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Research Paper

Missing markets. Microstructure and liquidity on the London Stock Exchange[☆]

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A B S T R A C T

This paper studies the behavior of specialist dealers operating in the London Stock Exchange in the 1870s. The LSE was a free-entry exclusive dealers market, where dealers were free to choose which securities to deal in. We show that dealers concentrated their market making in the most liquid securities. A combination of adverse selection and inventory costs prevented the development of liquid markets in most securities, with dealers opting instead to provide matchmaking services. Our results call for a reappreciation of the liquidity of the London market and offer a new interpretation of stylized facts about the Victorian investor behavior.

1. Introduction

In the late 19th century, the London Stock Exchange (LSE) was the premier international market for companies and countries to access liquidity. It operated on a vast scale, funneling the savings of not only the British but also of an international clientele into a diverse and highly international portfolio. This dominance was borne out by all standard measures of size. Market cap increased from £1.2 billion in 1853 to £2.3 in 1873 and £9.6 in 1913. The number of listed securities rose proportionally from c. 1300 in 1875 to over 4000 in 1913. Such a large market was served by a rising number of specialists. In 1850 there were only 864 members of the LSE (brokers and dealers), but by 1876 the number had risen to 1900, supported by an additional 1000 clerks (Michie, 2001).[1]

One of the reasons mentioned for the dominance of London was the market's microstructure—specifically its working as a pure dealer's market (Davis and Neal, 1998; Michie, 2006). Expert opinion routinely recognized the value of dealers in providing liquidity or 'marketability' (to use 19th century jargon) for the securities traded at the LSE. Robert Giffen, for instance, ranked marketability as the second most important driver of securities' valuations and stated that the LSE dealers "disposing of a considerable capital and credit, tend[ed] to keep up the level of the prices of securities above what would otherwise be maintained" (Giffen, 1877, 39).

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[1] The number of specialists peaked at over 5600 members in 1905. This was followed by some consolidation leaving close to 4900 members operating on the eve of World War I (Michie, 2001).

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What is less appreciated is that the LSE's microstructure was not without its critics. Although dealers made their business by providing liquidity, contemporaries and later historians noted that trading on the LSE was not as liquid as desirable (Lavington, 1921; Morgan and Thomas, 1969). Indeed, a cynical LSE broker remarked that it was "rather a curious thing that although the dealers are such a convenience, yet up to the present year, 1877, no one Bourse in the world has found it to their advantage to adopt the system except London" (RC, 1878a, 180).

At the heart of this criticism was the fact that most of the stocks listed in the LSE did not have market makers. These 'non-current' securities were traded via an agency model where dealers directly matched buyers and sellers. This increased transaction costs directly, as investors could no longer avail themselves of the immediacy in trading with a dealer. Moreover, critics noted that in these cases dealers acted as 'brokers between brokers' and accused them of charging much larger fees than the brokers' own commissions without taking any balance sheet risk. However, neither the extent of such a market failure nor its causes have been investigated.

In this paper, we quantify the scope and consequences of the lack of liquidity on the LSE by combining data on securities listed on the LSE with evidence given to a 1877 Royal Commission gathered to inquire into whether the LSE's trading rules and customs respected the law and were "salutary to the public's interests" (RC, 1878b, 5). The final report of the Commission concluded that the majority of securities (up to 80%) listed in the LSE were not supported by dealers and recommended the adoption of a limit-order book to facilitate their trading at lower transaction costs. A brief rival to the LSE, a 'West-End Stock Exchange,' attempted to do just that by setting up as a competing exchange in London operating with a limit-order book.

The Royal Commission concluded that unsupported securities were orphaned because their "quantity… is limited" and because "there is little buying or selling constantly going forward" (RC, 1878b, p. 9). However, such description does not identify the causes of illiquidity. Our research design allows us to estimate which types of securities were orphaned by the London microstructure, and which types traded at lower spreads. We show evidence of a separating equilibrium where dealers only provided liquidity services for the most liquid securities and refused them to those they expected to be less liquid.

Our investigation is grounded in the large theoretical literature on market microstructure (Grossman and Miller, 1988). Microstructure theory posits two main reasons why dealers may refuse to serve the market. Dealers face inventory risks if demand for transactions in a given asset is sufficiently infrequent that buys and sells cannot be matched in a reasonable time-frame (Garman, 1976). This risk intensifies for securities with volatile prices, exposing the dealer to potentially wild swings in the value of their portfolio as they wait for an offsetting order to arrive. If dealers have fixed costs in setting up a market, and these costs are large relative to the "entry-inhibiting trading risks", then they may choose not to create a market (Grossman and Miller, 1988, p. 629).

Adverse selection provides a different reason for dealers to refuse to make a market (Bagehot, 1971; Glosten and Milgrom, 1985; Hasbrouck, 2007; Kyle, 1985; O'Hara, 1998). As Glosten and Milgrom (1985) showed, the dealer's willingness to transact on demand exposes them to potential 'informed' traders. As the share of informed traders grows among a dealer's clientele, they are obliged to widen the spread. But a wider spread may dissuade noise traders. From the dealer's perspective, this winnowing of customers towards the well-informed demands a still-higher spread, and eventually the market unravels. Stoll (2003) remarks that inventory risks and adverse selection can both be thought of as information costs. The former corresponds to the risk that new public information arrives between one order and its offsetting trade. The latter represents the risk that after transacting with an informed trader, their private information is incorporated into the market price before an offsetting trade arrives.

A pervasive difficulty in empirical studies of liquidity provision by dealers in securities markets is that nearly all contemporary markets involve combinations of market trading mechanisms, including specialist dealers, limit-order books and auctions (Stoll, 2003). They also typically include high entry costs for dealers, and frequently assign securities to dealers, thus ensuring that some specialist supports each listed security (Stoll, 2003). In return, dealers are often offered some substantial market-power. Finally, there are two related problems of observation and endogeneity. The information about which securities are dealer-supported is typically non observable. This in turn is related to the endogenous responses of intermediaries to liquidity conditions, who can change between market making and matchmaking (Adrian et al., 2017; Saar et al., 2023). In the former model, dealers offer immediacy by using their balance sheets as buffers. In the latter, they match buyers and sellers directly and take no inventory risk.

In this paper, we overcome these empirical challenges by focusing on an historical market, the London Stock Exchange (LSE) in the 19th century. First, in the LSE securities were exclusively traded by dealers with no limit order books (Davis and Neal, 1998; Michie, 2006). Second, dealers were free to trade any security, and barriers to entry on the LSE were very low, unlike the NYSE (Davis and Neal, 1998). The cost of joining the LSE was around 12 guineas in the 1870s (£1,123 in 2020 prices).[2]

We also make a methodological contribution to the problem of non-observability of dealer support. Exceptionally, the historical sources provide information about the probability that dealers made a market on each of the securities listed in the LSE. We use this information as a noisy signal of dealer support in our empirical model. We derive a likelihood function that combines the decision to deal in a security – inspired by the classic Roy model (Heckman and Honore, 1990; Heckman and Taber, 2008) – with a model for misclassification of the dependent variable (dealer support) that is closely related to the approach of Hausman et al. (1998). This allows us to jointly estimate the association between dealer support for a security and the bid–ask spread on that security. The decision by dealers to make a market had a direct influence on the liquidity of a chosen security by creating a spread at which traders could buy and sell immediately. Without this spread, immediate execution was not attainable at any cost. But the level of the spread was influenced by the underlying characteristics of each security. To identify the decision to deal in a security, we use as instrument the number of other supported securities within each LSE market segment in which the dealers operated. The

[2] Contrast this with the fees on the NYSE in the 2000s, which stood at roughly $2 million (Stoll, 2003).

instrument shows evidence of agglomeration: the probability of a security being dealer-supported increased with the number of other marketable securities in the same segment.

Despite the centrality and low entry costs of the LSE, we show that barely a fifth of the securities listed there were dealer-traded.[3] In the Roy model we find evidence of negative selection on observable features of securities. Dealers preferred making markets in large issues rather than small, in bonds rather than in equities, and for corporate issuers rather than for sovereigns. We find that bid–ask spreads decreased in the size of the issue and the nominal price of the security. They were also smaller for domestic securities and for equities.

Moreover, we find negative selection on unobservables for the determination of the bid–ask spread. Holding their observed characteristics constant, the securities dealers made a market in tended to have lower spreads. This negative selection is consistent with the literature on liquidity 'bifurcation' (Buchak et al., 2020; Beau, 2014; Saar et al., 2023; Nagel, 2012; Fender and Lewrick, 2015). Some securities were extremely liquid and could be sold immediately in large volumes with little price impact; others could not be sold immediately at all. This bifurcation helps explain a number of stylized facts about 19th-century investment behavior, namely, the prevalence of buy-and-hold portfolios and the preference for high dividends over capital gains.

Our results speak as well to the contemporary debate about the reduction in market liquidity in the aftermath of the 2008 Global Financial Crisis (GFC) (Adrian et al., 2017; Beau, 2014; Brunnermeier, 2009; Saar et al., 2023; Nagel, 2012). From the peak to the trough of the GFC, the size of dealers' balance sheets fell from $5 trillion to $3.5 trillion (Adrian et al., 2017). A BIS special commission on market makers found "increased liquidity bifurcation and fragility, with market activity concentrating in the most liquid instruments and deteriorating in the less liquid ones" (Beau, 2014, p. 1). What the BIS called 'liquidity bifurcation' is essentially the same separating equilibrium we identify in the 19th century LSE. Research from the BIS documented this 'liquidity bifurcation,' and concluded that a better grasp of "what drives the behavior of these liquidity providers is a precondition for understanding how well placed markets are to accommodate potential future shifts in supply and demand" (Fender and Lewrick, 2015, p. 97).

In the rest of the paper we start by setting out the historical background of the microstructure of the LSE in the 19th century. After this, we describe the sources for the claim that a large fraction of LSE listed securities were not supported by dealers. We then lay out the statistical modeling strategy, and present our estimates. Finally, we discuss the model estimates and what they tell us about historical liquidity provision before concluding.

2. Historical background

A large stock market crash affected the LSE in 1876. Concentrated on foreign securities, public opinion demanded an investigation into the placement of foreign loans by British merchant banks. Parliament duly complied by gathering a *Select Committee on Foreign Loans* (Michie, 2001). This was then extended to an investigation into the stock exchange itself led by a *Royal Commission on the Origin, Objects and Constitution of the London Stock Exchange*, hereafter RC (1878). The stated aim of the Commission was to assess whether the LSE's "Rules, Customs, and Mode of Conducting Business were in accordance with Law, and with the Requirements of Public Policy" (RC, 1878b, p. A3).

