QUCEH WORKING PAPER SERIES
http://www.quceh.org.uk/working-papers

PRICES AND INFORMED TRADING: EVIDENCE FROM AN EARLY STOCK MARKET

Graeme G. Acheson (University of Stirling)
Christopher Coyle (Queen's University Belfast)
John D. Turner (Queen's University Belfast)

Working Paper 2018-05

QUEEN'S UNIVERSITY CENTRE FOR ECONOMIC HISTORY
Queen's University Belfast
185 Stranmillis Road
Belfast BT9 5EE

April 2018

Prices and Informed Trading:
Evidence from an Early Stock Market

Graeme G. Acheson[1], Christopher Coyle[2#] and John D. Turner[2]

Abstract

Using a novel dataset where all traders are identifiable, we examine trading in the shares of a major company on the London Stock Exchange before 1920. Our main finding is that bid-ask spreads increased in the presence of informed trades. However, we also find that spreads narrowed during periods of informed trading when such trades were timed to periods of large uninformed volume and that professional traders consistently timed larger volume to such periods. We also find that spreads increased during the 1914 closure of the Stock Exchange. Our results provide support for the classical microstructure theories of informed trading.

JEL codes: G12, N23, N24.

Keywords: Informed Trading, Uninformed Trading, Liquidity, Effective Spread, Adverse Selection, Stock Exchange Closure.

[1] Stirling Management School, University of Stirling.
[2] Queen's Management School, Queen's University Belfast.
[#] Corresponding author: Queen's Management School, Queen's University Belfast, 185 Stranmillis Road, Belfast, BT9 5EE; Email: c.coyle@qub.ac.uk.

*We would like to thank seminar participants at the EurHistock 2016 Workshop, Western Economics Association Conference 2017, World Congress of Cliometrics 2017, Australasian Cliometrics Workshop 2017, University of Melbourne and Queen's University Belfast for their comments. In particular, thanks to Gareth Campbell, David Chambers, Neal Galpin, Bruce Grundy, Les Hannah, Lyndon Moore, John Tang, and Zhuo Zhong. We are indebted to the archivists at the Aviva Archive, Surry House, Norwich for their wonderful support and access to their archives. Research assistance was provided by Stephen Billington and David Jordan.

1. Introduction

Information-based theories of market microstructure posit that stock illiquidity should rise with increased levels of informed trading (e.g., Glosten and Milgrom, 1985; Kyle, 1985; Easley and O'Hara, 1987). For example, in the sequential trading model of Glosten and Milgrom (1985), when market-makers quote bid-ask prices at which they are willing to buy and sell, they expose themselves to adverse selection risk from better-informed traders. As a result, market-makers, increase their bid–ask spread to prevent losses, implying lower liquidity and high transaction costs for traders.

However, there are substantial challenges in testing such information-based theories. The first challenge is that traders' information sets are almost never observable. The second challenge is that the nature of modern trading and trading data, such as high-frequency trading, odd lots, flickering quotes caused by order cancelations, revisions and resubmissions, means that the actions of informed traders may not always be fully reflected in bid-ask prices (Hasbrouck, 2017; O'Hara, Yao and Ye, 2014; O'Hara, 2015; Foucault, Hombert and Rosu, 2016). This makes testing of fundamental theories of informed trading very challenging.

In this paper, we overcome these issues by using an historical case study to evaluate the fundamental relationship between information and bid-ask spreads. We use a hand-collected dataset from the North British and Mercantile Insurance Company (NBMIC) for the period 1882 to 1920. The NBMIC was one of the largest insurance companies in the world at the time and one of the largest companies in the UK. This novel dataset enables us to identify all traders and their trades in the shares of this company over a 38-year period, including trades by informed traders. Furthermore, our dataset also enables us to identify cleanly a subset of uninformed traders. Identifying uninformed traders has proved very difficult in modern markets because they have not been identified in court cases or by disclosure rules, as has been the case with a subset of informed traders.

As well as enabling us to identify all traders, another novel feature of our study is the institutional structure in place during our sample period. Stock prices were not distorted by high-frequency or algorithmic trading. Submitted orders could not be cancelled and the exact identity of all traders was revealed to market-makers through the completion of transfer forms following each trade. The use of limit orders was infrequent, and, because there was no standing limit order book, passive trading was not commonplace. There was limited opportunity for a trader to disguise their identity or intentions from a market-maker in order to conceal information. Consequently, the nature of trading during our sample period reduces many of the difficulties associated with testing information-based theories in modern markets.

A yet further advantage of our dataset is that it allows us to see how liquidity and informed trading responded when the London Stock Exchange closed, for the first time in its then 113-year history, for five months at the outbreak of World War I. This quasi-natural experiment helps us to understand how markets respond to trading suspensions in organized security markets.

The first thing we do with our dataset is generate a measure of the volume of informed trading. Specifically, our measure of informed trading includes all company insiders, institutional investors, and professional investors who bought or sold shares. Our dataset also allows us to identify a subset of uninformed traders. Because executors of wills were obligated to sell shares as soon as legally possible after the death of a shareholder, we have a cleanly identified large sample of uninformed trades. In order to estimate the effect of informed and uninformed trading on bid-ask prices, the next thing we do is estimate the effective bid-ask spread for NBMIC shares using the Corwin and Schultz (2012) and Roll (1984) measures.

Our main finding is that, in contrast to many empirical studies, increases in the volume of informed trading are associated with statistically and economically significant increases in the effective bid-ask spread. However, we also find evidence that increases in the level of

uninformed trading volume relative to informed volume are associated with decreases in the effective bid-ask spread, suggesting that the effect of informed trading can be reduced if it is timed to periods of high uninformed volume. In addition, our evidence suggests that professional traders strategically timed their buying to periods of high uninformed trading. Finally, we find that when the London Stock Exchange was closed at the beginning of World War I, trading activity continued. However, in contrast to the concurrent closure of the New York Stock Exchange (see Silber, 2005), the closure of the London exchange resulted in a large decrease in liquidity.

Our study contributes to the literature that has attempted to measure the volume and effect of informed trading. As informed traders are hard to identify, one branch of this literature assumes that informed traders trade in a particular way and attempts to extract this information from trade data.[1] This data is then incorporated into measures that are designed to capture the level of information asymmetry (Kyle, 1985; Glosten and Harris, 1988; Huang and Stoll, 1996; Easley, Kiefer, O'Hara and Paperman, 1996). However, equating informed traders with particular trading behaviour is no longer viewed as an accurate measure (Bloomfield, O'Hara, and Saar, 2005; Hasbrouck and Saar, 2009; Eisler, Bouchaud, and Kockelkoren, 2012; Kim and Stoll, 2014; O'Hara, 2015; Easley, de Prado, O'Hara, 2016). Other attempts to identify information within trades have used variables that have been suggested as indirect indicators of informed trading, such as institutional order flow (Boulatov, Hendershott and Livdan, 2013; Hendershott, Livdan and Schürhoff, 2015; Chakravarty, 2001), size of trades (Easley and O'Hara, 1987; Hasbrouck, 1988; Barclay and Warner, 1993; Heflin and Shaw, 2005), and time of day (Harris, 1986, Admati and Pfleiderer, 1988).

[1] A number of trade classification algorithms have been developed in order to do this. See, Lee and Ready (1991), Ellis, Michaely and O'Hara (2000), Chakrabarty, Moulton and Shilko (2012), Easley, de Prado, O'Hara (2016).

Our paper is closest to the set of papers that have calculated more direct measures of information asymmetry based on novel data that reveals the identity of a small subset of informed traders in one or more companies. For example, Meulbroek (1992), Cornell and Sirri (1992), Chakravarty and McConnell (1997; 1999) and Kacperczyk and Pagnotta (2016) use data from cases of illegal trades by insiders to measure information asymmetry. Collin-Dufresne and Fos (2015) use trades by Schedule 13D filers as a measure of informed trading. Most of these studies find that trades by insiders or activist investors are significantly correlated with stock price movements, but they do not find evidence that illiquidity and bid-ask spreads increase with informed trading. However, our evidence suggests that illiquidity and bid-ask spreads increase with informed trading, which is consistent with classical microstructure theory.

We also find that the effect of informed trading can be reduced if it is timed to periods of high uninformed volume. This supports the claim of Cornell and Sirri (1992) and Collin-Dufresne and Fos (2015) that the absence of a positive effect of informed trading on bid-ask spreads may be due to strategic or passive trading on the part of informed investors. Kacperczyk and Pagnotta (2016) also find some evidence of strategic trading when analysing insider-trading cases filed by the SEC from 2001 to 2012. We find that professional traders consistently timed their larger trades to periods when uninformed volume was highest.

Our findings also augment the literature on historical market microstructure which has estimated NYSE liquidity during its World War I closure (Silber, 2005), the effective spread on the Berlin Stock Exchange between 1880 and 1910 (Gehrig and Fohlin, 2006; Burhop and Gelman, 2010), quoted bid-ask spreads for Dow Jones stocks for 1900 to 2000 (Jones, 2002), and the effect of information on prices in historical stock markets (Koudijs, 2016).

The paper proceeds as follows. Section 2 discusses the institutional structure of this market. Section 3 explains our data sources, gives some background on the NBMIC, and

describes our dataset. Section 4 investigates the relationship between informed trading and the share price. Section 5 constructs and examines measures of the effective bid-ask spread. Section 6 presents results of the effect of informed trading on effective spread measures. Section 7 examines the effect of the volume imbalance between uninformed and informed trading on the effective spread measures and whether informed traders strategically timed their trades to periods of high uninformed volume. Section 8 provides a brief summary and suggestions for further research.

2. Institutional structure

London was the world's dominant securities market in the late nineteenth and early twentieth centuries (Michie, 1999). No other exchange could match London in terms of scale and scope of securities on offer (Neal and Davis, 2006). In 1877 and 1910, there were 2,000 and 5,000 members of the London Stock Exchange respectively (Van Antwerp, 1913, p.334). The London Stock Exchange differed from foreign exchanges at this time in that members were divided into one of two functions - brokers or jobbers. Brokers worked directly with the public and acted as an agent between them and the jobber, but were forbidden from dealing in shares directly.[2] The broker received a commission for each trade and had a duty to see that all trades were made at fair prices for his clients and that all transfers were properly registered.

The jobber, or market-maker, took part in all trades but was not allowed to deal directly with the public; they worked on the exchange floor providing liquidity by 'making prices' and dealing only with brokers or fellow jobbers from Monday through Saturday. The market for each security had an assigned area within the exchange, while each jobber had a particular place within the market in which they dealt, reducing search costs and making it easy for

[2] Brokers caught dealing shares would be suspended from the Stock Exchange. In one such case, a broker dealing for a clerk of Baring's was suspended for four years (The Baring Archive, HC1.14.4.42).

members to do business (Cordingly, 1901, pp.12-13). Jobbers focused their operations on a particular market or stock and were expected to be ready at all times to buy or sell in any quantity. When approached to deal, the jobber did not know or have the right to ask whether the broker was acting on behalf of a buyer or seller, thus ensuring proper quotations (Cordingly, 1901, p.21). Having quoted a bid and ask price, the jobber was then bound by the rules of the Exchange to deal at these prices. Changes in jobber quotations were quickly recorded on the Exchange's 'tape', which was then transmitted to subscribers. The jobber, therefore, was the equivalent of the dealer/market-maker in today's quote-driven markets.

