	724*	29.1	300,047	242,809	-19.1
Beside neither Exchange nor Company Office	4,943	6,826**	38.1	827,244	1,034,447	25.0
Total	7,027	10,308	46.7	1,945,7434	2,091,062	7.5

Source: National Archives, Summaries of Capital and Shares.

Notes: * and ** indicate the significance of Pearson chi-squared tests for a change in the proportion of informed investors at a 5% and 1% level respectively.

Table 7: Occupations of Pre-Peak Shareholders, Sellers, and Post-Peak Shareholders as a Percentage of all Shareholders

Occupations	% of Shareholders t_1	% of Sellers	% of Shareholders t_2
Cycle Industry	3.14	2.30	1.60**
Stockbrokers	0.98	4.29**	1.20
Banking and Finance	5.34	4.69	4.48
Companies	0.03	0.24	0.04
Upper Management and Secretaries	5.38	4.29	3.39**
Merchants, Agents, and Commercial	10.89	8.82*	8.02**
Legal Workers	3.62	4.05	3.28
Public Sector	0.91	0.56	0.61
Health Services	3.58	1.75**	2.67*
News Media	0.24	0.00	0.23
Education	2.30	0.64**	1.58*
Clerks and Assistants	6.29	3.34**	4.29**
Police	0.85	0.00**	0.82
Retail	5.24	2.86**	4.57
Gentlemen and Nobility	14.50	38.68**	33.85**
Non-Cycle Manufacturers and Engineers	8.22	8.50	6.69*
Skilled and semi-skilled trades	8.08	4.69**	5.54**
Agriculture	0.85	0.32*	0.72
Manual Labourers and Servants	2.81	1.03**	1.75**
Military	1.45	0.40**	1.41
Married Women	5.88	3.81**	4.99
Spinsters	6.22	2.54**	5.68
Widows	1.12	0.87	0.97
Clergy	2.10	1.35	1.60
Total (Excl Unknown)	100.00	100.00	100.00

Source: National Archives, Summaries of Capital and Shares.

Notes: * and ** indicate the significance of Pearson chi-squared tests for difference from the t_1 sample at a 5% and 1% level respectively.

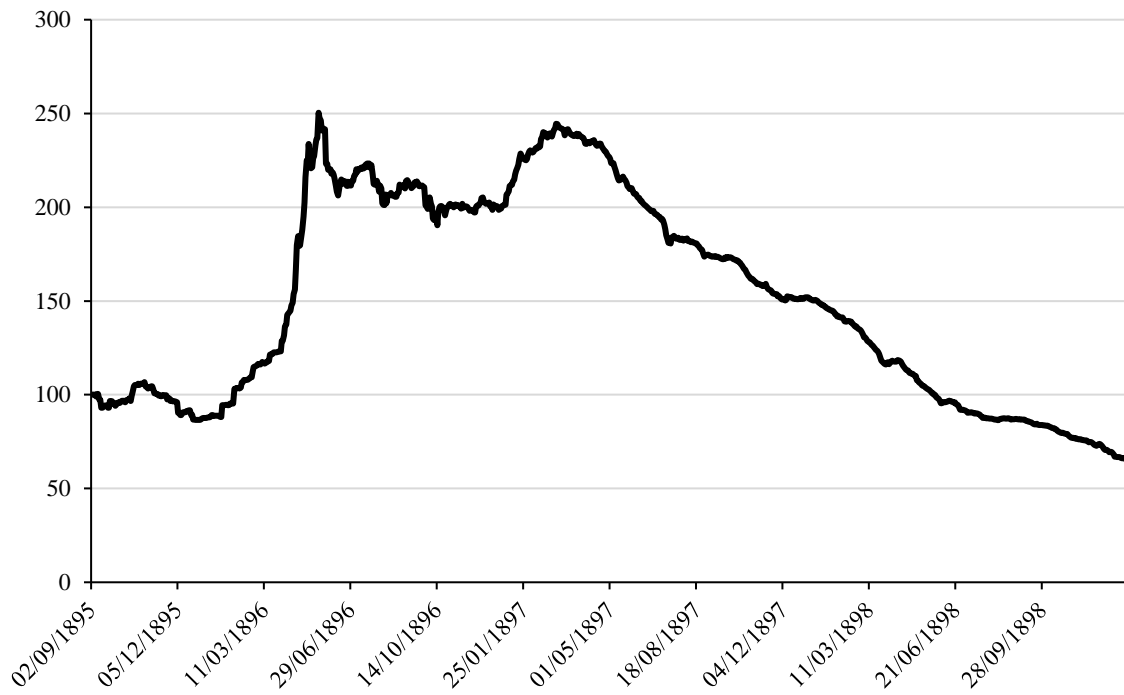
Table 8: Locations of Pre-Peak Shareholders, Sellers, and Post-Peak Shareholders as a Percentage of all Shareholders