The Commission sat for over a year, during which it interrogated dozens of market insiders. The final report and especially the minutes of the evidence given by the specialist witnesses contain a detailed account of the microstructure of the London securities market in the late 19th century. The Commission confirmed that the LSE was *exclusively* a dealer market, defined by a rigid division between brokers – who traded on behalf of clients for a commission – and dealers (or jobbers, as they were known in London), who traded on their own account providing liquidity and offering immediacy (Gibson, 1889; Attard, 2000; Neal and Davis, 2006).[4] At the time of the Commission sitting, the close to 2000 members of the LSE were split between one third dealers and two thirds brokers (Michie, 2001).[5]

In theory, dealers stood ready to provide immediate execution at their quoted prices. Dealers specializing in a particular line of securities – American railroads for instance – would congregate at a particular point within the floor of the exchange (Lavington, 1921). A would-be customer could approach any dealer and, without revealing whether they intended to buy or to sell, ask the dealer for a quote (RC, 1878b, pp. 8, 129). After the dealer had revealed his bid–ask prices, the customer could then buy or sell for any amount they pleased up to a specific cap (RC, 1878b, p. 130). If the customer felt the prices he had been quoted were 'wide', he could approach any other dealer until satisfying himself of finding the best price. Towards the end of the trading day, dealers were surveyed to obtain their last quotes (bid and ask), and these were printed in the official price list of the LSE under a column entitled 'Closing Quotations.' Contemporaries referred to the spread between the two quotes as the 'turn.'[6]

The inventory risks facing dealers are well understood in the historical literature (Powell, 1916; Lavington, 1921). Nevertheless, inventory management was greatly facilitated by the LSE's long settling period: transactions were typically for delivery on the next 'account day,' with account days occurring twice a month in most securities and once a month in government securities (RC, 1878b, p. 8). Thus the time to delivery in a typical transaction would be up to two weeks, which surely helped dealers with managing their inventory. Low barriers to entry created a competitive setting for dealers. Unlike today, where dealers are mostly large banks or hedge funds, there were hundreds of dealers in the LSE, operating as specialized firms. Even though they could trade on their own

[3] The source for this figure is discussed in detail below. The ratio by value is lower: roughly 52% of securities by capital issued were supported by dealers.

[4] We use the term dealer from now on as it is more familiar to a modern reader.

[5] In point of fact, the separation between brokers and dealers was a matter of custom, but all sources confirm that it was extremely rare for LSE members to act on both capacities (Gibson, 1889; RC, 1878b, p. 7).

[6] Presumably because this would be the cost of a round-trip transaction.

account, dealers routinely funded their positions by borrowing short term in the money market: "as in most other markets, the dealers employ not only their own capital, but the money they can borrow from the banks in the operations of buying and selling" (Giffen, 1877, 71). Consequently, short-term market rates directly influenced the costs of liquidity provision in the LSE.

Many witnesses who testified to the Royal Commission praised the LSE microstructure for enabling "a man to do his business quickly" and giving him "a reasonable assurance that it [his business] is transacted at the market price" (RC, 1878b, p. 130). Though perhaps conflicted, L. L. Cohen, a dealer operating at the LSE, summarized the importance of market making for the liquidity of tradable securities:

> "With respect to securities which are indigenous to any particular country, such as water or gas, the difficulty of dealing with them is so great, that I am told that it sometimes amounts to almost an impossibility, and that estates hang for three or six months, because it is difficult to find buyers in the absence of the middlemen; not withstanding the solvent character of the securities, their convertibility is very difficult because of the absence of middlemen" (RC, 1878a, 114).

The authors of the report of the Royal Commission duly concurred, writing: "So great is the accommodation provided by the system that purchases required on the provincial exchanges or the foreign Bourses are constantly sent to London to be made on the Stock Exchange there" (RC, 1878b, p. 9).

However, not all members of the LSE agreed that the dealer system worked as intended in all cases. Charles Branch, a sworn broker, stated that this "theory of the Stock Exchange business … only holds good with a certain portion of stocks in the Stock Exchange; it is true only, I may say, of a small minority of securities" (RC, 1878b, p. 130). In the majority of cases (Branch estimates in 80% of cases), the listed securities were "negotiable but not freely marketable" (RC, 1878b, p. 131) meaning that a dealer would *not* quote bid and ask prices and would *not* provide immediacy. Instead, the customer would have to disclose whether they wanted to buy or sell, and the dealer would then hunt for a counterparty and only if he found one would the transaction take place (RC, 1878b, p. 130–1). In other words, Branch was describing a situation in which dealers locked in a profit on the transaction that was only subject to counterparty risk. Branch lamented the size of that profit, which was greatly in excess of the broker's customary $\frac{1}{2}$% commission and was not justified by risk since if a dealer "deals with a member of the Stock Exchange" and "if he is worth anything he knows whose cheque he can take and whose cheque he cannot take" (RC, 1878b, p. 132). Another broker, Frederick Banbury, complained that "if a dealer in order to avoid risk constitutes himself merely a broker between brokers, I don't see why his profit should be greater than my brokerage" (RC, 1878b, p. 179).

The existence of this practice was confirmed by the dealers themselves. William Ingall, a dealer in foreign stocks, claimed to be one of the dealers who had inaugurated the practice of refusing to quote a price, because he "felt it would be very unwise indeed to go and make a price in everything and anything" (RC, 1878a, 199). According to Ingall, the practice of refusing to make a market was a recent development that had emerged as a response to shrinking spreads driven by increased competition. "Years ago", he testified, "the price which a jobber would make was very much wider, and therefore it would pay him to take the risk and always make a price" (RC, 1878a, 199).

In the contemporary literature, we find mentions that the LSE Closing Quotations were 'merely indicative' and not a certain guide (Clare, 1898). They indicated where the bid and ask likely were, but were not binding prices at which dealers were obliged to buy or sell. Contemporaries referred to them as 'valuations.' In active markets, Closing Quotations appear to behave quite similarly to a bid–ask.[7] Despite this, research on 19th century liquidity on the LSE is relatively thin. Acheson et al. (2018) use a unique dataset of individually identified traders in just one security listed in the LSE, between 1882 and 1920, to assess the impact of informed trading on spreads. Alquist (2010), Chavaz and Flandreau (2017) study how liquidity (measured by the width of Closing Quotations) affected the pricing of colonial and sovereign debt traded at the LSE.

Research on contemporary markets has borne out Ingall's reasoning, finding that competition between exchanges can be detrimental to specialists (O'Hara, 1998), and that intermediaries in the bond market choose either to make a market or play matchmaker with corresponding trade-offs in dealer risk and execution time (Pinter and Uslu, 2022; Saar et al., 2023). Today, the natural solution to the problem of unwilling dealers and brokers struggling to match orders is the limit order book. A limit order book enables would-be buyers and sellers to find each other and circumvent the dealers. This was precisely the solution proposed by Branch and other brokers, such as T. W. Powell (RC, 1878b, p. 206) and Frederick Banbury (RC, 1878b, p. 179). It was also endorsed in the final recommendations of the Royal Commission, which suggested that "a book or register should be kept… in which brokers should be invited to enter from time to time the names and quantities of any securities [that are not supported by dealers] … with or without a price at which they are willing to deal" (RC, 1878b, p. 10). That the proponents of this system were all brokers is hardly surprising, nor is it surprising that dealers opposed it. In the end, this recommendation of the Royal Commission was not acted upon.

The desire for a solution to the problem of persistently illiquid securities was substantial, and the problem of dealers refusing to make markets was deemed severe enough by contemporaries that in 1878 there was an abortive attempt to create a rival exchange to the LSE organized around the limit-order book. Dubbed the 'West End Stock Exchange,' this rival start-up marketed itself on the LSE's failure to adopt the suggestion of a limit-order book: "The London Stock Exchange having failed to adopt this suggestion, the benefit of which to the public is too obvious to require comment, this Association has been established, upon the principles

[7] A reason to believe that the Closing Quotations could not deviate too much from true bid–asks is the fact that brokers could ask to have them altered if they could not trade at those prices (RC, 1878a, p. 38).

APPENDIX No. VI.

Summary of the Official List of the London Stock Exchange of 19th October 1877, handed in by Mr. Branch, showing the Comparative Number of Marketable and Non-Marketable Stocks.

Description of Securities.	Marketable.		Not Marketable.	
	No. of Stocks.	Amount in Millions.	No. of Stocks.	Amount in Millions.
Funds and Government stocks	10	—	21	—
Colonial Government	12	46·4	47	38·
Foreign Government stocks	69	—	99	—
Railways, ordinary stocks	22	158·	38	43·5
„ preference cumulative	1	12·	54	53·
„ preference contingent	5	37·7	75	65·3
„ leased lines	—	—	39	21·3
„ debenture stocks	9	67·	40	39·
„ British Colonies	18	113·3	39	13·
Indian Railway debentures	—	—	7	3·
„ debenture stocks	—	—	5	5·4
Foreign railways	15	34·8	35	14·2
American dollar bonds	20	—	24	—
„ sterling bonds	9	29·	40	32·5
Foreign railway obligations	8	—	44	—
Banks	10	20·1	64	76·7
British mines	—	—	28	—
Foreign mines	1	5·	44	6·4
Telegraphs	16	20·3	18	4·6
Insurance	3	4·5	50	50·
Gas	2	3·2	54	15·6
Docks	1	5·7	10	8·
Waterworks	—	—	17	7·
Canals	—	—	4	2·9
Loans and trusts	16	29·8	46	14·6
Coal, copper, and iron	—	—	25	12·
Commercial, financial, &c.	17	15·	46	20·
Land	7	3·7	12	3·1
Shipping	3	4·4	13	5·1
Tea	—	—	7	1·1
Tramways	12	2·5	5	0·6
Miscellaneous	8	3·6	32	6·9
Total	285	610·	1,082	562·8

The amount in these figures is in millions; in some cases I have not been able to follow out the amounts, and have given only the numbers of the stocks. *See* Evidence, 3447–59.

Fig. 1. Evidence submitted by the broker Mr. Branch to the Royal Commission on the London Stock Exchange.

indicated by the Royal Commission".[8] Having taken up large advertisements in major newspapers, it emphasized the scale of the problem of unsupported securities, arguing that "another great advantage... will be that of providing a ready market for that class of securities called 'non current,' the value of which is estimated in the Report above referred to at 562 millions, and for dealings in which... great difficulty is now experienced".[9]

The fact that in a setting with low entry costs and no restriction on market making, dealers chose to support such a small segment of the market demands an explanation. One possibility is that markets struggled to function due to adverse selection. This would be consistent with the fact that insider trading was not illegal at the time, and corporate governance was generally weak (Guinnane et al., 2017). Another possibility is that high transaction costs worked to suppress volume, and that this amplified the risk of holding securities and limited market making by dealers who had limited capacity to bear balance sheet risk (Powell, 1916). Of course, these alternatives are not exclusive and can work in combination. In the next sections, we will unpack the reasons for market-maker's choices by jointly modeling the decision to deal in a security and the security's expected spread.

3. Data

As part of his testimony to the Royal Commission, the broker Branch submitted a copy of the *London Daily Stock & Share List* for October 19th, 1877, in which he had marked with a red pen the securities that were 'not marketable'—meaning that dealers would not make a market in them for immediate execution. Unfortunately, this hand-annotated document was not included in the report of the Royal Commission, which published instead a table summarizing Branch's classification by sub-market within the LSE.[10] The table is reproduced in Fig. 1.