The separation of jobbers and brokers did not exist in any market outside of London at this time. It was the view of the Editor of *The Economist* that, 'the separate existence of Jobbers makes for a free market and close prices. There is no place in the world where good stocks are more easily and quickly realisable at a minimum of loss, or purchasable at so near the market price, as on the London Stock Exchange' (Hirst, 1911, p.74).

While trading on the London Stock Exchange during our sample period was low frequency relative to today's advanced markets, the institutional structure provides a unique and interesting laboratory in which to test theories of informed trading in a quote-driven market because it overcomes many of the problems associated with today's trading data. The nature of modern trading not only presents difficulties with identifying exactly who is informed, but also whether these informed trades are fully reflected in trading data. Throughout our sample period, prices could not be distorted by high-frequency or algorithmic trading. Once an order was submitted by a broker to a jobber, it could not be cancelled. While the jobber may have had an indication of whether a trade was likely to be informed or not ex-ante, based on repeated interactions with specific brokers (Benveniste, Marcus and Wilhelm, 1992), the completion of transfer forms following each trade revealed the exact identity of all buyers and sellers ex-post. Therefore, the direct interaction between brokers and dealers meant that trader characteristics

and any information underlying specific trades could be recognized and reflected in prices; there were few impediments to the learning process. There was also limited opportunity for a trader to disguise their identity or intentions from a market-maker in order to conceal information. In addition, there were no legal restrictions on insider trading (Braggion and Moore, 2013), which meant that traders could freely take advantage of any potentially profitable information that they had. It would be expected, therefore, that changes in the level of information asymmetry and informed trading would be reflected in effective spreads, as market-makers attempted to prevent losses to informed traders and to recover losses from uninformed traders.

Our sample period covers World War I and the closure of the London Stock Exchange from July 1914 until January 1915. The exchange announced its closure for the first time in its history on 31 July 1914. After learning that war was inevitable, this decision was taken by the Stock Exchange Committee in order to prevent panic and widespread failures (Michie, 1999). Despite the closure of the exchange, J. M. Keynes stated that unofficial transactions in cash took place by 13 or 14 August, or possibly earlier (Keynes, 1914). Notably, our dataset shows that trades in NBMIC shares took place on each day from 4 to 14 August 1914. During the five-month closure, there were 111 trades in NBMIC shares.

During the closure of the Stock Exchange, trading generally took place in the street, and was therefore subject to the elements. Adverse weather typically led to a lower attendance of Stock Exchange members and reduced business (*Western Mail*, 27 August 1914, p. 8; *Financial Times*, 12 Sept. 1914, p. 1). Trading also took place in brokers' offices or other convenient meeting places, e.g., Durlachers, the jobbers, dealt in the shares of rubber plantation companies at the Savoy hotel (Michie, 1999, p.147). Trading was also facilitated through the use of the Exchange Telegraph's challenge system, previously used for only the most inactive

securities (Michie, 1999, p.147). Auctions of securities also occurred, especially in the interests of solicitors, who had difficulty in valuing or settling estates (Michie, 1999, p.147).

On 4 January 1915, the London Stock Exchange reopened after over five months of closure. Despite the reopening of the exchange, severe restrictions on trading remained in place throughout World War I (Michie, 1999, pp.147-8). These included a shortened trading day to between 11am and 3pm, minimum price levels, and cash-only transactions with immediate payment. The use of options was banned, as was arbitrage, while non-UK investors could not sell their holdings.

3. Data

3.1 Data sources

We hand-collected data from the *Share Transfer Books* and *Register of Shareholders* of the North British and Mercantile Insurance Company (NBMIC) from October 1882 to December 1920.[3] Unfortunately, the transfer books prior to 1882 have not survived and Aviva's protection of company information meant that we could not see the transfer books from 1921 onwards. Most stocks dealt in the UK at this time were not bearer stocks, and so did not pass from hand to hand as was the case with US stocks. Instead, traders were required to submit a transfer form following each trade, which gave detailed trader information (Van Antwerp, 1913 p. 355). As a result, the NBMIC's share transfer books recorded not only the date, price and size of all trades that took place in the company's shares, but also the personal information of all buyers and sellers, including name and address. To the best of our knowledge, such a detailed source has not survived for other companies of the time.

In order to calculate a monthly return on the overall stock market for our entire sample period, we collected end-of-month stock prices and market capitalization for all common

[3] *Share Transfer Books* of the NBMIC are held at the Aviva Archive, Surry House, Norwich.

equities quoted in the *Investor's Monthly Manual*, which we obtained from Yale School of Management's International Center for Finance. This enabled us to construct a value-weighted monthly market index.

3.2 NBMIC background

NBMIC is today part of the Aviva Group and has been registered as a non-trading firm since 2006. Formed in 1809 as the North British Insurance Company, it was initially headquartered in Edinburgh and aimed to give Scotland an insurance firm that would rival those based in England (Raynes, 1964, p.227). With a starting capitalisation of £500,000, the firm survived substantial early payouts, before gaining a Royal Charter of incorporation in 1824 (NBMIC, 1909). Over the next half-century, it expanded, moving into both fire and life insurance, opening branches throughout Britain and the colonies, and taking over several smaller insurance firms. In 1862, the North British and Mercantile Insurance Company was created as part of a merger with the London-based Mercantile Fire Insurance Company, with Head Offices in both Edinburgh and London. The NBMIC was the second largest insurance firm and the 43rd largest public company by market capitalisation in Britain at the turn of the twentieth century (Kennedy and Delargy, 2000). Similar to most other large public companies of the era, it had diffuse ownership (Foreman-Peck and Hannah, 2012). For example, in 1911 its 25 directors only controlled 16.4% of the company's voting rights. In 1882, the largest shareholder, top 5 largest and top 10 largest shareholders owned 2.9%, 10.4%, and 14.9% of the capital, while in 1921, the largest shareholder, top 5 largest and top 10 largest shareholders owned 0.9%, 4.0% and 6.5% of the capital.

3.3. Data description

All trades were recorded by hand in the *Share Transfer Books* of the NBMIC in the order in which they were executed. These transfer books recorded the date of the transfer, the transferor

and transferee's names and addresses, the number of shares transferred and the price per share. When an executor of a will was selling shares on behalf of a deceased shareholder, this information was recorded in the transferor's designation. We hand-collected all this information from the transfer books from October 1882 to December 1920. In total, we have a sample of circa 32,000 trades. Summary statistics of daily trading activity are presented in Table 1.

<TABLE 1 HERE>

Table 1 indicates that although trading during our sample period was relatively infrequent in terms of the number of trades per day and share volume traded, trading occurred on the majority of days, with no trades occurring on 33.7% of days in the full sample and 31.7% of days excluding World War I. This is comparable to more recent data. Lesmond, Ogden and Trzcinka (1999) examine all firms on the AMEX and NYSE from 1962 to 1990, measuring no-trade days by the frequency of zero-return days. They find that firms in the smallest two deciles by size had greater than 31% zero-return days on average, and 60% of firms (the six smallest deciles by size) had greater than 20% zero-return days. Goyenko, Holden and Trzcinka (2009) estimate that NYSE firms had 14.5% zero-return days, on average, between 1993 and 2005, with a maximum of 91.7%.

Because we want to identify trades by informed traders, we use the NBMIC's *Registers of Shareholders,* which identifies the complete trading record of all investors in the company's shares.[4] Using this source, we can identify the occupations of all traders who may have had superior knowledge about the company or its prospects and compile their trading records. This enables us to develop a much more comprehensive measure of informed trading than is usually possible.

[4] *Registers of Shareholders* of the NBMIC are held at the Aviva Archive, Surry House, Norwich.

Our sample of informed traders covers four types of investor. Firstly, we collect trading records including dates, prices and volumes of all buy and sell trades of company directors during the sample period. Secondly, we collect trading records for other senior company officers who are identified in the company's annual accounts.[5] This includes managers, actuaries, company secretaries, and company auditors. We refer to this group as 'management'. Thirdly, data are collected on any institutional investor that trades the company's shares. This includes banks, such as Barclay's Bank, investment trusts, including the Edinburgh Investment Trust, and insurance companies such as the Royal Insurance Company. Finally, trading records are collected for any 'finance professional' that trades the company's shares on their own personal account. This includes any individual identified as a stockbroker, a banker or an insurance broker; stockbrokers, however, dominate this group.

Table 2 shows that the majority of informed trades by both number and volume are by individual finance professionals, followed by institutional investors and directors. The company's management were few in number and account for a relatively small number of trades. From Table 3, we see that the average monthly informed buy volume across our sample is 75 shares and the average monthly informed sell volume is 57 shares.

<TABLE 2 AND 3 HERE>

4. Effect of informed trading on the NBMIC share price

While a unique feature of this sample of informed traders is that it is relatively comprehensive, it is also likely that the measure includes some 'falsely informed traders', who do not have superior information (Cornell and Sirri, 1992). This will introduce some noise into the measure. Additionally, the motive behind some of these trades may not have been to profit on superior information, but for liquidity reasons. These factors, if significant in scale, could lead to a type

[5] Annual Accounts of the NBMIC are held at the Aviva Archive, Surry House, Norwich.

II error, biasing the results against finding the theorized link between informed trading and prices. Consequently, we test whether trades by these investors actually correlate with changes in the company's share price. If these investors were incorporating information when they traded, then this should be reflected in the share price. To do so, we estimate the following regression:

$$R_{NBMIC,t} = \alpha + \beta R_{m,t} + \beta_1 InfBuy_t + \beta_2 InfBuy_{t-1} + \beta_3 InfSell_t + \beta_4 InfSell_{t-1} + e_t \quad (1)$$

where $R_{NBMIC,t}$ is the monthly return on NBMIC shares in month *t*; $R_{m,t}$ is the value-weighted return of the 100 largest companies or the value-weighted return of the all-share market index in month *t*; $InfBuy_t$ is the volume of shares bought by our sample of 'informed' traders in month *t*; $InfBuy_{t-1}$ is the lagged volume of shares bought by our 'informed' sample of traders; $InfSell_t$ is the volume of shares sold by our 'informed' sample of traders in month *t*, and $InfSell_{t-1}$ is the lagged volume of shares sold by our sample of informed traders.

<TABLE 4 HERE>

The regression results in columns 1 and 3 of Table 4 suggest that when the informed buy volume increases, the share price, controlling for market returns, also increases by an economically meaningful rate of 0.90 to 0.98 percentage points per 75 shares bought, which is the average monthly informed buy volume in our sample (see Table 3). This is consistent with the indication that these investors possess favourable information. Notably, Cornell and Sirri (1992) find that, controlling for the market, returns increase by 0.67 percentage points during a month where there is insider trading and Collin-Dufresne and Fos (2015) find that average market-adjusted returns are 0.68 percentage points higher on days that Schedule 13D filers trade.