Location	% of Shareholders t_1	% of Sellers	% of Shareholders t_2
Beside Stock Exchange	19.70	51.66**	24.09**
Beside Company Office	25.33	45.03**	22.55**
Beside Exchange AND Beside Company Office	12.31	32.59**	13.18
Beside Exchange but NOT Beside Company Office	7.38	19.07**	10.91**
Beside Company Office but NOT Beside Stock Exchange	13.02	12.44	9.37**
Beside neither Exchange nor Company Office	67.29	35.91**	66.54
Unknown	0.31	0.19	0.91**
Total	100.00	100.00	100.00
Gentlemen/Nobility AND Beside Exchange	1.57	18.07**	8.22**

Source: National Archives, Summaries of Capital and Shares.

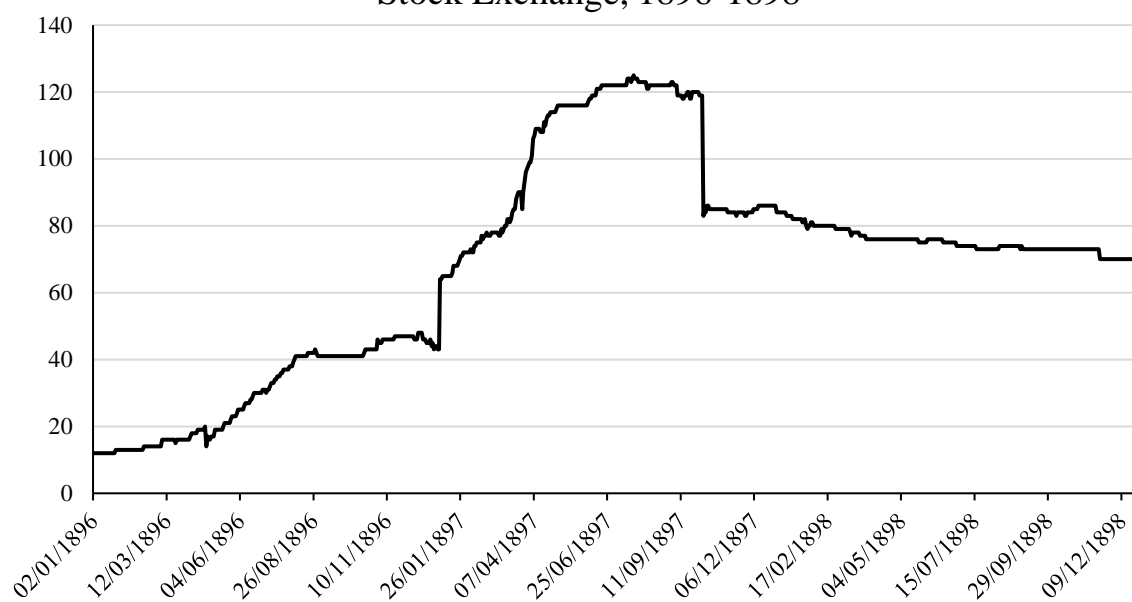
Notes: * and ** indicate the significance of Pearson chi-squared tests for difference from the t_1 sample at a 5% and 1% level respectively.

Figure 1: Cycle Share Index, 1895-1898



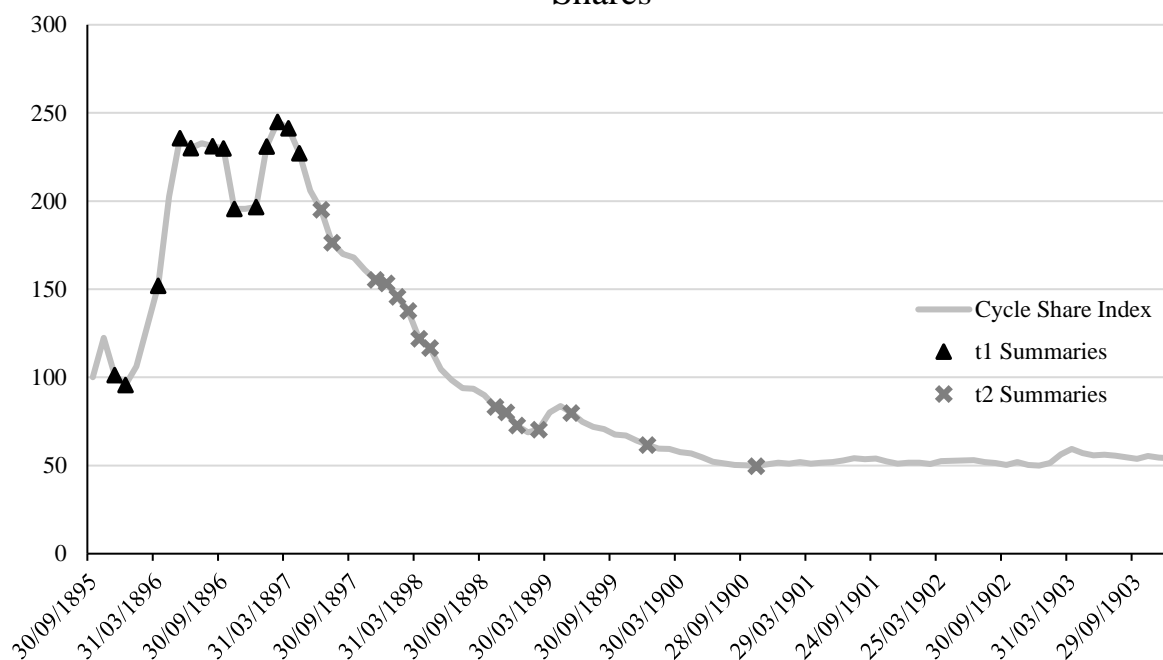
Sources: see text.