A frustrating limitation of Branch's table is that it identifies which individual securities were marketable and which were not *only in aggregate*. The picture can be refined however. First, there were securities for which no dealer provided bid and ask prices, from which we can clearly infer that these securities were 'not marketable'. In addition, dealers occasionally testified as to which securities they made markets in, and the information in Branch's table allows us to determine dealer support in certain cases. We discuss this in greater detail at the start of Section 5.

8 Advertisement in *Economist*,15 May 1880, p. 584.

9 *The Times*, 8 November 1880, p. 8.

10 A sub-market is a group of securities by type such as 'foreign mines.' Dealers in this type of security would stand in the same location in the Exchange so that brokers wanting to trade foreign mining stock could simply walk there.

BANKS.

Authorised Issue.	Share.	When x d or x in.	NAME.	PAID.	CLOSING QUOTATIONS. Oct. 19	BUSINESS DONE
100,000	10	28 Sept.	Agra, Limited	all	10½ — 11	11a10¾
80,000	25	31 July	Alliance, Limited	10	12¾ — 13¼	13
150,000	200l. †	31 Mar.75	Anglo-Austrian	120l. †	8¼ — 8¾	
23,970	20	13 Sept.	Anglo-Californian, Limited	10	¾ — ¼ dis	
80,000	20	30 Nov.75	Anglo-Egyptian Banking, Limited	all	11½ — 12½	12a11¾
60,000	20	27 April	Anglo-Foreign Banking, Limited	10	1¾ — 1¼ dis	
40,000	100l.	29 My.73	Anglo-Hungarian	all	4 — 4½	
15,000	20	14 Feb	Anglo-Italian, 1866, Limited	10	4¾ — 4¼ dis	

Fig. 2. An excerpt from the London Daily Stock and Share List October, 19th 1877.

We have every reason to think that October 19th was a typical day on the stock market. To the best of our knowledge, Branch's choice to annotate the daily list of October 19th was not strategic and was instead driven by the scheduling of his deposition to the Royal Commission. Branch was heard on Monday, October 22nd and prepared his table with reference to the securities listed on the Friday prior. The contemporary press described the week ending on October 20th as mostly uneventful: "As the money market lost its strained appearance, prices this week tended to recover, and the advance is both marked and general" (*Economist* Oct 20th 1877, p. 1252).[11]

Since Branch's original data was an annotation of the LSE's Official *List*, we digitized the same edition of the *List* on which Branch relied to classify securities: October 19th, 1877. The *London Daily Stock & Share List*, published in 1877 by Henry H. Wetenhall, contained 7 pieces of information for a typical security (see Fig. 2 for an excerpt from the list). The 'Name', and 'Authorized Issue' columns provided the name of the security and the number of shares or bonds listed. The 'Share' column gave the nominal value of each security. In the case of shares, which were paid on installments, this column must be read in conjunction with the 'Paid' column which detailed how much of the value of the share had been called up by the company. For instance, referring to Fig. 2, only £10 had been paid out of the nominal £25 of the shares in the Alliance Limited bank. The company could request shareholders to contribute up to another £15 in capital calls. With the share trading at £13, we see it had risen in value relative to its effective issue price. The column 'When x.d.' indicated when the security was priced without the dividend or interest.

The markings in the 'Business Done' column represent the prices of actual transactions that occurred on the day. Unfortunately, they do not necessarily represent *all* the Business Done, and in some cases may represent very little of the Business Done at all (Odlyzko, 2016).[12] This censoring effectively prevents us from using intra-day data to estimate the bid–ask spread via the 'bid–ask bounce' (Glosten, 1987; Glosten and Harris, 1988).[13]

We focus therefore on the spread between the Closing Quotations, which was known at the time as the 'turn'. These Closing Quotations were collected from dealers at 3pm, and where dealers stood ready to make a market they were a generally accurate measure of the existing bid and ask prices.[14] When dealers were not willing to make a market, they either reported no information, or they provided instead a loose valuation indicating where they believed an unsupported security could trade. Thus the printed Closing Quotations are a mixture of actual bid–ask prices and valuations.

Fig. 3 plots all the available Closing Quotations normalized by the mid-price and grouped by each of the 32 LSE sub-markets. It is easy to see both the extent of missing quotations – shown as gaps in the chart – and the variability in the size of turns across markets. The contrast between the very large turns for foreign mines and the thin turns of railway debentures already suggests that access to information was one of the drivers of transactions costs in the LSE. Foreign mines were widely known to be highly speculative investments, whereas UK railway companies published frequent traffic and income returns. Predicting the return on a mine was therefore much harder for the average investor than the coupon of a railway debenture. Based on Branch's testimony, we will identify which of the reported turns corresponded to dealer's bid–asks and which were mere 'valuations.' The model derived in the next section accomplishes that.

4. Specification

Our empirical analysis jointly models the determinants of dealer liquidity provision, the determinants of spreads and the determinants of the dealers' valuations. Our model needs to accommodate both the problem facing dealers, as well as the problems of measurement that confront the researcher.

[11] The strain mentioned in the quote was the 100 bips increase in the Bank rate to 5% a week before that had failed to impact the short-term lending rates in the money market which would be relevant for dealers. The *Times* mentioned "a large excess of unemployed funds available for short loan at rates nominally about 3 per cent ... The funds have scarcely varied" (*The Times*, 20.10.1877, p. 7). The settlement dates, which could influence short-term liquidity were also still two weeks away in the case of consols or one week for the other securities.

[12] For details see Appendix A.

[13] Other common measures of liquidity such as the illiquidity metric of Amihud (2002) cannot be computed without information on volumes.

[14] See for instance the testimony of the broker Percival Spurling (RC, 1878a, 37).

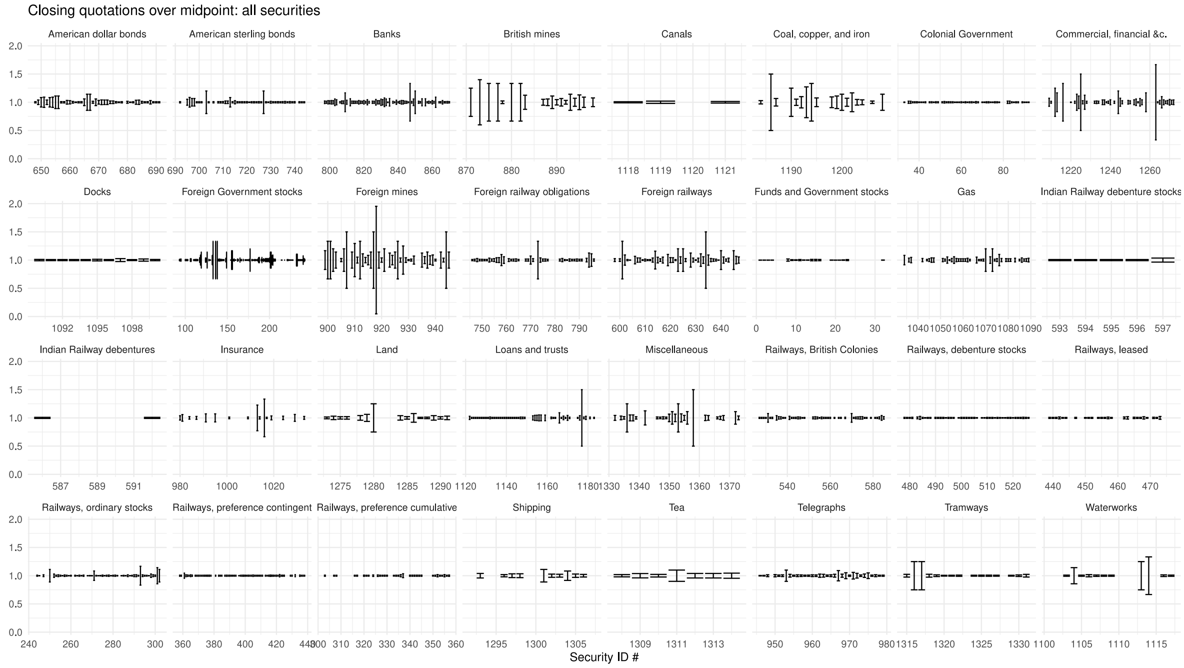

Fig. 3. Distribution of Closing Quotations Spreads in the LSE.
Notes: The Closing Quotations are normalized by their mid-point. Data was collected from the October, 19th 1877 edition of the *London Daily Stock and Share List.*

We are particularly interested in understanding the relationship between the dealers' decision to make a market and the expected spread. Using a parametric model of the decision to deal and the spread, we can evaluate this relationship in terms of both the observable covariates and the unobservables.

The model needs to correct for two problems. The first problem is that the sources report dealers' spreads mixed with 'valuations.' For a minority of securities, we can infer from the historical sources whether they were supported by dealers or not. For the majority, we decompose spreads from valuations with a mixture model. The second problem is that dealers' decisions about which securities to support were non-random, and could depend on security characteristics that we cannot observe—such as the dealer's internal profit when trading the security. In consequence, we need to model the dependence between the spread and the unobserved variables that affected a dealer's decision to make a market as in a classic Heckman selection model. As a result of these two problems, the model we derive is a mixture of Heckman-style selection models for the true spreads and the valuations.

Fig. 4 represents the data-generating process in a directed acyclic graph (DAG). The graph shows that both core outcomes are only partially observed, and that selection between outcomes confounds estimation. Node X represents security characteristics that we use as covariates. Node z is a latent dummy variable for being selected by dealers to make a market. This node z generates the probabilistic information we observe about dealer choices from Branch's table and elsewhere in node *prob*. Node *spread* is latent as we only observe spreads mixed with valuations, which are given by the node val. Together, spreads and valuations constitute the closing quotations (or turn), which we observe in the node *quote*. The relationship between X and the spread is confounded by unobservables ϵ which influence both selection by dealers and the turn. Consequently, we require a parametric model to compute the average spread charged by dealers. Below we sketch the intuition of our statistical model and report the full derivation in Appendix B.

4.1. Econometric model

If we knew which securities were dealer supported and which were not, it would be straightforward to model the selection into dealing using a sample selection model. Given the true vector of dealer support, which we will call z, the joint probability of dealer support and observed bid–ask spreads s would be generated with probability $P(z=0)^{1-z}P(s, z=1)^{z}$.[15] However, we do not know exactly which securities are dealer-supported, although we do have strong *probabilistic* information about dealer support. Specifically, Branch's table gives us the probability of dealer support in each group of securities.

[15] Given some functional form assumptions this could be estimated by maximum likelihood or Bayesian estimation, or in a two-step process (Heckman, 1979; Amemiya, 1985).

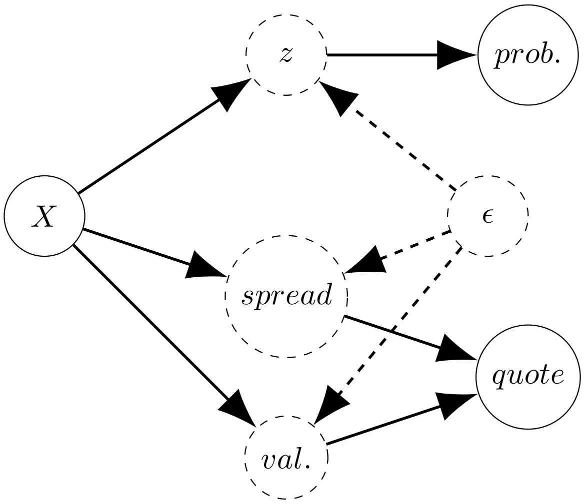

Fig. 4. A DAG representing the relationships between model variables. Solid nodes are observed and dashed nodes are latent.