Columns 1 and 3 of Table 4 also show that informed sells correlate negatively with stock price changes, as we would expect, but this is not significant at the 10% level. As there are likely to be some periods of overlap in our sample between informed buy and sell trades,

for example for liquidity reasons, columns 2 and 4 of Table 4 show results for the following regression:

$$R_{NBMIC,t} = \alpha + \beta R_{m,t} + \beta_1 InfBuy\_Sell_t + \beta_2 InfBuy\_Sell_{t-1} + e_t \quad (2)$$

where $R_{NBMIC,t}$ is the monthly return on NBMIC shares; $R_{m,t}$ is the value-weighted return of the 100 largest companies or on the value-weighted all-share market index at time *t*; $InfBuy\_Sell_t$ is the monthly volume imbalance between informed buy and sell trades and $InfBuy\_Sell_{t-1}$ is the lagged monthly volume imbalance between informed buy and sell trades.

Columns 2 and 4 of Table 4 indicate that, controlling for the return on the market, when the imbalance of informed trades is positive (i.e., there is greater volume of informed buys than sells in a given month), the share price increases. Conversely, a negative imbalance of informed trades (i.e., there is a greater volume of informed sells in a given month) is correlated with decreases in the share price. This supports the view that our sample of informed traders possesses superior information.

5. Estimating bid-ask spreads

Because there is no source of consistent and complete quoted spreads on a daily basis during our sample period, we use our dataset of intraday prices to generate estimates of the bid-ask spread for NBMIC from 1882 to 1920.[6] To the best of our knowledge, these are the first estimates of the effective bid-ask spread for a company traded on the London Stock Exchange during this period. As trading was relatively infrequent during the period of our study, we focus on two low-frequency estimators – those developed by Corwin and Schultz (2012) and Roll (1984). We use both estimators for the sake of robustness.

[6] The *Stock Exchange Daily Official List* only published daily spreads recorded from one point in the day from 1899 onwards. The list was not published during the Stock Exchange closure in 1914.

The Corwin and Schultz (2012) high-low estimator is derived as a function of high-low price ratios over one-day and two-day intervals. Corwin and Schultz (2012) show that their measure does a good job of estimating spreads and generally outperforms other low-frequency estimators. The Corwin and Schultz (2012) high-low spread estimator is shown in Equation (3):

$$S = \frac{2(e^{\alpha}-1)}{1+e^{\alpha}} \tag{3}$$

where α is

$$\alpha = \frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}} - \sqrt{\frac{\gamma}{3-2\sqrt{2}}} \tag{4}$$

$$\beta = \sum_{j=0}^{1}\left[ln\left(\frac{H_{t+j}^{o}}{L_{t+j}^{o}}\right)\right]^{2} \tag{5}$$

$$\gamma = \left[ln\left(\frac{H_{t,t+1}^{o}}{L_{t,t+1}^{o}}\right)\right]^{2} \tag{6}$$

Equations (5) and (6) show the calculations for β and γ, where $H_{t,t+1}^{o}$ and $L_{t,t+1}^{o}$ are the observed high and low prices across the two days t and t_{+1}.

The Corwin and Schultz (2012) high-low estimator assumes that the expectation of a stock's two-day variance is twice as large as the expectation of a single day variance. However, if the observed two-day variance is large enough, for example during volatile periods, the estimator may produce a negative bid-ask spread. When such a situation occurs, it is possible to treat these negative values as missing or set them equal to zero. Since Corwin and Schultz (2012) find that setting negative daily values of the spread equal to zero produces the most accurate monthly averages, we will focus on these results.

The second measure we use is the Roll (1984) spread estimator. Roll derived a method to estimate effective bid-ask spreads based on the negative autocovariance of price changes. The Roll (1984) spread is given by the following formula:

$$S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})} \quad (7)$$

where the difference in prices, *P*, between time *t* and t_{-1} is only dependent on whether a trade is a buy or a sell (which are equally probable), and assuming that no new information arrives between price observations (Roll, 1984, p.1128). For this estimator to exist, the covariance of price changes must be negative. When prices show positive serial correlation, the Roll spread cannot be properly defined. In this case, undefined values are replaced with zeros or treated as missing. Harris (1990) finds that positive autocovariances are more likely to be associated with low values of the spread and suggests setting the spread estimate to a value of zero as a remedy to the problem.

The Roll measure gives a simple method to calculate spread estimates, but violation of these assumptions can cause the estimator to be biased and underestimate the bid-ask spread and, in particular, the adverse selection component of the spread. However, evidence suggests that when using intraday data, the Roll spread is an accurate measure in practice (especially for large stocks) because the effects of each bias are essentially offsetting (Schultz, 2000; Huang and Stoll, 1996; Goyenko, Holden and Trzcinka, 2009). Consequently, in this paper, to minimise any potential biases, we use intraday data to calculate effective Roll spread estimates.[7]

From Table 5, Panel A, we see that the Corwin-Schultz and Roll spreads average 1.264% and 1.903% across our full sample (Table 5, Panel A), but there is significant variation around this figure. As can be seen from Figure 1, Some of the largest increases in the spread estimates occur at the beginning of World War I, with the closure of the London Stock

[7] Due to the structure of trading during our sample period, we cannot calculate spread estimators or Roll-measure refinements that require information on whether a transaction was buy or sell initiated, or bid-ask quotes at the time of the trade, as this data does not exist.

Exchange. This closure had a sizeable impact on liquidity; the Corwin-Schultz spread averaged 4.271% during the five months that the exchange was closed, while the Roll spread averaged 7.544%. The magnitude of this increase is much greater than that observed during the simultaneous closure of the NYSE (Silber, 2005). This difference may have occurred because of the importance of the centralized jobber, a position that did not exist on NYSE, to the London Stock Exchange.

Although the Stock Exchange was re-opened on 4 January 1915, severe restrictions remained on trading activity during World War I. As can be seen from Panel A of Table 5, when we exclude the war period from our sample, the average Corwin-Schultz and Roll spreads fall to 1.194% and 1.785%.

<TABLE 5 and FIGURE 1 HERE>

Outside of the 1914-18 period, two of the largest increases in the spread in Figure 1 occur in 1906 and 1920. These increases correspond to periods of significant uncertainty surrounding the NBMIC. In May 1906, the Corwin-Schultz spread increases to 5.358%, while the Roll spread increases to 7.554%. This coincides with the San Francisco earthquake on 18 April 1906, to which the NBMIC, along with a number of other British insurance companies, was directly exposed. Despite speculation as to the extent of the company's liability, potential loss figures quoted in the press were described as "considerably exaggerated" (*Financial Times,* 21 April 1906, p.5). By early May, the *Financial Times* reported that the NBMIC would be able to meet its commitments (*Financial Times*, 1 May 1906, p.7). Further confirmation of this was given during the NBMIC AGM on 11 May, when the Chairman announced that the firm would be able to meet its obligations.[8] The uncertainty surrounding the company's exposure to the earthquake would have increased the asymmetric information problem for

[8] The final pay-out by the NBMIC to policyholders was £666,083, equivalent to 24% of its total market capitalisation.

dealers, who appear to have responded by increasing their bid-ask spread to cover the increased adverse selection cost. Trade volume from our sample of informed traders during both April and May 1906 was larger than in any of the previous fourteen months, suggesting that the increase in the spread coincided with an unusually large increase in informed volume.

As can be seen from Figure 1, the largest spread across the entire sample period occurs in May 1920, when the Roll spread spikes briefly at almost 14%. Again, this coincides with a period of increased information asymmetry surrounding the company, and more specifically, the insurance industry. The war, while detrimental to life departments, was highly profitable for other branches of insurance. This led to a number of insurance companies announcing large increases to their dividends following the end of the war, with some dividends exceeding 100%. While there may have been an expectation that all insurance companies would follow suit, NBMIC eventually announced only a marginal increase to their dividend at their AGM on 7 May 1920. Notably, from March to May 1920, over 50 % of trade volume was from our sample of informed traders.

There is a divergence between the Roll and the Corwin-Schultz estimators during some periods of volatility, including May 1920, when the Corwin-Schultz spread measures just 3.638% (Figure 1). This is largely caused by adjustments to the estimator for a number of negative spreads (discussed above). Therefore, in Figure 2 we show monthly spreads calculated from the average of weekly spread estimates, as this reduces the frequency of negative values. As can be seen from Figure 2, using this approach reduces the divergence between the two measures. For example, the Corwin-Schultz and Roll spreads for May 1920 are 12.663% and 14.974% respectively.

<FIGURE 2 HERE>

6. Informed trading and bid-ask spreads

Panel B of Table 5 presents the average daily bid-ask spreads during months in which our sample of informed traders bought and sold shares in NBMIC. Spreads are higher when our identified informed traders are active. When informed traders buy or sell shares in the company, average Corwin-Schultz spreads are 1.269% and 1.273% respectively (excluding the war period), compared to 1.041% when our informed sample do not trade. Trading by each of the four categories of informed traders corresponds to larger spreads. The largest spreads occur when management of the NBMIC or financial institutions trade. The Corwin-Schultz spread measures 2.003%, on average, when management buy shares in the company, while the average spread is 1.622% when institutions buy. Institutional sells correspond to an average spread of 1.406%, while spreads average 2.386% in months that management sell shares. Large Roll spreads are also evident when our informed sample are active, and remain, even when we control for the liquidity constraints brought about by the LSE closure and war-time restrictions (Table 5, Panel B). These results support the hypothesis that market-makers increase spreads during periods of increased informed trading.[9]

In the remainder of this section, we examine if there is a statistically significant link between changes in our spread estimators and activity by informed traders. In order to do this, we present results from regressions of our Corwin and Schultz (2012) and Roll (1984) spread estimates on the volume of informed trading as per the following regression:

$$S_t = \alpha + \beta_1 InfBuy_t + \beta_2 InfBuy_{t-1} + \beta_3 InfSell_t + \beta_4 InfSell_{t-1} + \beta_5 War + \beta_6 LSE\_Closure + e_t \quad (8)$$

where S_t is the Corwin and Schultz (2012) or Roll (1984) estimate of the effective bid-ask spread in month *t*; $InfBuy_t$ is the volume of shares bought by informed traders in month *t*;

[9] See Appendix Table 1 for average effective spreads measured using the monthly average of weekly spread estimates.

$InfBuy_{t-1}$ is the lagged volume of shares bought by informed traders; $InfSell_t$ is the volume of shares sold by informed traders in month *t* and $InfSell_{t-1}$ is the lagged volume of shares sold by our informed traders. *War* is a dummy variable that is equal to 1 during World War I, and 0 otherwise; *LSE_Closure* is a dummy variable that is equal to 1 during the London Stock Exchange closure, and 0 otherwise.