Figure 2: Number of Cycle Firms Traded on Birmingham Stock Exchange, 1896-1898



Sources: *Financial Times* and *Birmingham Daily Mail*.

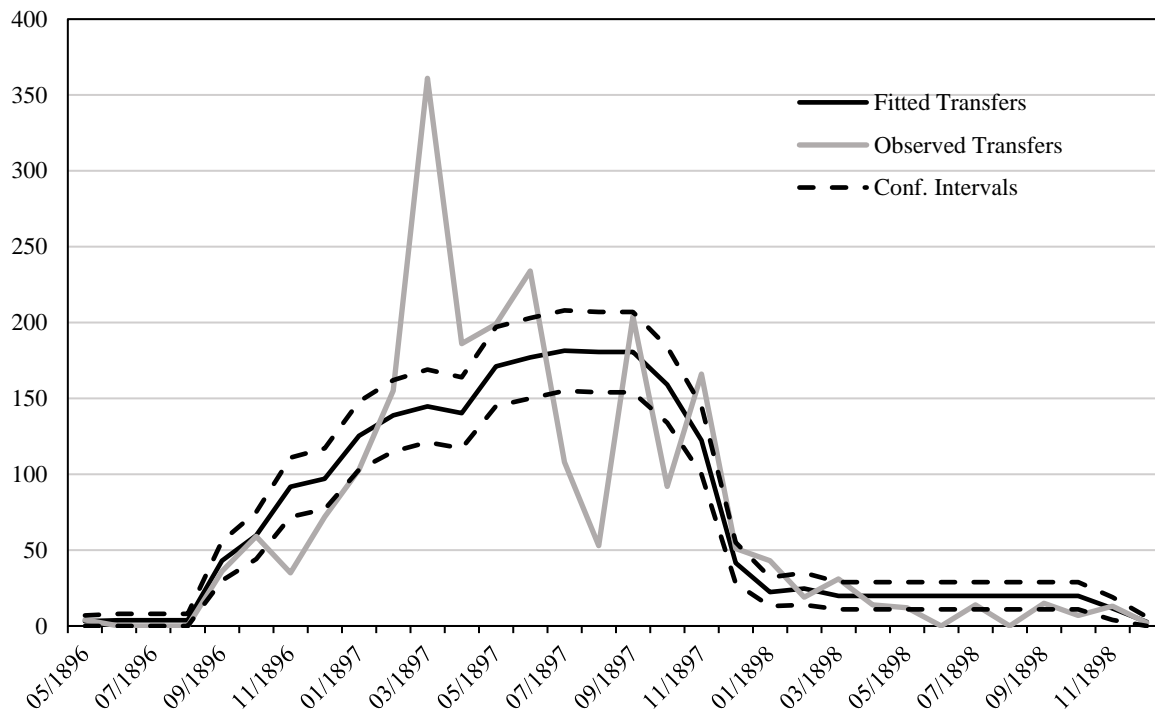
Figure 3: Cycle Share Prices and Summaries of Capital and Shares



Source: *Birmingham Daily Mail*, *Birmingham Daily Post*, *Financial Times*, *Summaries of Capital and Shares*.