Of the turns we observe, we know that a large proportion were not spreads. These 'valuations' have to be modeled in order to obtain clean estimates of both the spread and the selection into dealer-support. To do this, it is helpful to start by thinking in terms of the observed turns as comprising two distinct 'regimes': regime 1 being real spreads supported by dealers, and regime 0 being valuations.

Thinking in two regimes requires a model in three equations: the equation determining whether a security gets supported by the dealers, the equation linking the security's characteristics to the spread in the case where the dealers support it, and the equation linking the security's characteristics to its valuation when the dealers do not support it.

For each security for which we observe a pair of Closing Quotations we compute the log spread normalized by the mid-price

$$p_{i,mid} = \frac{A_i + B_i}{2} \tag{1}$$

$$s_i = \ln\left(\frac{A_i - B_i}{p_{i,mid}}\right) \tag{2}$$

where A_i is the larger and B_i the smaller of the Closing Quotation pair. A normalized spread is the percent return of a round-trip transaction for the dealer. The Closing Quotations that we observe can be described as:

$$s_{1i} = f_1(X_{1i};\theta_1), \text{ Regime 1: spread} \tag{3}$$

and

$$s_{0i} = f_0(X_{0i};\theta_0), \text{ Regime 0: valuations} \tag{4}$$

for $i = 1, \dots, N$, where $f_i(.)$ is some function and θ_i is a vector of parameters. Finally, we assume that dealers decided to make a market in a security if they anticipated that the return would exceed the cost. This decision gets its own equation:

$$z_i = \mathbf{1}\left[g(Z_i, \gamma) \geq 0\right], \text{ Selection equation,} \tag{5}$$

where $g(.)$ is some functional form for the binary outcome z_i and γ is a vector of parameters.

A common way to model problems like this is to treat each regime and the selection equation as having normally distributed errors. The advantage of joint normality is that it allows the selection problem to be parameterized and for the correlation between the outcome and selection equation to be estimated (Lee and Porter, 1984; Maddala, 1986; Smith, 2003).[16]

[16] Switching regressions of this form have been widely applied in finance and economics (Hu and Schiantarelli, 1998; Hyytinen et al., 2018; Lee and Porter, 1984; Lichard et al., 2013).

Our model becomes

$$\begin{aligned} &s_{1i} = X_{1i}\beta_1 + \upsilon_i, \iff z_i = 1 \\ &s_{0i} = X_{0i}\beta_0 + e_i, \iff z_i = 0 \\ &z_i = \mathbf{1}[Z_i\gamma + \xi_i \geq 0] \\ &[\upsilon_i, e_i, \xi_i] \sim N_3(\mathbf{0}, \Sigma) \\ &\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{10} & \sigma_{1\xi} \\ \sigma_{10} & \sigma_0^2 & \sigma_{0\xi} \\ \sigma_{1\xi} & \sigma_{0\xi} & 1 \end{bmatrix}. \end{aligned} \tag{6}$$

In this notation, $N_3()$ is the trivariate normal distribution. Conveniently, we can simplify the covariance matrix of this model. In switching models σ_{10} is never observed so we can set it to zero. Thus the variance–covariance matrix simplifies to:

$$\Sigma = \begin{bmatrix} \sigma_1^2 & 0 & \sigma_{1\xi} \\ 0 & \sigma_0^2 & \sigma_{0\xi} \\ \sigma_{1\xi} & \sigma_{0\xi} & 1 \end{bmatrix} \tag{7}$$

If the term $\sigma_{1\xi}$ is not 0 then the estimation of the regression coefficients in regime 1 is subject to omitted variable bias. Specifically, the expected value of s_i in regime 1 is given by its expectation when $Z_i\gamma \geq -\xi_i$:

$$E(s_{1i}|z_i = 1) = X_i\beta_1 + \rho_1\sigma_1\left[\frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)}\right] \tag{8}$$

where ρ_1 is the correlation between the error in the selection equation and the error in regime 1, and $\phi()$ and $\Phi()$ are the standard normal density and cumulative distribution functions, respectively. If ρ_1 is negative it means that, holding X_i constant, the spreads of securities dealers elected to make markets in were *lower* than the spreads on securities dealers chose not to support.

A reasonable concern is that the act of dealing itself might alter the spread. However, it does not apply to this setting as spreads only exist when dealers make a market. By estimating β_1 in Eq. (8) adjusting for selection we identify how spreads vary with respect to the explanatory variables *in the case where dealers make a market in everything*. Thus the purpose of the selection model is to get the population covariance between a security's characteristics and the prices the dealers charge, so that we can report for each security 'if dealers made a market in security X_i we would predict them to charge $X_i\beta_1$'. Thus the core counterfactual the model estimates is the spread dealers *would* charge for securities for which we do not observe a spread.

On the contrary, we do not try estimating the cost of dealing across regimes 1 and 0 as this contrast is not coherent between spreads and valuations. For securities not dealer-supported, the Closing Quotations marked by dealers were subjective valuations and are not comparable to actual spreads. Indeed they frequently appear to be smaller than actual spreads, but that does not mean anyone could trade at those prices.

We derive (see Appendix B) a likelihood function by combining work on switching models with noisy signals (Maddala, 1986; Lee and Porter, 1984) with work on binary choice with misclassification (Hausman et al., 1998). This allows us to write a log-likelihood function for estimating the parameters of model (6) using only the observed spreads and covariates, and the partial information about dealer support given to us by Branch and augmented by our own calculations. This log-likelihood, given in Eq. (9) is a mixture of sample selection likelihoods for the spread and valuation equations. Where no turn is reported, we estimate only the probit portion of the model.

$$\begin{aligned} \log\mathcal{L} = &\sum_{\text{No turn}} \ln\left\{1 - \Phi(Z_i\gamma)\right\} + \\ &\sum_{\text{Has turn}} \left\{ \ln\left(\Phi\left(\frac{Z_i\gamma + \rho_1\frac{(s_i - X_i\beta_1)}{\sigma_1}}{\sqrt{1-\rho_1^2}}\right)\phi\left(\frac{s_i - X_i\beta_1}{\sigma_1}\right)p_i + \right.\right. \\ &\left.\left. \Phi\left(\frac{-Z_i\gamma - \rho_0\frac{(s_i - X_i\beta_0)}{\sigma_0}}{\sqrt{1-\rho_0^2}}\right)\phi\left(\frac{s_i - X_i\beta_0}{\sigma_0}\right)(1-p_i) \right) \right\} \end{aligned} \tag{9}$$

We estimate this model in `Stan` (Carpenter et al., 2017) via Markov Chain Monte Carlo (MCMC). We also used simulated data to test whether the derived likelihood consistently estimates posterior distributions that capture the true parameters (see Appendix C). The code implementing the estimator, as well as the data and code to reproduce all the results in the paper are published online (Esteves and Geisler Mesevage, 2025).

5. Results

A crucial component of our estimation is the vector p collecting probabilistic information about dealer support for each security. We use this vector to estimate the likelihood function. To populate this vector, we start by classifying securities manually, marking

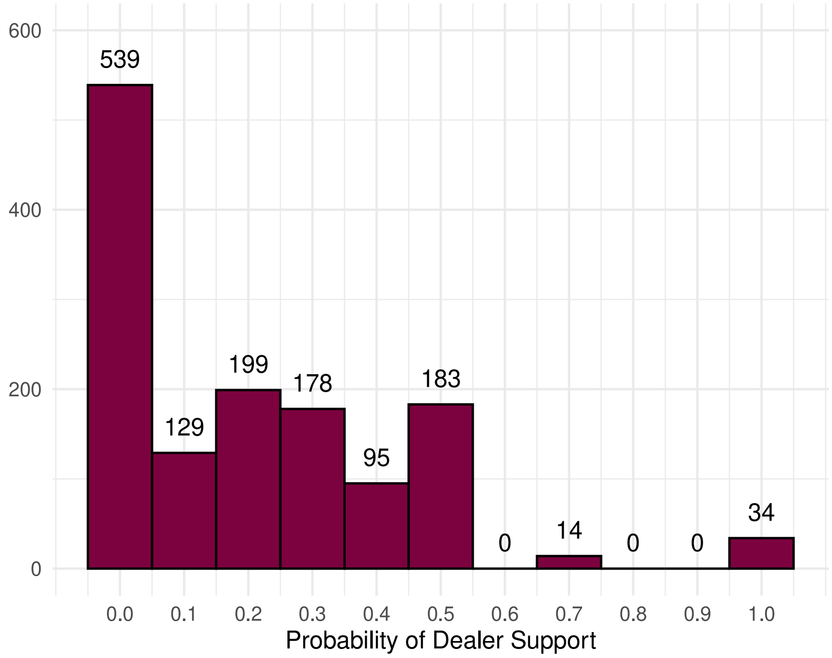

Fig. 5. Probabilities of dealer support.
Notes: Authors' computations from Branch's table, testimony by brokers and dealers to the Royal Commission on the London Stock Exchange, and the published record of Closing Quotations taken from Wetenhall's official list for October 19th, 1877.

zeros for securities that do not report Closing Quotations. We then classify as zeros all securities in a group Branch reported to be entirely unsupported by market makers. We also used the information in the 'amount in millions' column of Branch's table (see Fig. 1) to try to identify which securities were dealer supported in each group. For sub-markets with one or two dealer-supported securities this resolved the group.

Consider for instance the case of the 'Docks' sub-market. Branch listed 10 not-dealer supported securities and one dealer-supported. He also reported that the "Amount in Millions" of the dealer-supported security was £5.7 million. Cross-referencing Branch's table with the *London Daily Stock & Share List*, we see that of the listed docks only one had an authorized issue of £5.7 million: the London & St. Katherine. Thus we coded the London & St. Katherine as dealer-supported, and the remaining 10 docks as not dealer-supported.

Next, we added in information offered in testimony to the Royal Commission about specific securities as being dealer-supported or not. For instance, Branch himself declared that "if I go with certain stocks into the market, such as National Provincial Bank of England Shares, East and West India Dock stock…I have practically to disclose whether I am a buyer or a seller" (RC, 1878a, 130). We coded accordingly these two securities as not dealer supported. In the end, we were able to identify 34 securities that definitely *were* dealer supported, plus 500 that were *not* dealer supported.[17] The remaining 839 have varying probabilities of dealer support but cluster below 0.5. Fig. 5 plots the distribution of these probabilities.

Given the observed probabilities in Fig. 5, we can estimate the likelihood function given in Eq. (9). The model includes a set of covariates Z that may be salient to the costs of providing liquidity and another set X that controls for security characteristics influencing liquidity beyond their market support by dealers. Table 1 contains the summary statistics for the covariates split by the probability of market support p.