Table 6 shows the relationship between informed trading and our spread estimates. From Columns 1 to 3 of Table 6, we see that informed buy activity had a positive and significant effect on Corwin-Schultz spreads. The coefficients show that in our sample, holding all else constant, for each extra share that an informed trader buys in a given month, the average effective spread increases 0.003 percentage points, indicating a decrease in liquidity. There are 79 shares bought by informed traders in our sample on average per month (excluding the period of World War I), which corresponds to an economically significant increase in the effective spread of 0.237 percentage points. This represents an increase of 19.85% from the average spread across the sample. This supports the theory that bid-ask spreads increase with increased levels of informed trading and information asymmetry. This positive correlation exists, but to a lesser extent, with the one-month lag of informed buy volume. This suggests that the effect of informed trading can be persistent, as well as contemporaneous.

<TABLE 6 HERE>

Columns 4 to 6 of Table 6, where the Roll (1984) spread is the dependent variable, also indicate a positive relationship between informed trading and effective spreads. However, these results are weaker, which may indicate an underestimation of the adverse selection component in the Roll bid-ask spread estimator. Table 6 offers limited support for a significant relationship between informed sell volume and the effective spread. This may be because a proportion of sell volume will always be for liquidity reasons, rather than due to any specific information.

As discussed above, the closure of the London Stock Exchange for five months at the beginning of World War I, and the severe trading restrictions that were enforced throughout the war, had a significant effect on liquidity. The effects of the closure of the London Stock Exchange and World War I are controlled for in Columns 2, 3, 5 and 6 of Table 6. The results indicate that liquidity decreased significantly during the war, while there was a large impact on the effective spread when the exchange was closed. However, although the increase in the Corwin-Schultz spread during the closure of the Stock Exchange is large, it is not significant. This is due to a large number of negative spread estimates during this volatile period, leading to a potential underestimate of the spread value. In order to reduce this problem, we also run tests using the monthly average of weekly spread estimates, rather than daily estimates.

Table 7 presents results from regressions of our Corwin and Schultz (2012) and Roll (1984) bid-ask spreads, calculated from monthly averages of weekly spread estimates, on the volume of informed trading. The results in Columns 1-6 of Table 7 offer further evidence that increased informed buy volume correlates with statistically significant increases in the effective bid-ask spread. Informed buy volume is positively correlated with our Corwin and Schultz (2012) spread estimates at the 1 % level across all regressions. These results are consistent with those produced using our Roll (1984) spread estimates, but the level of statistical significance is reduced. Additionally, these results suggest that increases in informed sell volume are also associated with significant increases in the effective spread. Informed sell volume is significant at least at the 5% level for Corwin and Schultz (2012) spread estimates and at 10% for Roll (1984) estimates, once the Stock Exchange closure is controlled for. Table 7 also shows further evidence of a persistent effect of informed trading on the effective spread in the following month.

<TABLE 7 HERE>

7. Uninformed trading and bid-ask spreads

How does the level of *uninformed* trading affect bid-ask spreads? If the dealer only trades with uninformed traders, there will be no adverse selection risk, leading to reduced spreads that only reflect the dealer's transaction costs. Even with the presence of informed traders, if a dealer can quickly restore their target inventories after trading with someone with superior information, or match trades between informed and uninformed traders, losses due to adverse selection can be prevented or reduced. As a result, large increases in the level of uninformed investors should reduce the market-maker's adverse selection risk and bid-ask spreads, thus increasing liquidity.

We exploit a unique facet of our data in order to test the effect of uninformed trades. Our data source records share sales that were executed by executors of wills following the death of any shareholder who had not bequeathed their shares to a beneficiary. As such trades simply occurred because a shareholder had died, and because executors were required to sell shares as soon as legally possible, trades executed in this manner should not have any relevant information attached, and so should be purely uninformed. UK law compelled executors to sell shares as quickly as possible. For example, in the case of *Currey v. Watson and Others* (1895), it was ruled that executors had to dispose of shares as soon as possible, that they should not attempt to speculate by timing trades, and that executors were liable for losses incurred from not disposing of shares quickly. Advice given by the *Financial Times* to executors was that, doing anything other than selling shares immediately was 'gambling' and should not be done, 'even for a week' (*Financial Times*, 30 Aug. 1927).

We have a relatively large sample of trades by executors, averaging 140 shares and 16 trades per month across our sample period. Results from regressions of our Corwin-Schultz and Roll estimates of the bid-ask spread, on the volume imbalance of uninformed and informed trading are shown in Table 8.

<TABLE 8 HERE>

Panel A of Table 8 shows that there is a negative and significant relationship between the imbalance of executor and informed trades and the effective spread. This means that when there is a higher volume of executor uninformed trades than informed trades in a given month, the effective bid-ask spread decreases, indicating increased liquidity. This is consistent across both Roll and Corwin-Schultz spread estimators and controlling for the war period and exchange closure. Our method of detecting uninformed trades only enables us to identify uninformed share sales, which, from the dealer's point of view, can only reduce adverse selection costs associated with informed buys, as executor share sales will allow the dealer to rebalance inventory efficiently. Consequently, in Panel B of Table 8, we separate informed buy and sell volume in order to regress our spread estimates on the imbalance of uninformed executor sell and informed buy volume. Again, we find evidence of a negative relationship between the uninformed volume imbalance and the bid-ask spread, indicating that when there is a large volume of uninformed sells relative to informed buys, the effective spread decreases, suggesting a reduced level of adverse selection risk and indicating increased liquidity. Results are supported when using the monthly average of weekly spread estimates (Appendix Table 2). These results demonstrate that informed trading can be consistent with reduced spreads and increased liquidity, provided that informed trading is timed to periods of high uninformed volume.

These results are consistent with the models of Collin-Dufresne and Fos (2016) and Admati and Pfleiderer (1988), which predict a negative relationship between informed trading and spreads. They are also consistent with Cornell and Sirri (1992) and Collin-Dufresne and Fos (2015), who both find that bid-ask spread estimates are lower on days that informed investors trade. They suggest that this may be due to informed investors trading passively through the use of limit orders or timing their trades to periods of large uninformed volume.

Due to the nature of trading during our sample period, the use of limit orders was infrequent. In addition, because there was no standing limit order book, passive trading of this nature was unlikely to be commonplace. Consequently, the most likely explanation for our finding is that some informed traders were benefiting from timing their trades, strategically or serendipitously, to periods of large uninformed volume. In order to investigate whether such trading was strategic, we analyse the timing of buy volume by each of our categories of informed trader.

<TABLE 9 HERE>

Table 9 shows the correlation between informed buy volume and uninformed executor sell volume for our full sample. This table indicates that there is a positive correlation between uninformed executor sell volume and the volume of shares bought by our categories of informed trader. This correlation is significant for three of our informed categories, suggesting that some informed traders tend to trade more in months when uninformed volume increases.

Table 10 shows the average monthly informed buy volume when uninformed volume is above the median (and increasing), and average informed buy volume otherwise. Finance professionals buy 44.60 shares per month, on average, when uninformed executor sell volume is above the 50th percentile, and 15.06 shares when it is below the 50th percentile. Remarkably, they buy 110.98 shares in months when uninformed executor sell volume is above the 90th percentile, but just 20.90 shares otherwise. Table 10 suggests that all four categories of informed investors traded more when uninformed volume is high, than they otherwise did. This difference is statistically significant for the finance professional category when uninformed sell volume is above the 70th to 90th percentiles, and is statistically significant for institutional investors when uninformed sell volume is above the 50th to 90th percentiles, suggesting that these experienced investors may be deliberately timing their largest trades.

<TABLE 10 HERE>

Table 11 explores when the largest 10, 20 and 30 months of informed buy volume take place because in these months traders have the most to gain from being strategic with their timing. The results show that the largest months of buy volume by informed traders disproportionately occur when uninformed executor volume is extremely high. For example, 70% (45%) of the 10 (20) largest months of finance professional buy volume, and 60% (40%) of the 10 (20) largest months of institutional buy volume occur when executor sell volume is above the 90th percentile.

These results suggest that informed professional traders consistently timed larger trade to periods when uninformed counterparty volume was high. How were these investors able to time periods of increased executor sell volume? Our findings, for institutional investors and finance professionals, support recent literature that suggest that institutional investors and brokers are able to learn from one another's information on order flow whether it is a beneficial time to trade. This diffusion of information, for example, can indicate a large number of shares coming to the market, or shares coming to the market from a certain type of investor (Barbon, Di Maggio, Franzoni, Landler, 2017, Di Maggio, Franzoni, Kermani, Summavilla, 2017).

Evidence on strategic timing of trades is weaker for company directors and management. Although directors and management appear to buy more shares with increasing levels of uninformed sell volume than they do otherwise, this difference is often not statistically significant, generally falling just outside the 10% level (Table 10). In addition, a smaller proportion of the largest trading months for these categories occur when uninformed volume is high (Table 11). This result may be because these individuals would not have had the expertise or order-flow information of the professional investors in our sample to consistently time trades strategically. Additionally, they traded less frequently, and so are less likely to have been attentive to changes in the volume of uninformed trade and the potential effect on bid-ask prices.

8. Conclusions

In this paper, we use a novel dataset which allows us to identify all traders and their trades in the shares of a large UK corporation over a 38-year period. This enables us to build a comprehensive measure of the volume of informed trading, including all company insiders and professional investors, and to study how this affects bid-ask spread measures of stock liquidity.

In contrast to many recent empirical studies, which are limited by the traders that it is possible to identify, we find consistent evidence that increases in the volume of informed trading is associated with statistically and economically significant increases in the effective spread. This supports the classical microstructure theories of informed trading which suggest that stock illiquidity should increase with increased information asymmetry. Additionally, our dataset allows us to exploit the disclosure of trades by executors of wills following the death of a shareholder, to identify a large sample of uninformed trades and evaluate their impact on bid-ask spreads. Supporting the conclusions of Cornell and Sirri (1992) and Collin-Dufresne and Fos (2015), we show that informed trading can be consistent with decreases in the bid-ask spread, provided that it is timed to periods of large uninformed volume. We also find that experienced investors appear to have consistently strategically timed larger trade volume to the periods of largest uninformed volume.

Although this analysis covers only one company, our results suggest that trading by informed investors will decrease liquidity and increase the transaction costs that market participants face, and that this effect can be persistent as well as contemporaneous. However, the costs associated with informed trading can be reduced if trades are strategically timed. Finally, the sharp increase in the effective spread during the 1914 closure of the Stock Exchange suggests that market liquidity cannot survive such an extended circuit-breaker. However, further research is needed to investigate whether this was the case across all

securities traded during the closure of the exchange, and, if so, what were the differences in market structure that explain why this happened in London, but not in New York.

References

Admati, Anat, and Paul Pfleiderer, 1988, A theory of intraday patterns: Volume and price variability, *Review of Financial Studies* 1, 3–40.

Barbon, Andrea, Marco Di Maggio, Francesco Franzoni, Augustin Landler, 2017, Brokers and order flow leakage: evidence from fire sales, NBER Working Paper 24089, November.