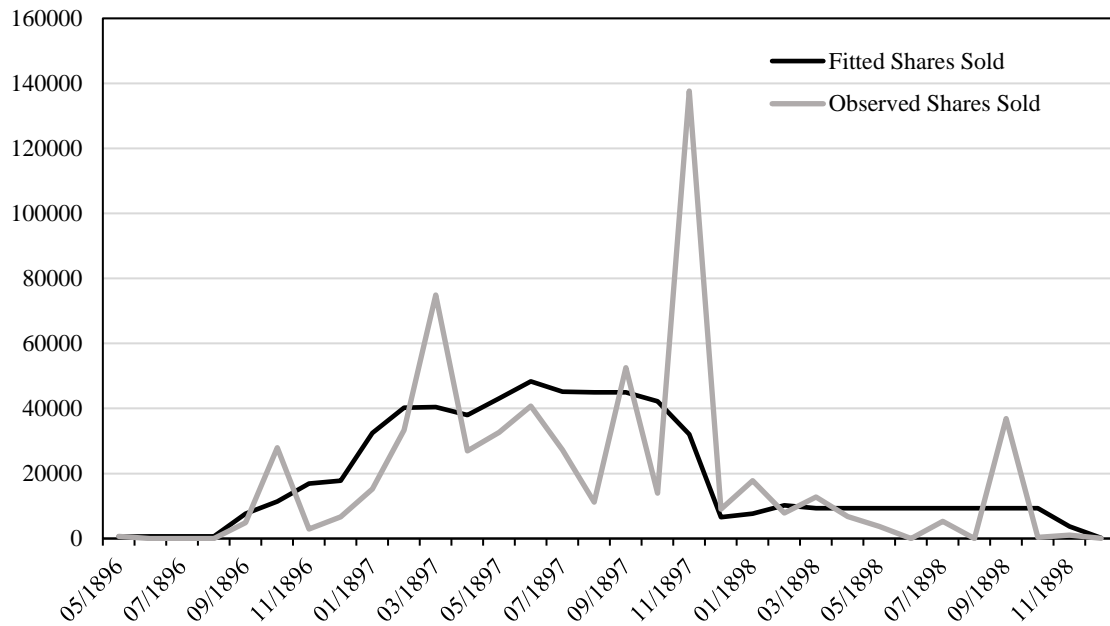
Notes: t_1 is defined as the period of time prior to or during the peak of the company's share price, with t_2 defined as the period of time after its share price had peaked.

Figure 4: Fitted Transfers vs. Observed Transfers, 1896-1898



Notes: Fitted transfers are those which would have occurred in each month if all transfers were evenly distributed across the time covered by each individual *Summary of Capital and Shares*, with confidence intervals calculated under the assumption of a Poisson distribution. Observed transfers are the number of transfers which occurred.

Figure 5: Fitted Shares Sold vs. Observed Shares Sold,
1896-1898



Source: *Summaries of Capital and Shares*.

Notes: Fitted shares sold are the number of shares which would have been sold in each month if shares sold were distributed evenly across the period covered by each individual *Summary of Capital and Shares*. Observed shares sold are the number of shares which were actually sold.

Appendix Table 1: Cycle Company Shareholder Records

Company	Shareholder Register t ₁	Shareholder Register t ₂	Total Shareholders (t ₁ + t ₂)	Total Shares (t ₁ + t ₂)
Accles	16/10/1896	31/12/1898	248	294,642
Appleby Joseph	11/08/1896	05/07/1897	157	129,424
Austral Agency	08/03/1897	08/03/1898	272	220,000
Belle Vale Tube	04/01/1897	21/04/1898	202	39,845
Boudard Peveril	19/11/1894	25/12/1898	622	8,791
Bown	31/01/1897	24/02/1899	293	101,040
Brookes Cycle	18/09/1896	31/12/1898	466	120,000
Claremont	30/10/1896	18/01/1898	894	150,145
Concentric Tube	03/09/1896	25/06/1897	596	149,000
Coventry Cross	22/09/1896	27/12/1898	442	72,705
Dunlop J B Fittings	12/04/1897	12/10/1900	222	57,029
Empire	21/12/1896	22/11/1898	312	49,667
Endurance Tubes	26/09/1896	10/12/1897	502	124,902
Humber and Goddard	07/10/1896	01/02/1899	278	144,638
Larue	28/10/1896	02/02/1898	371	145,795
Mutual	27/11/1895	14/01/1898	1,742	250,384
New Seddon	17/09/1896	30/04/1897	3,358	498,806
Puncture Proof	11/05/1896	06/02/1899	805	59,294
Quadrant	02/03/1896	24/10/1900	248	97,619
Raleigh	05/06/1896	14/12/1897	2,042	400,035
Reliance	10/09/1896	08/04/1898	266	48,479
Rosser Brake	20/02/1897	14/01/1898	42	58,014
Sanspareil	06/04/1897	09/02/1899	215	40,000
Simpson's Chain	31/12/1895	31/12/1897	1,393	471,012
Truffault	13/09/1896	13/11/1897	1,000	158,379
Total			16,988	3,889,645

Source: *Summaries of Capital and Shares*