The variables *Domestic*, *Empire*, *Equity*, and *Non-corporate* are categorical and self-explanatory. The variable *ln(Auth. Iss.)* is the log of the authorized issue of each security and is our measure of the float. The *ln(Price)* is the log of the price of the security.[18] This variable controls for scale effects in securities with small prices relative to tick sizes. At the time, the minimum tick size was $\frac{1}{16}$th of a pound, while some securities traded for as little as 5*s*. For these 'penny stocks,' the minimum turn was mechanically larger than for securities with higher prices.

The variable *ln(Group Size)* is the log of the number of securities listed in each sub-market of the LSE. The variable *N Marketable* is the count of the number of marketable securities reported by Branch in each sub-market. Finally, *Days to dividend* collects the number of days until the next coupon payment for bonds, or dividend payment for equities. In the estimation, we standardize all continuous variables to mean zero and standard deviation one, which lets us set priors in the Bayesian models without worrying

[17] A further 40 securities had probabilities very close to zero.

[18] We take the most recent price, or where that does not exist the nominal price, or the nominal amount paid in.

Table 1
Summary statistics of the variables used in the statistical analysis grouped by the probability of dealer support.

Variable	Mean	Median	sd	Min	Max
0 < p < 1					
N Marketable Sec.	18.113	12.000	16.710	2.000	60.000
Days to dividend	194.350	209.000	105.132	13.000	363.000
Domestic	0.342	0.000	0.475	0.000	1.000
Empire	0.187	0.000	0.390	0.000	1.000
Equity	0.430	0.000	0.495	0.000	1.000
Log Group Size	4.126	4.078	0.442	2.773	5.069
Log Auth. Iss.	12.825	12.899	2.329	7.378	20.029
Log price	3.638	4.287	1.301	−1.386	6.910
Non-corporate	0.254	0.000	0.436	0.000	1.000
Turn/Mid	0.070	0.028	0.126	0.000	1.333
p=0					
N Marketable Sec.	9.240	2.000	16.426	0.000	60.000
Days to dividend	223.967	253.000	97.530	11.000	363.000
Domestic	0.565	1.000	0.496	0.000	1.000
Empire	0.132	0.000	0.339	0.000	1.000
Equity	0.577	1.000	0.495	0.000	1.000
Log Group Size	3.737	3.892	0.713	1.386	5.069
Log Auth. Iss.	11.284	11.305	2.232	6.091	17.852
Log price	3.272	4.337	1.681	−1.674	5.799
Non-corporate	0.174	0.000	0.380	0.000	1.000
Turn/Mid	0.165	0.048	0.255	0.013	1.905
p=1					
N Marketable Sec.	13.412	10.000	15.496	1.000	60.000
Days to dividend	221.125	253.000	82.941	53.000	344.000
Domestic	0.500	0.500	0.508	0.000	1.000
Empire	0.265	0.000	0.448	0.000	1.000
Equity	0.500	0.500	0.508	0.000	1.000
Log Group Size	3.616	3.434	0.728	2.398	5.069
Log Auth. Iss.	13.972	12.958	3.333	9.210	19.792
Log price	3.776	4.089	1.482	−0.693	6.903
Non-corporate	0.382	0.000	0.493	0.000	1.000
Turn/Mid	0.045	0.019	0.087	0.001	0.500

about the scale of the corresponding variable. At the end of each panel in Table 1, we list the summary statistics of the reported turns in each panel, as a fraction of the posted price. By splitting the summary stats by probability of dealer support, we can check for sample balance of the covariates. Only in a few cases are there significant differences in means. Securities that we know to be unsupported ($p = 0$) were unsurprisingly listed in sub-markets with fewer marketable securities. The proportion of domestic securities and the group size were both lower among securities with probabilistic dealer support ($0 < p < 1$). There was also a lower proportion of non-corporate securities in the group with $p = 0$ and imperial securities were slightly overrepresented among securities definitely supported by dealers ($p = 1$). None of these appears worrying for our design, though, as we do not match on the outcomes p_i and s_i.

In principle, we could estimate the model without exclusion restrictions, but identification in that case would rest wholly on functional form. Therefore, we introduce two exclusion restrictions. First, in the selection equation we include the size of the group and number of marketed securities in each sub-market in the LSE list. A large number of marketed securities in a group required a large number of dealers servicing that market. Since it was easy for dealers to support an additional security traded in the same location, this should positively predict dealer support. The effect of the total number of securities (size) in the group is more ambiguous. Specializing in a small sub-market could have higher opportunity costs and dissuade entry. But large markets might be more competitive or crowded equally dissuading entry by dealers. As these were not characteristics of the securities but the venues in which they traded and arguably altered the behavior of the dealers, we exclude them from the spreads and valuations equations.[19]

To identify regimes 1 and 0, we exclude the variable days until dividend from the valuation equation. We expect that the approach of payment dates would force an increase in bid–ask spreads for at least two reasons. The first is asymmetric information about

[19] A possible concern here is that certain types of investors might have preferred or been constrained to invest in certain classes of securities. In this preferred habitat scenario, the number of marketed securities and the bid–ask spreads in a given group could be jointly driven by the presence of this type of investors. We do not find this a threat to our identification. First, because these type characteristics are likely absorbed into the group fixed-effects. Second, in the late 1870s the only case of mandated investments concerned the so-called trustee acts that restricted the portfolios of certain charities and thrifts to British government bonds and bonds guaranteed by Britain, which comprise the first group of securities at the LSE (Esteves and Tunçer, 2024). Finally, reconstructed historical portfolios show that Victorian investors pursued diversification, which limits concerns about bunching of liquidity-enhancing investors in particular sub-markets (Sotiropoulos and Rutterford, 2019; Rutterford and Sotiropoulos, 2016).

payment rates that would increase adverse selection risk for dealers (Duguid, 1902). In addition, coupon payment dates for fixed income securities were very clustered in time, with most coupons falling on the beginning of January and July, followed by the start of April and October. Such concentration put pressure on the money market which would increase the cost of market making. Both mechanisms should matter for spreads but not for valuations. To capture the sensitivity of spreads to the approach of a dividend date, we take the exponent of the negative number of days until a dividend which peaks for securities close to a payment and then falls rapidly.

Even though the exclusion restrictions we impose are plausible, no exclusion restriction is certain outside of experimental conditions, and it is reasonable to worry that they might be violated. In the next section, we allow for violations of the exclusion restrictions and show that the parameter estimates are substantively unchanged.

Table 2 reports estimated medians and 90% credible intervals for the parameters of the regression coefficients in the selection, spread (regime 1) and valuation (regime 0) equations of the model.[20] We report estimates for models including fixed-effects for the sub-markets of the LSE.[21] Since we place priors on the fixed-effects coefficients it is possible to estimate both the fixed-effects and parameters for variables like group size that only vary at the level of the fixed-effects.[22]

We start by discussing the results for the selection part of the model. Because the selection equation is non-linear (estimated by probit), we show in Fig. 6 the marginal effects of the estimates in Table 2. The estimates imply that equities were 10% less likely to be supported by a dealer. Similarly, non-corporate securities, issued by sovereigns and municipalities, were 23% less likely to be supported by dealers. This could reflect the tendency for bonds issued by public entities to be bought and held with little trading activity. Consistent with our expectations, larger issues were more likely to be dealer supported: a 1-standard deviation larger issue size is associated with 11% higher likelihood of dealer support. Both mechanisms should matter for spreads but not for valuations. Regarding our identification strategy, we confirm that the number of marketable securities in each LSE sub-market had a large and positive marginal effect. A one standard-deviation increase is associated with a 14% rise in the probability of a security being dealer supported.

This fits with our intuition that if there are many dealers already operating in the sub-market it is more probable that a security will be supported. In contrast, group size appears to be a weak instrument for selection into dealing. Securities with higher prices were less likely to be dealer supported. Selection on unobservables into the spreads equation – regime 1, where a dealer made a real market – is very negative, as shown by the estimate of the correlation of error terms $\rho_1 = -0.8$. To translate this into an effect on spreads, we can start by noting that $\rho_1 = \frac{cov(\upsilon_i, \xi_i)}{sd(\upsilon_i) sd(\xi_i)} = \frac{cov(\upsilon_i, \xi_i)}{\sigma_1}$.

To obtain the linear projection of the spread error υ_i on the selection error ξ_i we can simply multiply ρ_1 by σ_1 yielding the covariance of the errors.[23] Doing so, we conclude that the covariance of the errors in the two equations is −0.75. Since the error in the selection equation is standard normal, the covariance can be interpreted as the marginal effect on the log-spread of a 1-standard-deviation increase in the error of the selection equation ξ_i. Taking the estimate, −0.75, this implies that a 1-standard deviation increase in the unobservable selection error results in $(e^{-0.75} - 1) \times 100\% = -53\%$ fall in the spread. This halving of spreads expresses the importance of unobservables on selection into dealing.

The results for the observable covariates on spreads and valuations are intuitive. Large issues were not only more likely to be dealer-supported they also had smaller spreads. As we standardized the continuous variables, we can directly compare the size of the marginal effects. The size of the issue has clearly the largest effect size on spreads. This confirms contemporary opinion. According to Robert Giffen, for "a stock to be highly marketable, and even to make it safe to have dealings in, it must be large enough to make it worth the while of a great number of people to be interested in it" (Giffen, 1877, 90).

It is important to recall that the estimates show the coefficient *adjusting for selection into dealer-support* so large issues attracted thinner spreads irrespective of whether or not a dealer made a market in them. This speaks to the intuition of the exercise, namely that there are characteristics of securities that make them likely to be more liquid irrespective of whether or not someone makes a market in them. The effect of issue size on valuations is very close to zero, once more confirming that valuations were not commitments to make a market at the posted Closing Quotations.

In the spreads equation, we also see that the relationship between the nominal price of a security and its spread is negative. This likely reflects the impact of discrete tick sizes on the spread when the security price was small. In addition, domestic securities had thinner spreads, a seeming confirmation of the importance of informational frictions, which increased with distance. Perhaps surprisingly, equities also had thinner spreads relative to bonds. This, however, probably reflects the large number of thinly traded bonds listed on the LSE. Finally, the number of days until a dividend has a large effect and the expected sign: a 1-standard deviation reduction in the time until a dividend or coupon payment increased spreads by 30%.

In the valuation equation, it is interesting to note that non-corporate borrowers appear to have much tighter valuations. This may reflect the practice of reporting unsupported sovereign bonds around their last price plus or minus one or two pounds. The model also estimates that the distribution of true bid–ask spreads is much wider and more variable, with a higher estimated variance (σ_1) than the valuations extracted from securities where dealers were not actually making a market (σ_0). This is sensible: market making in some names would result in very thin spreads in active markets (e.g. British government securities), and would be very expensive and require very large spreads in speculative assets with intense adverse selection or low order flow. In contrast, the valuations provided by dealers for securities they did not support have a comparatively small variance. Given that the two regimes are mutually exclusive, negative selection into regime 1 implies a countervailing positive selection for the valuation regime (i.e. a positive estimate of ρ_0).