Barclay, Michael J, and Jerold B. Warner, 1993, Stealth trading and volatility: Which trades move prices? *Journal of Financial Economics* 34, 281–306.

Benveniste, Lawrence M., Alan J. Marcus, and William J. Wilhelm, 1992, What's special about the specialist? *Journal of Financial Economics* 32, 61-86.

Bloomfield, Robert, Maureen O'Hara, and Gideon Saar, 2005, The make-or-take decision in an electronic market: Evidence on the evolution of liquidity, *Journal of Financial Economics* 75, 165-199.

Boulatov, Alex, Terrence Hendershott, and Dmitry Livdan, 2013, Informed trading and portfolio returns, *Review of Economic Studies* 80, 35-72.

Braggion, Fabio, and Lyndon Moore, 2013, How insiders traded before rules, *Business History* 55, 565–584.

Burhop, Carsten, and Sergey Gelman, 2010, Transaction costs, liquidity and expected returns at the Berlin Stock Exchange, 1892–1913, Working Paper, Max Planck Institute, Bonn

Chakrabarty, Bidisha, Pamela C. Moulton, and Andriy Shkilko, 2012, Short sales, long Sales, and the Lee Ready trade classification algorithm revisited, *Journal of Financial Markets* 154, 467-491.

Chakravarty, Sugato, 2001, Stealth-trading: Which traders' trades move stock prices? *Journal of Financial Economics* 61, 289-307.

Chakravarty, Sugato, and John J. McConnell, 1997, An analysis of prices, bid/ask spreads, and bid and ask depths surrounding Ivan Boesky's illegal trading in Carnation stock, *Financial Management* 26, 18-34.

Chakravarty, Sugato, and John J. McConnell, 1999, Does insider trading really move stock prices? *Journal of Financial and Quantitative Analysis* 34, 191–209.

Collin-Dufresne, Pierre, and Vyacheslav Fos, 2015, Do prices reveal the presence of informed trading? *Journal of Finance* 70, 1555–1582.

Collin-Dufresne, Pierre, and Vyacheslav Fos, 2016, Insider trading, stochastic liquidity, and equilibrium prices, *Econometrica* 84, 1441–1475.

Cordingley, William G., 1901, *Cordingley's guide to the Stock Exchange*, London: E. Wilson

Cornell, Bradford, and Erik R. Sirri, 1992, The reaction of investors and stock prices to insider trading, *Journal of Finance* 47, 1031-1059.

Corwin, Shane A., and Paul Schultz, 2012, A simple way to estimate bid-ask spreads from daily high and low prices, *Journal of Finance* 67, 719-760.

Di Maggio, Marco, Francesco Franzoni, Amir Kermani and Carlo Summavilla, 2017, The relevance of broker networks for information diffusion in the stock market, NBER Working Paper, No 23522, June.

Easley, David, Nicholas M. Kiefer, Maureen O'Hara, and Joseph B. Paperman, 1996, Liquidity, information, and infrequently traded stocks, *Journal of Finance* 51, 1405–1436.

Easley, David, and Maureen O'Hara, 1987, Price, trade size, and information in securities markets, *Journal of Financial Economics* 19, 69–90.

Easley, David, Marcos Lopez de Prado, and Maureen O'Hara, 2016, Discerning information from trade data, *Journal of Financial Economics*, 120, 269-285.

Eisler, Zoltán, Jean-Philippe Bouchaud, and Julien Kockelkoren, 2012, The price impact of order book events: Market orders, limit orders and cancellations, *Quantitative Finance* 129, 1395-1419.

Ellis, Katrina, Roni Michaely, and Maureen O'Hara, 2000, The accuracy of trade classification rules: Evidence from Nasdaq, *Journal of Financial and Quantitative Analysis* 354, 529-551.

Foucault, Thierry, Johan Hombert, and Ioanid Rosu, 2016, News trading and speed, *Journal of Finance* 71, 335–382.

Foreman-Peck, James, and Leslie Hannah, 2012, Extreme divorce: the managerial revolution in UK companies before 1914, *Economic History Review* 65, 1217-1238.

Gehrig, Thomas, and Caroline Fohlin, 2006, Trading costs in early securities markets: The case of the Berlin Stock Exchange 1880–1910, *Review of Finance* 10, 587–612

Glosten, Lawrence R., and Lawrence E. Harris, 1988, Estimating the components of the bid/ask spread, *Journal of Financial Economics* 21, 123–142.

Glosten, Lawrence R., and Paul R. Milgrom, 1985, Bid, ask and transaction prices in a specialist market with heterogeneously informed traders, *Journal of Financial Economics* 14, 71–100.

Goyenko, Ruslan, Craig Holden, and Charles Trzcinka, 2009, Do liquidity measures measure liquidity, *Journal of Financial Economics* 92, 153-181.

Harris Lawrence, 1990, Statistical properties of the Roll serial covariance bid/ask spread estimator, *Journal of Finance* 45, 579–590.

Harris, Lawrence, 1986, A transaction data survey of weekly and intraday patterns in stock returns, *Journal of Financial Economics* 16, 99-117.

Hasbrouck, Joel, 1988, Trades, quotes, inventories and information, *Journal of Financial Economics* 22, 229-252.

Hasbrouck, Joel, 2017, High frequency quoting: short-term volatility in bids and offers, *Journal of Financial and Quantitative Analysis*, forthcoming.

Hasbrouck, Joel, and Gideon Saar, 2009, Technology and liquidity provision: the blurring of traditional definitions, *Journal of Financial Markets* 12, 143-172.

Heflin, Frank, and Kenneth W. Shaw, 2005, Trade size and informed trading: which trades are "big"? *Journal of Financial Research* 28, 133–163.

Hendershott, Terrence, Dmitry Livdan, and Norman Schürhoff, 2015, Are institutions informed about news? *Journal of Financial Economics* 117, 249–287.

Hirst, Francis W., 1911, The Stock Exchange: a short study of investment and speculation, London: Williams and Norgate

Huang, Roger D., and Hans R. Stoll, 1996, Dealer versus auction markets: A paired comparison of Execution Costs on NASDAQ and NYSE, *Journal of Financial Economics* 41, 313–357.

Jones, Charles M., 2002, A century of stock market liquidity and trading costs, Working paper, Columbia University.

Kacperczyk, Marcin T., and Emiliano S. Pagnotta, 2016, Chasing private information, *SSRN Working paper 2695197*.

Koudijs, Peter, 2016, The boats that did not sail: Asset price volatility in a natural experiment, *Journal of Finance*, 71, 1185–1226.

Kennedy, William, and Robert Delargy, 2000, Explaining Victorian entrepreneurship: A cultural problem? A market problem? No problem? *London School of Economics Department of Economic History Working Paper*, 61.

Keynes, John M., 1914, War and the financial system, *Economic Journal*, 24, 460-86.

Kim, Sukwon T., and Hans R. Stoll, 2014, Are trading imbalances indicative of private information? *Journal of Financial Markets* 20, 151-174.

Kyle, Albert S., 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315–1335.

Lee, Charles M. C., and Mark J. Ready, 1991, Inferring trade direction from intraday data, *Journal of Finance* 46, 733-746.

Lesmond, David A., Joseph P, Ogden and Charles A., Trzcinka, 1999, A new estimate of transaction costs, *Review of Financial Studies* 12, 1113–41.

Meulbroek, Lisa K., 1992, An empirical analysis of illegal insider trading, *Journal of Finance* 47, 1661-1699.

Michie Ranald C., 1999, *The London Stock Exchange: a history*, Oxford: Oxford University Press.

North British and Mercantile Insurance Company, 1909, *North British and Mercantile Insurance Company: centenary*, Edinburgh: Banks & Co.

Neal, Larry, and Lance Davis, 2006, The evolution of the structure and performance of the London Stock Exchange in the first global financial market, 1812-1914, *European Review of Economic History* 10, 279-300.

O'Hara, Maureen, 2015, High frequency market microstructure, *Journal of Financial Economics* 116, 257–270

O'Hara, Maureen, Chen Yao, and Mao Ye, 2014, What's not there: odd lots and market data, *Journal of Finance* 69, 2199–2236.

Raynes, Harold E., 1964, *A history of British insurance, 2nd edn*., London: Sir Isaac Pitman & Sons Ltd.

Roll, Richard, 1984, A simple implicit measure of the effective bid-ask spread in an efficient market, *Journal of Finance* 39, 127-1139.

Schultz, Paul, 2000, Regulatory and legal pressures and the costs of NASDAQ trading, *Review of Financial Studies* 13, 917-957.

Silber, William L., 2005, What happened to liquidity when World War I shut NYSE? *Journal of Financial Economics* 78, pp. 685–701.

Van Antwerp, William C., 1913, *The Stock Exchange from within*, Garden City, N.Y.: Doubleday, Page & Company.

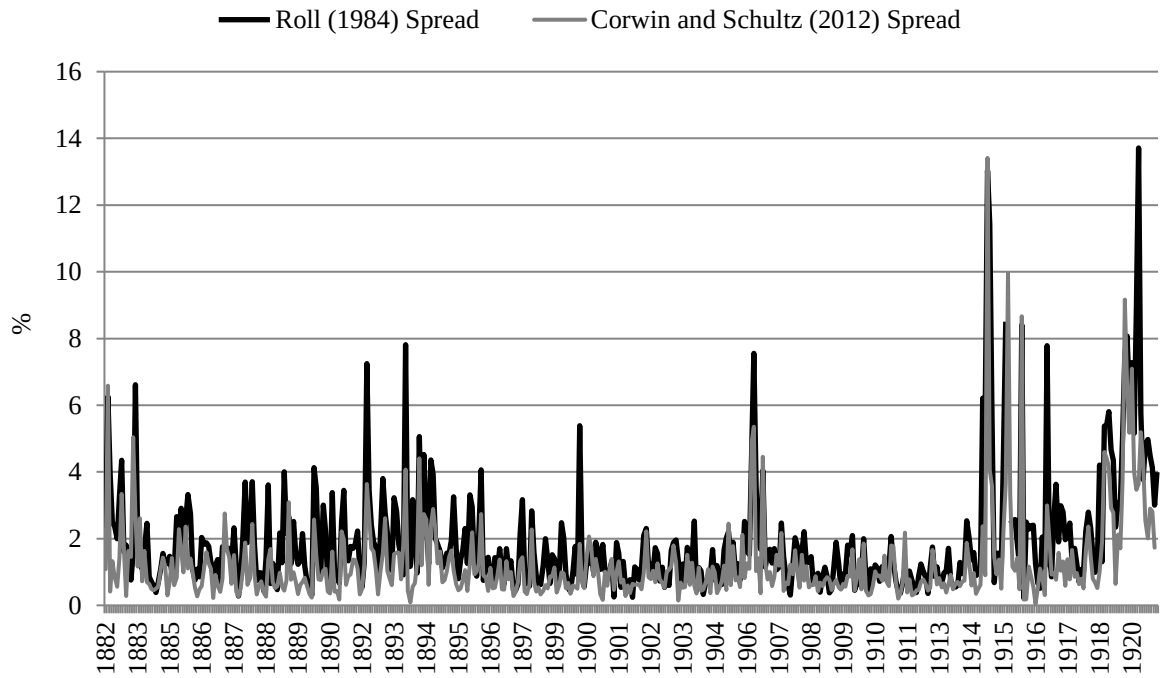

Figure 1: Monthly Average of Daily NBMIC Effective Spread, 1882-1920

This Figure shows monthly average of daily bid-ask spread estimates for the North British and Mercantile Insurance Company (NBMIC) from October 1882 to December 1920 inclusive. The bid-ask spread estimators are the Roll (1984) measure and the Corwin and Schultz (2012) high-low spread estimator. Negative daily values of the Corwin and Schultz estimator are set to zero when computing monthly averages, and daily values of the Roll spread with positive serial covariances in the formula 2·SQRT –COV are set equal to zero.