[20] The columns R-hat and ESS are two convergence diagnostics, which evaluate how well the sampler has estimated each parameter.

[21] We also estimate without fixed-effects but these models have worse diagnostics. See Section 5.2.

[22] This is comparable in a frequentist setting to a ridge regression.

[23] Since ξ_i is normalized to have a variance of 1, the covariance of the errors is equivalent to the projection of the spread error υ_i onto the selection error ξ_i.

Table 2
Regression models: Mean and 5% and 95% quantiles.

Coef.	Simple model with group FE: (N=1319)			
	Mean	90% CI	R-hat	ESS
Selection				
Std. N Marketable	1.21	[0.62, 1.83]	1.00	5880.38
Std. ln(Group Size)	−0.22	[−0.55, 0.12]	1.00	6714.37
Std. ln(Price)	−0.33	[−0.52, −0.14]	1.00	8337.66
Equity	−0.89	[−1.33, −0.47]	1.00	9270.95
Domestic	−0.08	[−0.53, 0.37]	1.00	3364.29
Empire	−0.36	[−0.91, 0.17]	1.00	8237.02
Std. ln(Auth. Iss.)	1.00	[0.81, 1.20]	1.00	10 243.23
Non-corporate	−2.02	[−2.88, −1.17]	1.00	8056.73
Std. exp(-Days to Div.)	−0.07	[−0.28, 0.09]	1.00	16 342.02
Spread				
Std. ln(Price)	−0.89	[−1.07, −0.71]	1.00	9272.04
Equity	−1.03	[−1.67, −0.43]	1.00	3790.63
Domestic	−0.72	[−1.23, −0.17]	1.00	4735.63
Empire	−0.40	[−1.07, 0.25]	1.00	11 103.80
Std. ln(Auth. Iss.)	−1.61	[−1.75, −1.48]	1.00	8928.58
Non-corporate	0.13	[−0.76, 1.03]	1.00	7343.63
Std. exp(-Days to Div.)	0.30	[0.09, 0.52]	1.00	17 974.21
Valuation				
Std. ln(Price)	−0.76	[−0.81, −0.71]	1.00	8469.85
Equity	−0.29	[−0.40, −0.18]	1.00	5046.84
Domestic	−0.26	[−0.38, −0.15]	1.00	4312.28
Empire	−0.44	[−0.57, −0.31]	1.00	7360.93
Std. ln(Auth. Iss.)	−0.10	[−0.15, −0.04]	1.00	10 858.58
Non-corporate	−2.67	[−3.31, −2.03]	1.00	3061.99
Additional parameters				
sigma1	0.94	[0.83, 1.06]	1.00	9605.46
sigma0	0.46	[0.44, 0.49]	1.00	6176.36
rho1	−0.80	[−0.91, −0.66]	1.00	8100.74
rho0	0.32	[0.01, 0.57]	1.00	6747.14

Notes: Mean coefficient estimates with a 90% credible interval in brackets. The posterior distribution is computed in Stan via HMC sampling from 4 chains each running 1000 warmup and 4000 final samples. All variables have standard-normal priors. The R-hat column shows a convergence diagnostic that compares between- and within-chain parameter estimates and well-sampled parameters should have a diagnostic close to 1. The ESS column shows the bulk-effective sample size drawn from the sampler and measures sampling efficiency of the mean of the distribution. Efficient samplers should have an ESS of at least 100 per chain.

5.1. Alternative identification strategies

To test the robustness of our exclusion restrictions, we adopt the approach of Conley et al. (2012), who treat exclusion restrictions as very dogmatic priors that place the entire mass of the prior distribution on zero. From this perspective, more robust exclusion restrictions can be obtained from less extreme priors. In this section, we show estimates from an alternative parameterization of the model. We show a 'robust' approach which treats all of our exclusion restrictions as potentially violated, and centers all prior distributions on zero to regularize estimates away from extreme findings. In this approach, we include the instruments in the equations from which they were excluded, but set their priors to be more narrowly centered around zero than the priors for the other coefficients as suggested by Conley et al. (2012). In Appendix D we extend this approach by imposing directionally intuitive priors on all model parameters including the exclusion restrictions. We also show in additional tables in Appendix D that the results are equally robust to making the priors much flatter by increasing their standard deviation.

Table 3 collects the 'robust' estimates of the model. The inclusion of the instruments in the outcome equations has essentially no impact on the estimates. The estimated posterior distributions are slightly wider as we would expect from including the instrument, but coefficient estimates are otherwise not substantively changed. Moreover, in the spreads equation, the excluded group-level instruments (group size and number of marketable securities) have coefficients that average zero—confirming the exclusion restriction.

In the valuation equation, the group-level instruments appear to have a positive effect on valuations. Groups with more marketable securities or more overall securities have wider valuations.[24] Nevertheless, the days-to-dividend instrument we use to distinguish spreads from valuations has a very precisely estimated coefficient of zero, once more confirming the exclusion restriction.

[24] This could be because the instruments pick up some of the security-type heterogeneity that would be captured by the group fixed effects if they were not constrained by the prior.

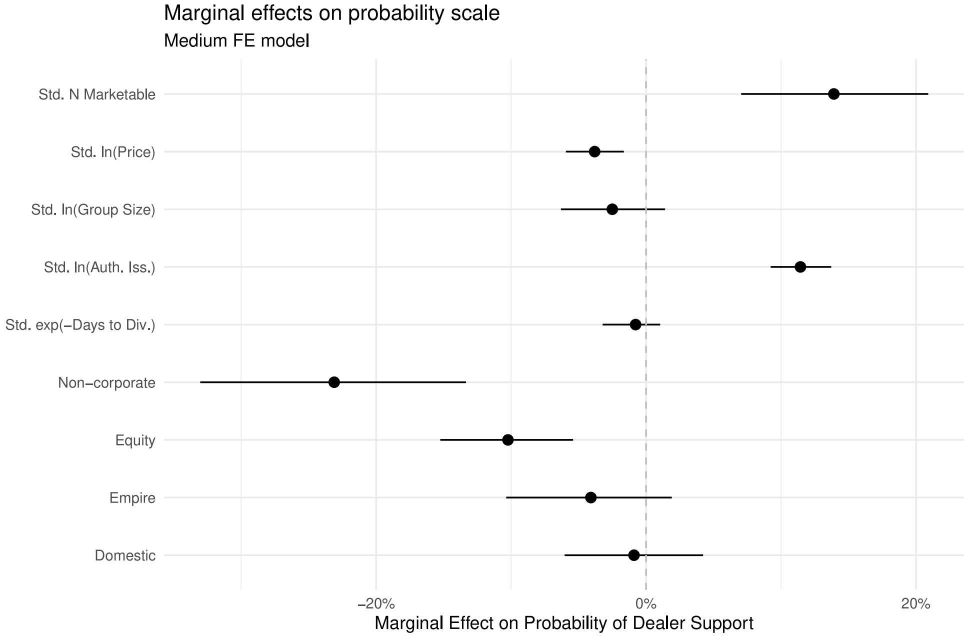

Fig. 6. Average marginal effects from probit estimates of dealer support.
Notes: Average posterior marginal effects plots for the selection equation. Average marginal effects are on the probability of dealer support and are computed for each observation in the sample at its observed covariate values and averaged. The lines show the average marginal effects at the 5% and 95% quantiles of the posterior distribution.

5.2. Model evaluation

In this section, we evaluate the performance of the model against several benchmarks. First we compare our baseline results to alternative sets of covariates. Second, we compare the selection equation estimates from our model to a simple probit run on only fully-labeled observations to see where they differ. Third, we compare the empirical distribution of turns to the predictive distribution from the model to see if the aggregate patterns we are producing look plausible.

We evaluate our relatively simple fixed-effects model against more complex models that add interaction terms (‘medium’) or that add all interactions plus polynomial terms for continuous variables (‘large’). We also compare our baseline estimates to simpler models that drop the fixed-effects. We include as a point of comparison the ‘robust’ and ‘informed’ models of the previous section. As criterium we focus on out-of-sample performance using a fast approximation to leave-one-out (LOO) cross-validation, which is commonly applied in Bayesian models that are computationally intensive to re-estimate (Vehtari et al., 2017). For each model, we compute the expected log point-wise predictive density (ELPD). This quantity is a measure of the predictive performance of the model on a new sample from the unknown true data-generating process, and that process is approximated with leave-one-out cross-validation. We can then compare the performance between models in terms of ELPD or the LOO information criteria. We report the performance metrics in Table 4.

All the simple and large FE models have statistically indistinguishable performance. That is, although the best performing model is the simple fixed-effects model with informative priors, the large fixed-effects model is only about one standard deviation away in terms of ELPD performance. Models without fixed effects substantially under-perform in out of sample prediction, being over three standard deviations away from the best FE model. The large models are also badly overfit. Given this evidence, we favor the simple FE model shown in Table 2. We show estimates from the alternative models in Appendix D.

For the subset of 534 securities where we know whether or not dealers were making a market, we can run a standard probit model and compare the results with our estimates of the selection part of the model. We unfortunately cannot run a switching model on this sub-sample because the small number of positively labeled observations is not enough for the probit to converge in the sub-sample.[25] This exercise tells us how different our estimates become by incorporating the securities whose labels are only probabilistically known. If the correctly labeled securities generate very different estimates then we would need to worry more about the impact of the dealers decision when not to report a turn. Fig. 7, compares our full-sample Bayesian model estimates to the estimates obtained by running a probit on the sub-sample.

The estimates are quite similar but more precise in the Bayesian model. This similarity suggests that the fully-labeled sample and the probabilistically-labeled sample are not significantly different, confirming the sample balance we had observed in Table 1.

[25] This comparison can only be done for the model without fixed-effects for the same reason.

Table 3
Regression models with robust priors.