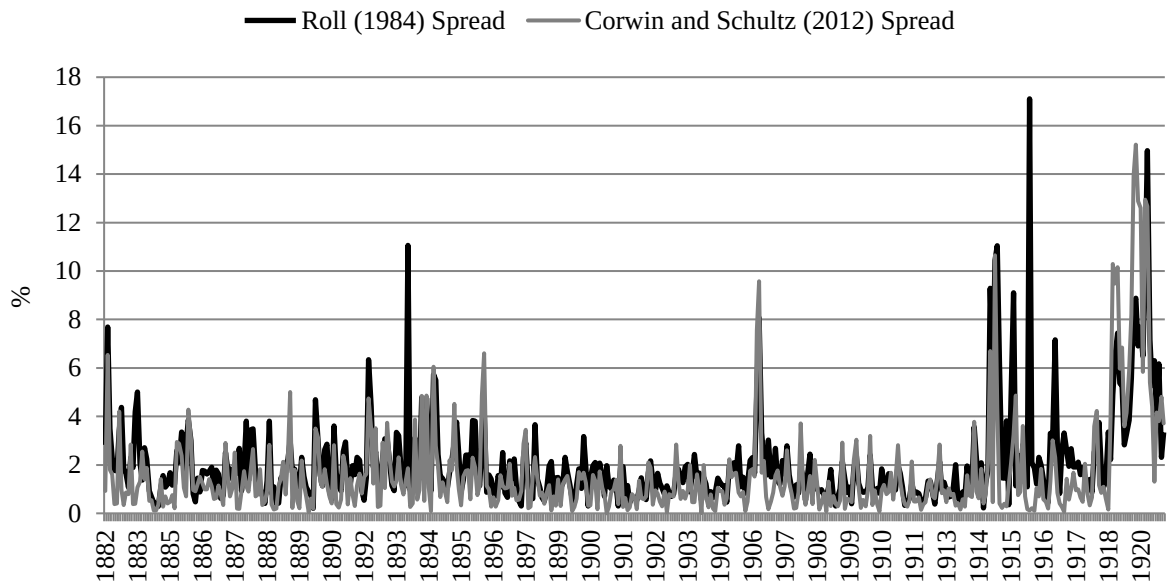

Figure 2: Monthly Average of Weekly NBMIC Effective Spread, 1882-1920

This Figure shows the monthly average of weekly bid-ask spread estimates for the North British and Mercantile Insurance Company (NBMIC) from October 1882 to December 1920 inclusive. The bid-ask spread estimators are the Roll (1984) measure and the Corwin and Schultz (2012) high-low spread estimator. Negative weekly values of the Corwin and Schultz estimator are set to zero when computing monthly averages, and weekly values of the Roll spread with positive serial covariances in the formula 2·SQRT –COV are set equal to zero.

Table 1: Summary Statistics of Daily Trading Activity, 1882-1920

This Table shows the summary statistics of daily trading activity in North British and Mercantile Insurance Company (NBMIC) shares across (a) the full sample, Oct. 1882 to Dec. 1920 (Panel A), (b) the full period excluding Stock Exchange closure from 31 Jul. 1914 to 3 Jan. 1915 inclusive (Panel B), and (c) the full period excluding World War I, i.e., 31 Jul. 1914 to 11 Nov. 1918 inclusive (Panel C). Columns 2 and 3 present the maximum and minimum number of daily trades, daily share volume and daily share turnover. The median, mean, standard deviation and sum values are presented in columns 4 to 7. The median, mean and standard deviation are calculated for days in which trades took place. *Trades* is the number of daily trades in the company's shares. *Share volume* is the daily volume of shares traded (in number of shares). *Share turnover* is the daily volume of shares traded divided by the number of shares outstanding. Total number of trading days is the number of trading days across our full sample. Total number of days with no trades is the number of trading days where no trades took place.

	Max	Min	Median	Mean	St.Dev.	Sum
Panel A: Full sample						
Trades	46	0	3	4.010	3.730	31,852
Share volume (shares)	879	0	16	28.669	40.116	227,718
Share turnover (%)	0.799	0	0.015	0.027	0.038	214.337
Total number of trading days: 11,975						
Total number days with no trades: 4,035 (33.7%)						
Panel B: Excluding London Stock Exchange closure						
Trades	46	0	3	4.020	3.737	31,696
Share volume (shares)	879	0	16	28.787	40.220	226,982
Share turnover (%)	0.799	0.000	0.015	0.027	0.038	213.668
Total number of trading days: 11,841						
Total number days with no trades: 3,956 (33.4%)						
Panel C: Excluding World War I						
Trades	46	0	3	4.132	3.835	29,943
Share volume (shares)	879	0	16	29.444	41.032	213,353
Share turnover (%)	0.799	0.000	0.015	0.028	0.039	201.278
Total number of trading days: 10,634						
Total number days with no trades: 3,371 (31.7%)						

Table 2: Number and Volume of NBMIC Trades by Informed Category

This Table shows the total number of buy and sell trades, total volume of buy and sell trades and number of traders in the shares of the North British and Mercantile Insurance Company (NBMIC) in our sample of informed traders from Oct. 1882 to Dec. 1920 inclusive. *Finance professionals* includes any individual identified as a stockbroker, a banker or an insurance broker; *Institutional* includes banks, investment trusts, and insurance companies; *Directors* includes NBMIC directors; *Management* includes managers, actuaries, company secretaries and auditors of the NBMIC.

	Finance Professionals	Institutional	Directors	Management	Total
Panel A: Number of trades					
Buy	1,148	436	228	34	1,846
Sell	1,154	372	206	19	1,751
Total	2,302	808	434	53	3,597
Panel B: Volume of trade (shares)					
Buy	14,046	6,813	5,331	280	26,470
Sell	12,070	4,649	3,433	350	20,502
Total	26,116	11,462	8,764	630	46,972
Panel C: Number of traders	36	35	63	8	142

Table 3: Average Monthly Trade Volume of NBMIC Shares

This Table shows the average total monthly trade volume and the average monthly buy and sell volume in North British and Mercantile Insurance Company (NBMIC) shares by our sample of informed traders. Max is the maximum monthly volume and Min is the minimum monthly volume. This data is presented for (a) the full sample, Oct. 1882 to Dec. 1920 (Column 1), (b) the full sample period excluding Stock Exchange closure from Aug. 1914 to Dec. 1915 inclusive (Column 2), and (c) the full period excluding World War I, i.e., Aug. 1914 to Nov. 1918 inclusive (Column 3).

	Full sample	Excluding London Stock Exchange closure	Excluding World War I
Average Monthly Share Volume	496	500	524
Max	4,845	4,845	4,845
Min	37	37	57
Average Informed Buy Volume	75	75	79
Max	991	991	991
Min	0	0	0
Average Informed Sell Volume	57	57	58
Max	506	506	506
Min	0	0	0

Table 4: Share Returns and Informed Trading

This Table shows the relationship between informed trading and North British and Mercantile Insurance Company (NBMIC) share returns over the period Oct. 1882 to Dec. 1920 inclusive. Columns 1 and 3 use the following specification: $R_{NBMIC,t} = \alpha + \beta R_{m,t} + \beta_1 InfBuy_t + \beta_2 InfBuy_{t-1} + \beta_3 InfSell_t + \beta_4 InfSell_{t-1} + e_t$, where we regress NBMIC's monthly stock return on the value-weighted market index, and the contemporaneous and lagged informed buy and sell volume, where; $R_{NBMIC,t}$ is the monthly return on NBMIC shares in month *t*; $R_{m,t}$ is the value-weighted return of the top 100 companies in the market (Columns 1 and 2) and the value-weighted return of the all-share market index (Columns 3 and 4) in month *t*, calculated from equities listed in the *Investor's Monthly Manual;* $InfBuy_t$ is the volume of shares bought by our 'informed' sample of traders in month *t*; $InfBuy_{t-1}$ is the lagged volume of shares bought by our 'informed' sample of traders; $InfSell_t$ is the volume of shares sold by our 'informed' sample of traders in month *t* and $InfSell_{t-1}$ is the lagged volume of shares sold by our 'informed' sample of traders. Columns 2 and 4 use the following specification: $R_{NBMIC,t} = \alpha + \beta R_{m,t} + \beta_1 InfBuy\_Sell_t + \beta_2 InfBuy\_Sell_{t-1} + e_t$, where $\beta_1 InfBuy\_Sell_t$ and $InfBuy\_Sell_{t-1}$ is the contemporaneous and lagged monthly volume imbalance between informed buy and sell trades calculated as informed buy volume minus informed sell volume. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

	(1)	(2)	(3)	(4)
R_m	2.013***	2.038***	2.668***	2.689***
	(0.394)	(0.390)	*(0.441)*	(0.438)
InfBuy	0.013**		0.012**	
	(0.006)		*(0.006)*	
Lag_InfBuy	-0.010		-0.009	
	(0.006)		*(0.006)*	
InfSell	-0.004		-0.002	
	(0.010)		*(0.010)*	
Lag_InfSell	0.006		0.005	
	(0.010)		*(0.009)*	
InfBuy_Sell		0.011*		0.010*
		(0.006)		(0.006)
Lag_InfBuy_Sell		-0.008		-0.007
		(0.006)		(0.006)
Constant	-0.375	-0.155	-0.655	-0.425
	(0.786)	(0.626)	*(0.782)*	(0.625)
Obs	453	453	453	453
R^2	0.068	0.066	0.088	0.086

Table 5: NBMIC Effective Spread

This Table shows average monthly bid-ask spread estimators for North British and Mercantile Insurance Company (NBMIC) shares. Monthly spreads are calculated from average daily spread estimates. Figures are shown for three periods: (a) the full sample, 1882-1921, (b) the full sample excluding World War 1 (Aug. 1914 to Nov. 1918 inclusive), and (3) the full sample excluding the London Stock Exchange closure (Aug. 1914 to Dec. 1914 inclusive). The bid-ask spread estimators are the Roll (1984) measure and the Corwin and Schultz (2012) high-low spread estimator. The two versions of the Corwin & Schultz measure differ in how they handle negative daily values of the estimator when computing monthly averages (see Corwin and Schultz (2012)). The two alternatives used in the Table are: (1) setting negative daily values to zero or (2) treating negative daily values as missing. The two versions of the Roll measure differ in how they adjust for positive serial covariances in the formula 2·SQRT −COV. The two alternatives used in the Table are: (1) defining the daily Roll measure as zero or (2) treating daily values as missing. Panel A presents summary statistics for each version of the spread estimate, whereas Panel B examines the average spreads by categories of informed investors. *Inf Buy* is informed buyers; *Inf Sell* is informed sellers; *Excluding Inf* is all trades excluding informed investors; *Director* is NBMIC directors, *Management* is NBMIC management, *FinPro* is Finance Professionals, *Institutional* is institutional investors; *Buy* is Buy-side informed trade; *Sell* is sell-side informed trade.

	Full sample				Excluding World War I				Excluding London Stock Exchange closure			
	Corwin & Schultz (2012)		Roll (1984)		Corwin & Schultz (2012)		Roll (1984)		Corwin & Schultz (2012)		Roll (1984)	
	Adjustment for negative Values		Adjustment for positive autocov.		Adjustment for negative values		Adjustment for positive autocov.		Adjustment for negative values		Adjustment for positive autocov.	
	Zero	Missing	Zero	Missing	Zero	Missing	Zero	Missing	Zero	Missing	Zero	Missing
Panel A												
Average	1.264	1.544	1.903	2.213	1.194	1.433	1.785	2.080	1.229	1.501	1.839	2.132
SD	1.342	1.497	1.727	1.980	1.113	1.212	1.520	1.720	1.213	1.340	1.566	1.763
Max	13.415	15.244	13.712	17.141	9.162	9.162	13.712	17.141	9.962	9.962	13.712	17.141
Min	0.049	0.199	0.208	0.208	0.092	0.207	0.242	0.307	0.049	0.199	0.208	0.208
Panel B												
Average with all Inf Buy	1.323	1.595	1.996	2.291	1.269	1.512	1.871	2.167	1.279	1.542	1.921	2.211
Average with all Inf Sell	1.313	1.597	1.935	2.226	1.237	1.486	1.838	2.128	1.271	1.546	1.877	2.161
Average Excluding Inf	1.111	1.462	1.799	2.361	1.041	1.255	1.513	1.877	1.078	1.420	1.685	2.103
Average with Director Buy	1.409	1.699	2.082	2.324	1.323	1.576	1.885	2.146	1.409	1.699	2.082	2.324
Average with Director Sell	1.184	1.445	1.739	2.024	1.182	1.426	1.734	2.016	1.184	1.445	1.739	2.024
Average with Management Buy	1.901	2.255	3.092	3.452	2.003	2.352	3.199	3.554	1.901	2.255	3.092	3.452
Average with Management Sell	2.386	2.686	2.898	3.205	2.386	2.686	2.898	3.205	2.386	2.686	2.898	3.205
Average with FinPro Buy	1.311	1.574	1.950	2.258	1.279	1.511	1.869	2.176	1.258	1.510	1.877	2.177
Average with FinPro Sell	1.266	1.544	1.956	2.246	1.245	1.497	1.900	2.190	1.256	1.528	1.923	2.205
Average with Institutional Buy	1.620	1.891	2.354	2.673	1.622	1.870	2.304	2.620	1.627	1.899	2.317	2.639
Average with Institutional Sell	1.554	1.855	2.116	2.434	1.406	1.637	2.014	2.348	1.440	1.726	2.010	2.331

Table 6: Informed Trading and the NBMIC Effective Spread

This Table shows the relationship between informed trading and the North British and Mercantile Insurance Company (NBMIC) effective spread over the period Oct. 1882 to Dec. 1920, using the following specification: $S = \alpha + \beta_1 InfBuy_t + \beta_2 InfBuy_{t-1} + \beta_3 InfSell_t + \beta_4 InfSell_{t-1} + \beta_5 War + \beta_6 LSE\_Closure + e_t$. We regress NBMIC's monthly effective spread on the contemporaneous and lagged informed buy and sell volume. The monthly effective spread is calculated from the average of the daily Roll (1984) effective spread, using intraday data; and the average of the daily Corwin and Schultz (2012) high-low estimator. $InfBuy_t$ is the volume of shares bought by our 'informed' sample of traders in month *t*; $InfBuy_{t-1}$ is the lagged volume of shares bought by our 'informed' sample of traders; $InfSell_t$ is the volume of shares sold by our 'informed' sample of traders in month *t* and $InfSell_{t-1}$ is the lagged volume of shares sold by our 'informed' sample of traders. We include a dummy variable *LSE_Closure* for the period Aug.-Dec. inclusive 1914, during which the London Stock Exchange was closed. We also include a dummy variable *War* for World War I (Aug. 1914 to Nov. 1918 inclusive), when the exchange was closed or trading restrictions were enforced. Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

	Corwin & Schultz (2012)			Roll (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
InfBuy	0.003***	0.003***	0.003***	0.002	0.002	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Lag_InfBuy	0.001	0.001*	0.001*	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
InfSell	0.001	0.001	0.001	0.003	0.003	0.003
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Lag_InfSell	0.001	0.001	0.001	0.002	0.002*	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LSE_Closure		3.244			6.001***	
		(2.124)			(1.912)	
War			0.741**			1.188***
			(0.346)			(0.398)
Constant	0.983***	0.935***	0.890***	1.491***	1.401***	1.344***
	(0.084)	(0.077)	(0.069)	(0.111)	(0.101)	(0.096)
Obs	459	459	459	458	458	458
R^2	0.113	0.176	0.143	0.110	0.241	0.158

Table 7: Informed Trading and the NBMIC Effective Spread (Weekly Spread Estimates)

This Table shows the relationship between informed trading and the North British and Mercantile Insurance Company (NBMIC) effective spread over the period Oct. 1882 to Dec. 1920, using the following specification: $S = \alpha + \beta_1 InfBuy_t + \beta_2 InfBuy_{t-1} + \beta_3 InfSell_t + \beta_4 InfSell_{t-1} + \beta_5 War + \beta_6 LSE\_Closure + e_t$. We regress NBMIC's monthly effective spread on the contemporaneous and lagged informed buy and sell volume. The monthly effective spread is calculated from the average of the weekly Roll (1984) effective spread, using intraday data; and the average of the weekly Corwin and Schultz (2012) high-low estimator. $InfBuy_t$ is the volume of shares bought by our 'informed' sample of traders in month *t*; $InfBuy_{t-1}$ is the lagged volume of shares bought by our 'informed' sample of traders; $InfSell_t$ is the volume of shares sold by our 'informed' sample of traders in month *t* and $InfSell_{t-1}$ is the lagged volume of shares sold by our 'informed' sample of traders. We include a dummy variable *LSE_Closure* for the period Aug.-Dec. 1914, during which the London Stock Exchange was closed. We also include a dummy variable *War* for World War I (Aug. 1914 to Nov. 1918 inclusive), when the exchange was closed or trading restrictions were enforced. Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

	Corwin & Schultz (2012)			Roll (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
InfBuy	0.005***	0.005***	0.005***	0.002*	0.002*	0.002*
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.0010
Lag_InfBuy	0.004**	0.004**	0.004**	0.002*	0.003**	0.003**
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.0010
InfSell	0.005**	0.005***	0.005**	0.004	0.004*	0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Lag_InfSell	0.003*	0.003*	0.003*	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
LSE_Closure		3.862***			5.975***	
		(1.596)			(1.557)	
War			0.216			1.374***
			(0.296)			(0.456)
Constant	0.778***	0.721***	0.751***	1.601***	1.513***	1.427***
	(0.117)	(0.112)	(0.116)	(0.125)	(0.117)	(0.105)
Obs	459	459	459	459	459	459
R^2	0.327	0.364	0.329	0.120	0.222	0.170

Table 8: Uninformed Trading and the NBMIC Effective Spread

This Table shows the relationship between uninformed trading and the North British and Mercantile Insurance Company (NBMIC) effective spread from Oct. 1882 to Dec. 1920 inclusive. We regress NBMIC's monthly effective spread on the contemporaneous and lagged volume imbalance between share sales by executors of wills and informed trading. The monthly effective spread is calculated from the average of the daily Roll (1984) effective spread using intraday data; and the average of the daily Corwin and Schultz (2012) high-low estimator. In panel A, *Exec_Minus_Inf* is the imbalance between the number of shares sold by executors of wills, and the number of shares traded by our sample of informed traders, calculated as the volume of executor sales minus the volume of informed trades. In Panel B, *Exec_Minus_Infbuy* (*Exec_Minus_Infsell*) is the imbalance between the number of shares sold by executors of wills, and the number of shares bought (sold) by our sample of informed traders, calculated as the volume of executor sales minus the volume of informed buys (sells). We include a dummy variable *LSE_Closure* for the period Aug.-Dec. 1914, during which the London Stock Exchange was closed. We also include a dummy variable *War* for World War I, (Aug. 1914 to Nov. 1918 inclusive), when the exchange was closed or trading restrictions were enforced. Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

Panel A

	Corwin & Schultz (2012)			Roll (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exec_Minus_Inf	-0.001**	-0.001**	-0.001**	-0.001**	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Lag_Exec_Minus_Inf	-0.001	-0.001	-0.001	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
War		0.619*			1.055***	
		(0.343)			(0.387)	
LSE_Closure			3.084			5.782***
			(2.110)			(1.886)
Constant	1.338***	1.268***	1.307***	2.031***	1.914***	1.973***
	(0.073)	(0.067)	(0.067	(0.106)	(0.104)	(0.100)
Obs	458	458	458	457	457	457
R^2	0.025	0.047	0.082	0.047	0.084	0.168

Panel B

	Corwin & Schultz (2012)			Roll (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exec_Minus_Infbuy	-0.002**	-0.002**	-0.002**	-0.001	-0.001	-0.001
	(0.001)	(0.0010	(0.001)	(0.001)	(0.001)	(0.001)
Lag_Exec_Minus_Infbuy	-0.001	-0.001*	-0.001*	-0.002	-0.002	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Exec_Minus_Infsell	0.002**	0.002**	0.002**	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Lag_Exec_Minus_Infsell	0.001	0.001	0.001	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
War		0.702**			1.116	
		(0.342)			(0.391)	
LSE_Closure			3.086			5.747
			(2.130)			(1.898)
Constant	1.201***	1.107***	1.163***	1.942***	1.796***	1.871***
	(0.110)	(0.104)	(0.104)	(0.171)	(0.173)	(0.166)
Obs	458	458	458	457	457	457
R^2	0.053	0.081	0.110	0.028	0.069	0.148

Table 9: Correlation between Informed Buy Volume and Uninformed (Executor) Sell Volume

This Table shows the correlation between the monthly buy volume of each of our categories of informed trader in the shares of North British and Mercantile Insurance Company (NBMIC) and the monthly volume of shares sold by executors of wills, from Oct. 1882 to Dec. 1920 inclusive. *FinPro* is volume of shares bought by finance professionals; *Institutional* is volume of shares bought by institutional investors; *Director* is volume of shares bought by NBMIC directors; *Management* is volume of shares bought by NBMIC management; *Executor* is volume of shares sold by executors of wills. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% levels.