Coef.	Medium model with group FE and robust exclusion: (N=1319)			
	Mean	90% CI	R-hat	ESS
Selection				
Std. N Marketable	1.18	[0.58, 1.80]	1.00	6075.64
Std. ln(Group Size)	−0.20	[−0.53, 0.14]	1.00	7579.52
Std. ln(Price)	−0.33	[−0.51, −0.14]	1.00	10 239.52
Equity	−0.89	[−1.32, −0.46]	1.00	10 473.99
Domestic	−0.13	[−0.59, 0.33]	1.00	4601.69
Empire	−0.37	[−0.93, 0.16]	1.00	10 175.95
Std. ln(Auth. Iss.)	1.01	[0.81, 1.21]	1.00	12 018.19
Non-corporate	−2.00	[−2.87, −1.16]	1.00	9163.42
Std. exp(-Days to Div.)	−0.07	[−0.28, 0.09]	1.00	16 975.32
Spread				
Std. N Marketable	−0.06	[−0.22, 0.10]	1.00	24 398.78
Std. ln(Group Size)	0.11	[−0.04, 0.27]	1.00	19 283.11
Std. ln(Price)	−0.90	[−1.08, −0.72]	1.00	10 279.05
Equity	−1.06	[−1.73, −0.43]	1.00	4915.68
Domestic	−0.66	[−1.21, −0.10]	1.00	7138.10
Empire	−0.37	[−1.04, 0.31]	1.00	12 175.89
Std. ln(Auth. Iss.)	−1.60	[−1.74, −1.47]	1.00	12 931.56
Non-corporate	0.09	[−0.81, 1.00]	1.00	9201.81
Std. exp(-Days to Div.)	0.29	[0.08, 0.51]	1.00	23 214.95
Valuation				
Std. N Marketable	0.20	[0.04, 0.35]	1.00	6514.90
Std. ln(Group Size)	0.26	[0.13, 0.39]	1.00	4133.77
Std. exp(-Days to Div.)	0.01	[−0.02, 0.04]	1.00	30 321.78
Std. ln(Price)	−0.76	[−0.81, −0.71]	1.00	9428.70
Equity	−0.27	[−0.38, −0.16]	1.00	6366.87
Domestic	−0.24	[−0.36, −0.12]	1.00	6765.36
Empire	−0.42	[−0.55, −0.29]	1.00	11 586.90
Std. ln(Auth. Iss.)	−0.10	[−0.15, −0.05]	1.00	13 330.16
Non-corporate	−2.50	[−3.15, −1.86]	1.00	4700.54
Additional parameters				
sigma1	0.92	[0.81, 1.05]	1.00	10 512.33
sigma0	0.46	[0.44, 0.49]	1.00	7464.71
rho1	−0.79	[−0.90, −0.65]	1.00	9194.67
rho0	0.31	[−0.01, 0.58]	1.00	7314.80

Notes: Mean coefficient estimates with a 90% credible interval in brackets from models with local-to-zero priors on violations of the exclusion restrictions. All parameters have standard-normal priors except potential instruments which scale the standard deviation by $\frac{1}{10}$. The posterior distribution is computed in Stan via HMC sampling from 4 chains each running 1000 warmup and 4000 final samples. The R-hat column shows a convergence diagnostic that compares between- and within-chain parameter estimates and well-sampled parameters should have a diagnostic close to 1. The ESS column shows the bulk-effective sample size drawn from the sampler and measures sampling efficiency of the mean of the distribution. Efficient samplers should have an ESS of at least 100 per chain.

Table 4
Comparison of models by Leave One Out Cross Validation (LOO-CV).

Model	elpd_diff	se_diff	looic	se_looic
Simple FE w/ informative priors	0.00	0.00	2566.84	79.18
Simple FE robust exclusion	−0.31	0.81	2567.45	78.98
Simple FE (Baseline)	−2.75	1.64	2572.34	78.79
Medium FE robust exclusion	−4.75	7.64	2576.34	78.65
Medium FE informative priors	−4.89	8.02	2576.63	79.13
Medium FE	−8.63	7.70	2584.10	78.78
Medium	−73.83	27.38	2714.50	91.15
Simple	−96.33	23.78	2759.49	84.96
Large	−533.39	66.50	3633.62	138.09
Large FE	−7987.14	898.26	18 541.11	1806.60

Notes: Table shows the difference in expected log pointwise predictive density (ELPD) between models, as well as the LOO information criterion. We also report the estimated standard error of this difference. The covariates in the Simple model come from Table 2. The medium model adds interactions and the large model adds all interactions and polynomials for all continuous variables.

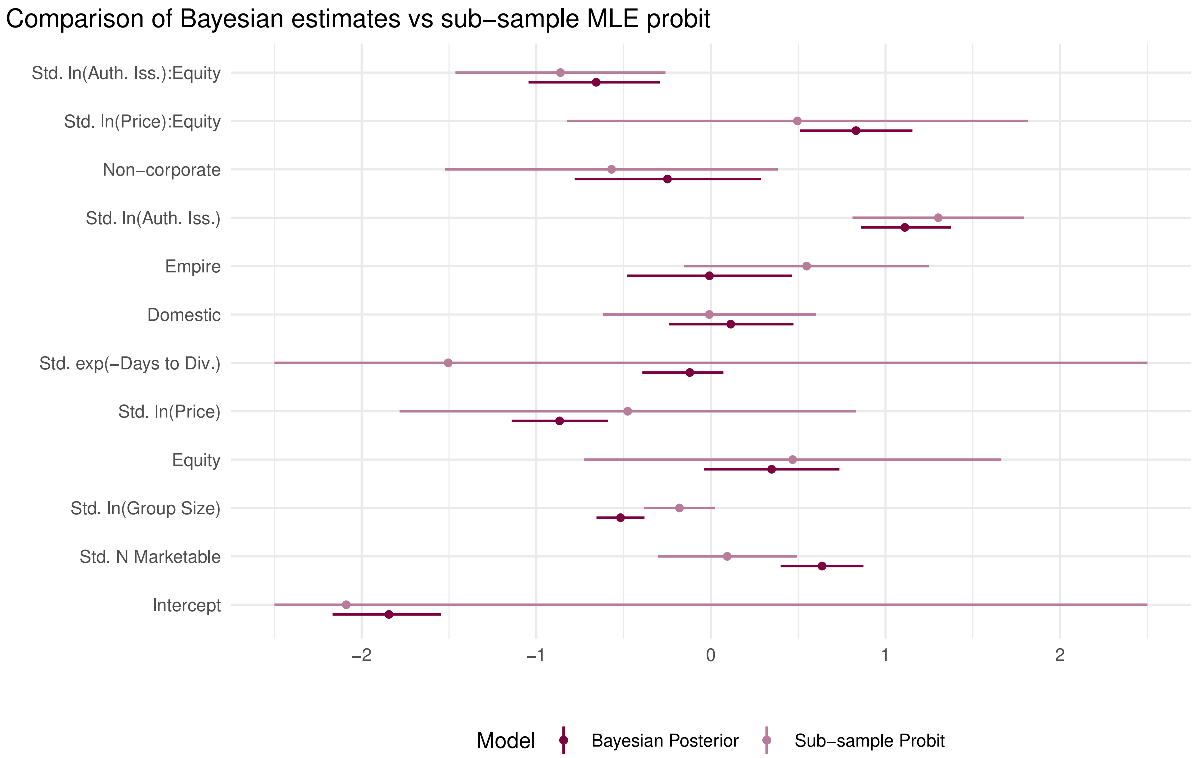

Fig. 7. Comparing Bayesian full-model estimates and sub-sample probit estimates.
Notes: All parameters given weakly-informative priors $\mathcal{N}(0, 1)$ and all continuous variables were normalized to have mean zero and unit variance. Bayesian model estimates show posterior mean and 95% credible interval, and Probit estimates show estimate +/- 2 standard errors. For both the Intercept and Std. exp(-Days to Div.) the standard errors of the probit estimates had to be truncated to fit the plot.

A final consideration is the comparison of the posterior distributions generated from the model to the empirical distribution of the dependent variable. This is not straightforward to do, because the model generates both valuations and spreads for securities that reported neither. Consequently, the empirical distribution of turns will miss the right tale of turns that dealers did not even report as valuations. We thus need to compare the empirical distribution to the distribution of the predictions from the valuation equation (s_0), as this constitutes the majority of observed turns, plus the left-hand side of the distribution of predictions from the spreads equation (s_1), as dealers made a market and reported a turn for securities that could be traded at low spreads. In Fig. 8 we can see that the empirical distribution of the turn over mid-price (ToM) resembles the valuation regime, with some added density reflecting the presence of true spreads mixed with valuations.

Overall, we conclude that simple fixed-effect estimators outperform the alternatives based on out of sample performance, that the model's estimates for the selection equation are similar to those from a probit ran on the fully-observed subsample, and that the distribution of outcomes generated by the model matches the distribution of the observed data. Having established this, we now consider the implications of our estimates for 19th-century asset pricing.

6. Discussion: liquidity bifurcation on the LSE

Our estimates of the relationship between LSE market-making activity and spreads reveal very strong negative selection. This selection happens along the observable characteristics of securities–dealers picked securities with characteristics that predicted thinner spreads– and also along the unobservable characteristics of securities–dealers were more likely to make a market in a security when the spread had a large negative residual.

We estimated a model in which log-spreads and an index of dealer support are drawn from a jointly normal distribution, for which we have estimated the conditional mean and the covariance. We can therefore sample from this jointly normal distribution for the population of securities, and plot the draws to visualize the relationship between dealer support and the predicted spread.

In Fig. 9 we draw from the joint posterior of the model and plot the spreads as a percentage of the mid-price against the probabilities of dealer support. We average these estimates by quartiles of the probability of dealer support to produce a binscatter. There is a very marked pattern: the combination of observed and unobserved security characteristics led dealers to strongly favor making markets in securities that charged a low turn. Securities with less than 25% chance of dealer support have average predicted turns of around 50%, whereas securities in the upper quartile of dealer support have predicted average spreads of around 2%. Even

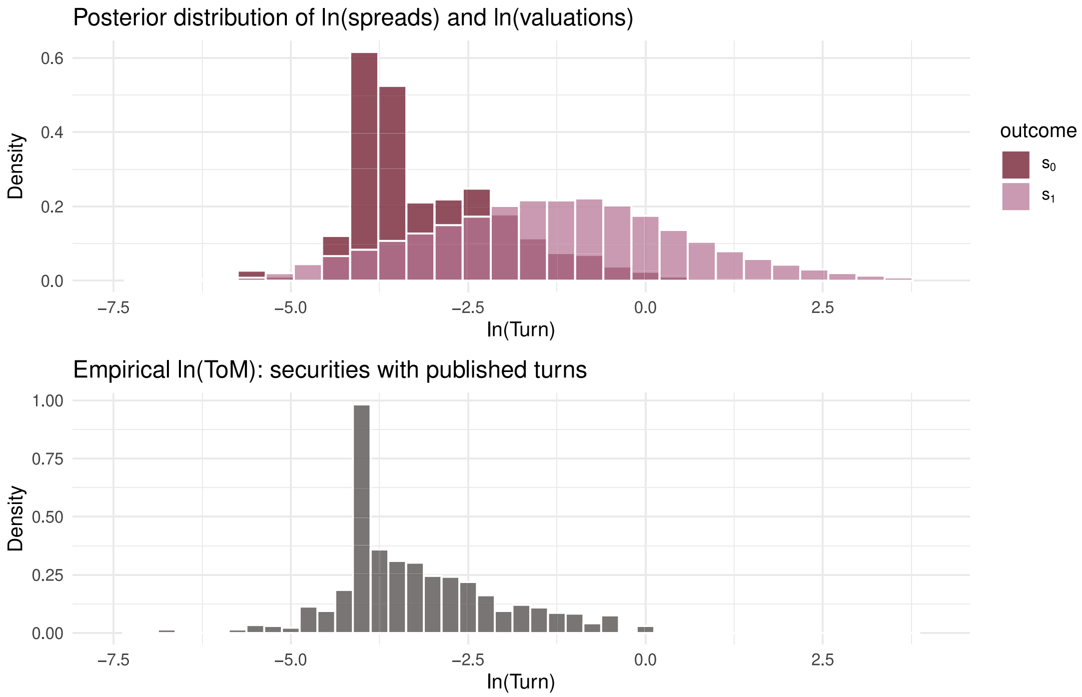

Fig. 8. Comparing predictive and observed outcome distributions.
Notes: Histograms in the top panel show the distribution of predicted log spreads (s_1) and log valuations (s_0) from equations 1 and 0 for all securities. This includes predictions for securities that report neither a spread nor a valuation. The bottom panel shows the empirical distribution of the log turn over the mid-price.