	FinPro	Institutional	Director	Management	Executor
FinPro	1.000				
Institutional	0.301***	1.000			
Director	0.009	-0.013	1.000		
Management	0.010	0.057	-0.000	1.000	
Executor	0.386***	0.437***	0.128***	0.038	1.000

Table 10: Informed Buy Volume with Increasing Levels of Uninformed (Executor) Sell Volume

This Table shows the average monthly number of North British and Mercantile Insurance Company (NBMIC) shares bought by each of our categories of informed trader, with increasing uninformed (executor) sell volume, from Oct. 1882 to Dec. 1920 inclusive. Average informed buy volume is shown for months when executor sell volume is above (and below) the 50th to 90th percentile. *FinPro* is average volume of shares bought by finance professionals; *Institutional* is average volume of shares bought by institutional investors; *Director* is average volume of shares bought by NBMIC directors; *Management* is average volume of shares bought by NBMIC management. *, **, and *** indicates statistical significance at the 10%, 5%, and 1% levels following t-tests.

	Percentile of monthly executor sell volume													
	<50th	>50th		<60th	>60th		<70th	>70th		<80th	>80th		<90th	>90th	
FinPro	15.06	44.60		15.53	51.26		18.1	56.87	***	19.23	72.59	***	20.9	110.98	***
Institutional	5.89	23.68	***	7.54	25.66	***	8.93	28.32	***	10.06	33.92	***	10.05	57.91	***
Director	6.40	12.00	*	6.70	12.90		6.90	14.40		6.90	18.70		7.40	26.00	
Management	0.44	0.39		0.42	0.42		0.37	0.53		0.33	0.75		0.32	1.28	

Table 11: Percentage of Largest Informed Buy Volume Months Occurring at Increasing Levels of Uninformed (Executor) Sell Volume

This Table shows the percentage of the 10, 20 and 30 months of largest buy volume in North British and Mercantile Insurance Company (NBMIC) shares, for each of our categories of informed trader, that occur when uninformed (executor) sell volume is above the 50th to 90th percentile, for Oct. 1882 to Dec. 1920 inclusive. *FinPro* is largest buy volume months by finance professionals; *Institutional* is largest buy volume months by institutional investors; *Director* is largest buy volume months by NBMIC directors; *Management* is largest buy volume months by NBMIC management. There is no data for the 30 largest buy volume months for management as they only bought shares in 21 months of the full sample period.

	Percentile of monthly executor sell volume				
	>50th	>60th	>70th	>80th	>90th
10 largest buy volume months					
FinPro	90.00%	90.00%	80.00%	70.00%	70.00%
Institutional	90.00%	80.00%	80.00%	60.00%	60.00%
Director	60.00%	50.00%	40.00%	30.00%	20.00%
Management	50.00%	30.00%	30.00%	30.00%	30.00%
20 largest buy volume months					
FinPro	85.00%	80.00%	70.00%	65.00%	45.00%
Institutional	85.00%	75.00%	60.00%	50.00%	40.00%
Director	45.00%	35.00%	20.00%	15.00%	10.00%
Management	55.00%	40.00%	35.00%	30.00%	20.00%
30 largest buy volume months					
FinPro	73.33%	70.00%	56.67%	53.33%	36.67%
Institutional	80.00%	70.00%	50.00%	43.33%	36.67%
Director	56.67%	46.67%	30.00%	26.67%	13.33%
Management	n/a	n/a	n/a	n/a	n/a

Appendix Table 1: NBMIC Effective Spread (Weekly Spread Estimates)

This Table shows average monthly bid-ask spread estimators for North British and Mercantile Insurance Company (NBMIC) shares. Monthly spreads are calculated from average weekly spread estimates. Figures are shown for three periods: (a) the full sample, 1882-1921, (b) the full sample excluding World War 1 (Aug. 1914 to Nov. 1918 inclusive), and (3) the full sample excluding the London Stock Exchange closure (Aug. 1914 to Dec. 1914 inclusive). The bid-ask spread estimators are the Roll (1984) measure and the Corwin and Schultz (2012) high-low spread estimator. The two versions of the Corwin & Schultz measure differ in how they handle negative weekly values of the estimator when computing monthly averages (see Corwin and Schultz, 2012). The two alternatives used in the Table are: (1) setting negative weekly values to zero or (2) treating negative weekly values as missing. The two versions of the Roll measure differ in how they adjust for positive serial covariances in the formula 2·SQRT −COV. The two alternatives used in the Table are: (1) defining the weekly Roll measure as zero or (2) treating weekly values as missing. Panel A presents summary statistics for each version of the spread estimate, whereas Panel B examines the average spreads by categories of informed investors. *Inf Buy* is informed buyers; *Inf Sell* is informed sellers; *Excluding Inf* is all trades excluding informed investors; *Director* is NBMIC directors, *Management* is NBMIC management, *FinPro* is Finance Professionals, *Institutional* is institutional investors; *Buy* is Buy-side informed trade; *Sell* is sell-side informed trade.

	Full sample				Excluding war				Excluding LSE closure			
	Corwin & Schultz (2012)		Roll (1984)		Corwin & Schultz (2012)		Roll (1984)		Corwin & Schultz (2012)		Roll (1984)	
	Adjustment for Negative Values		Adjustment for Positive Autocov		Adjustment for Negative Values		Adjustment for Positive Autocov		Adjustment for Negative Values		Adjustment for Positive Autocov	
	Zero	Missing	Zero	Missing	Zero	Missing	Zero	Missing	Zero	Missing	Zero	Missing
Panel A												
Average	1.601	1.866	2.077	2.193	1.610	1.854	1.940	2.054	1.567	1.826	2.015	2.132
SD	2.098	2.213	1.949	1.968	2.123	2.215	1.691	1.723	2.045	2.150	1.832	1.856
Max	15.217	16.884	17.105	17.105	15.217	16.884	14.974	14.974	15.217	16.884	17.105	17.105
Min	0.001	0.006	0.209	0.209	0.001	0.006	0.209	0.209	0.001	0.006	0.209	0.209
Panel B												
Average with Inf Buy	1.730	1.946	2.162	2.265	1.756	1.952	2.014	2.122	1.699	1.912	2.099	2.203
Average with Inf Sell	1.680	1.927	2.115	2.224	1.690	1.922	2.003	2.109	1.647	1.891	2.066	2.176
Average excluding Inf.	1.423	1.904	2.087	2.222	1.343	1.731	1.718	1.837	1.288	1.724	1.903	2.041
Average with Director Buy	1.734	1.916	2.377	2.473	1.835	1.984	2.049	2.135	1.734	1.916	2.377	2.473
Average with Director Sell	1.418	1.618	1.916	2.001	1.454	1.647	1.905	1.995	1.418	1.618	1.916	2.001
Average with Management Buy	3.036	3.442	3.267	3.355	3.232	3.576	3.374	3.471	3.036	3.442	3.267	3.355
Average with Management Sell	4.075	4.411	3.359	3.462	4.075	4.411	3.359	3.462	4.075	4.411	3.359	3.462
Average with FinPro Buy	1.836	2.058	2.125	2.220	1.864	2.070	2.048	2.148	1.796	2.014	2.063	2.159
Average with FinPro Sell	1.687	1.933	2.158	2.273	1.752	1.992	2.060	2.173	1.678	1.920	2.127	2.242
Average with Institutional Buy	2.583	2.749	2.685	2.767	2.756	2.890	2.541	2.619	2.605	2.773	2.655	2.738
Average with Institutional Sell	2.258	2.512	2.289	2.380	2.287	2.508	2.269	2.348	2.177	2.434	2.211	2.302

Appendix Table 2: Uninformed Trading and the NBMIC Effective Spread (Weekly Spread Estimates)

This Table shows the relation between uninformed trading and the North British and Mercantile Insurance Company (NBMIC) effective spread from Oct. 1882 to Dec. 1920. We regress NBMIC's monthly effective spread on the contemporaneous and lagged volume imbalance between share sales by executors of wills and informed trading. The monthly effective spread is calculated from the average of the weekly Roll (1984) effective spread using intraday data; and the average of the weekly Corwin and Schultz (2012) high-low estimator. In panel A, *Exec_Minus_Inf* is the imbalance between the number of shares sold by executors of wills, and the number of shares traded by our sample of informed traders, calculated as the volume of executor sales minus the volume of informed trades. In Panel B, *Exec_Minus_Infbuy* (*Exec_Minus_Infsell*) is the imbalance between the number of shares sold by executors of wills, and the number of shares bought (sold) by our sample of informed traders, calculated as the volume of executor sales minus the volume of informed buys (sells). We include a dummy variable *LSE_Closure* for the period Aug.-Dec. 1914, during which the London Stock Exchange was closed. We also include a dummy variable *War* for World War I, (Aug. 1914 to Nov. 1918 inclusive), when the exchange was closed or trading restrictions were enforced. Robust standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

Panel A

	Corwin & Schultz (2012)			Roll (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exec_Minus_Inf	-0.003***	-0.003**	-0.003**	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Lag_Exec_Minus_Inf	-0.002***	-0.002*	-0.002*	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
War		-0.076			1.212***	
		(0.291)			(0.446)	
LSE_Closure			3.396**			5.718***
			(1.592)			(1.532)
Constant	1.799***	1.808***	1.765***	2.220***	2.083***	2.162***
	(0.135)	(0.142)	(0.134)	(0.118)	(0.115)	(0.114)
Obs	458	458	458	458	458	458
R^2	0.072	0.072	0.100	0.045	0.084	0.138

Panel B

	Corwin & Schultz (2012)			Roll (1984)		
	(1)	(2)	(3)	(4)	(5)	(6)
Exec_Minus_Infbuy	-0.003	-0.003	-0.003	-0.001	-0.001	-0.001
	(0.002)	(0.002)	(0.002)	(0.001	(0.001)	(0.001)
Lag_Exec_Minus_Infbuy	-0.004*	-0.004*	-0.004*	-0.003*	-0.003*	-0.003*
	(0.002)	(0.002)	(0.002)	(0.002	(0.002)	(0.002)
Exec_Minus_Infsell	0.004*	0.004*	0.004*	0.001	0.002	0.001
	(0.002)	(0.002)	(0.002)	(0.002	(0.002)	(0.002)
Lag_Exec_Minus_Infsell	0.004**	0.004**	0.004**	0.002	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.001	(0.001)	(0.001)
War		0.103			1.290***	
		(0.291)			(0.450)	
LSE_Closure			3.400**			5.689***
			(1.609)			(1.542)
Constant	1.388***	1.374***	1.346***	2.090**	1.918***	2.020***
	(0.218)	(0.225)	(0.217)	(0.190)	(0.193)	(0.1880
Obs	458	458	458	458	458	458
R^2	0.105	0.105	0.133	0.045	0.076	0.124