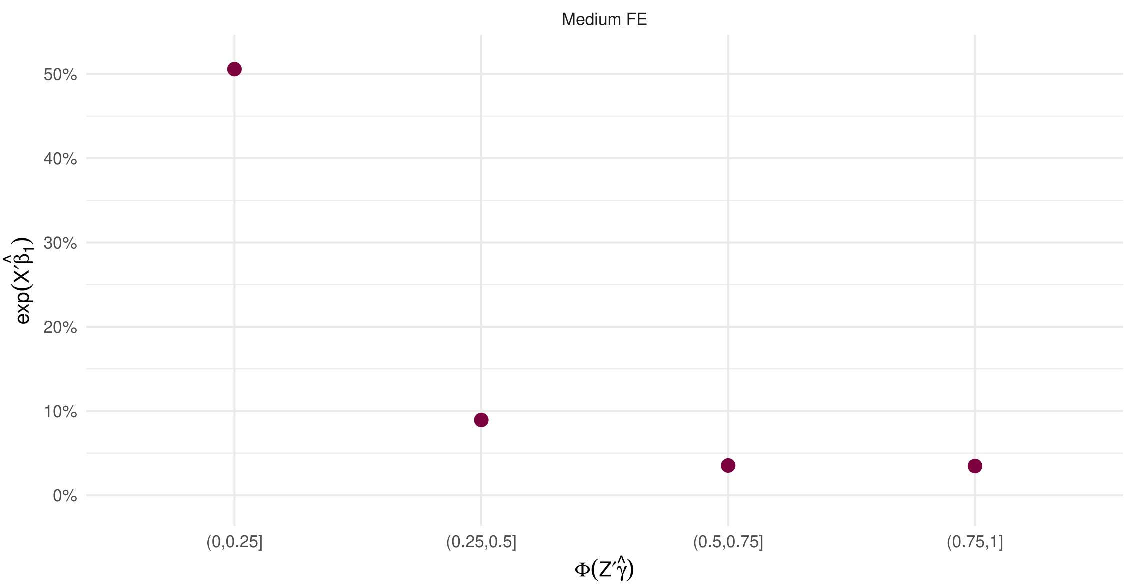

Fig. 9. Predicted Bid–Ask Spreads vs. probability of dealer support.
Notes: the plot shows the average spread, expressed as a percentage of the mid-price, against the probability of dealer support. All estimates come from posterior draws from the estimated model.

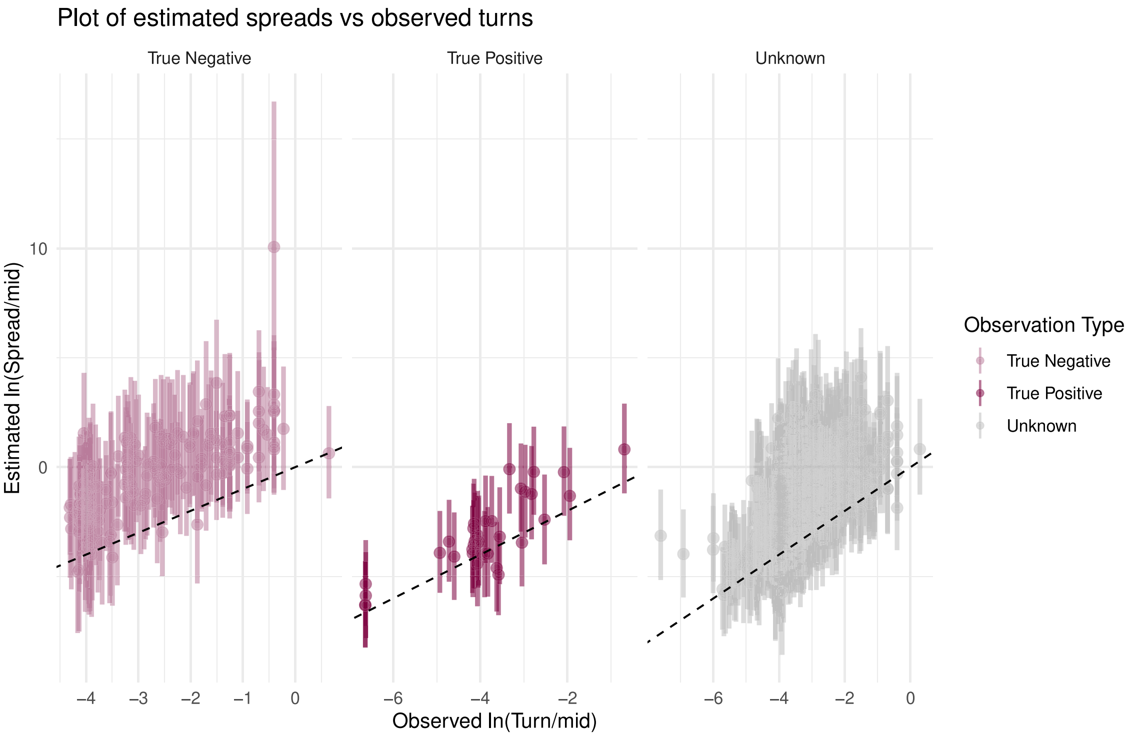

Fig. 10. Predicted Bid–Ask Spreads vs. Closing Quotations.
Notes: Posterior distributions of log spreads fitted from $X_{1i}\hat{\beta}_1$ are shown with associated 95% credible intervals against the log turns computed from the Closing Quotations printed in the LSE's official *List*. True positives (negatives) are securities we know (not) to be dealer supported. Unknown are securities with some probability of being dealer supported (see Fig. 5).

though 50% spreads appear extreme, of the printed turns in October 1877, c. 4% (41) had turns of over 50%.[26] Moreover, negative selection implies that dealers avoided making a market in securities with very large estimated transaction costs. Many of these did not have reported turns in the LSE's official *List* or if they did were treated as mere valuations, not actual bid–asks.

Our finding that selection was strongly *negative* is consistent with two mechanisms. The first is adverse selection. A simple way to think about this mechanism is to imagine that the unobservable error in the selection equation reflects the 'level of informed trading.' When this latent 'toxic flow' variable was large, dealers (who observed adverse selection through their profits and losses) avoided making markets in these names. As Giffen perceptively commented "A dealer in a small stock can never be quite sure against being cornered" (Giffen, 1877, 90).

An alternative mechanism would arise if the unobservables in the selection equation contained a latent variable for the time until the next transaction. If the time between transactions is large, dealers would be forced to hold and finance imbalanced (net-negative or net-positive) positions in a given security. Thus the costs associated with market-making in this security would be higher, as well as the corresponding break-even spread. In this case, the returns from making a market might not be high enough for any dealer to enter and offer immediacy. Our results show that the strongest predictor of both dealer support and a small spread was the size of the authorized issue. Large issues implied more holders which meant a higher turnover, other things equal. Giffen again observed that "the most valuable additional quality fitting an article for a good market…appears to be mass" (Giffen, 1877, 89). As a result, observed spreads would come from the group of securities with higher latent order flow.

Our selection models enable us to estimate counterfactual spreads. The parameters in the spread equation, once corrected for selection, can be used to predict the spread for any security (not only securities that were actually supported by dealers). We show these counterfactual spreads in Fig. 10. In the Figure, we ordered securities by their estimated probability of dealer support within three groups: securities we know were not dealer-supported (true negatives), those that were dealer-supported (true positives) and the remainder (unknown). We then plot their estimated spreads and the associated 95% credible intervals against their printed turns. The Figure shows graphically the intuition of our results: the majority of the reported turns (73%) were *narrower* than what the true spreads would be if dealers made a market in every security. The only exception are the true positives where the estimated spreads overlap with the 45 degree line.

[26] Among the 41, 35 were equities and 25 foreign securities.

Table 5
Total returns vs. transactions costs.

Security class	Total returns			Bid–ask spreads
	1877	1878	1877–78	
US corporate bonds	8.95%	15.10%	11.98%	6.31%
Foreign gov't bonds	2.11%	16.27%	8.96%	10.10%
Colonial gov't bonds	4.25%	2.21%	3.22%	5.60%
British gov't bonds	3.73%	2.89%	3.31%	2.82%

Notes: Total returns from Chabot and Kurz (2010); the figures for 1877–78 are two-years geometric averages. Average bid–ask spreads predicted from our model by security class.

The fact that real spreads would generally be larger than the width of the Closing Quotations means that these quotations paint an unrepresentative picture of the cost of immediate execution on the 19th century LSE. Our model's separation of actual spreads from valuations has also some interesting insights for stylized facts about 19th century investor behavior. The return on a security needs to compensate investors for the costs of transacting in it—transaction costs must be subtracted from nominal returns. Our finding of varied transaction costs across security types, and varied underlying market-mechanisms across security types, therefore has implications for attempts to understand comparative rates of return. For instance, in our estimates, domestic securities have substantially smaller spreads: at the median, log spreads were 0.7 smaller than for foreign securities. Economic historians have long debated the reasons for the concentration of the British portfolio in foreign holdings. Edelstein (2004) found that risk-adjusted returns on foreign securities were higher than on domestic assets. Others have shown that foreign securities extended the investment space for domestic investors and added value through diversification (Goetzmann and Ukhov, 2006; Chabot and Kurz, 2010). Our results add a further dimension to the comparison: domestic securities had lower transaction costs, which implies that the seemingly higher foreign rates of return are in fact over-estimated, as they fail to account for the greater expense of trading in foreign securities.

Table 5 contains a back-of-the-envelope comparison between the total returns of four security classes and their bid–ask spreads, as predicted by our model. This means we only consider the top n securities in terms of the probability of dealer support, where n is the number of marketable securities reported by Branch (see Fig. 1).[27] By doing so, we predict spreads for the securities the model estimates to have been actually dealt in. We do not include non marketable securities, as these were traded through an agency model with transaction costs we do not observe.

The exercise is only suggestive because we were only able to match four classes of fixed income securities to available data on total returns compiled by Chabot and Kurz (2010).[28] Another limitation comes from the fact that our model predicts spreads for October 1877 and we cannot ascertain whether the same microstructure carried through in later periods. Natural market volatility adds another complication. The 1876 crisis depressed returns for foreign securities. For this reason, we chose to compute annual returns in 1877 and also 1878, when most securities had rebounded from their previous trough.

Spreads appear to cancel a large share of higher returns of foreign securities relative to the base category of British government bonds. If we take the geometric average of returns in 1877–78, the cost of a single round-trip strategy in US corporate bonds would absorb 40% of the extra return relative to UK government securities. The fairly large return premium of foreign government bonds over British funds was also erased by higher transactions costs, although this may be swayed by the fallout of the 1876 crisis on the sovereign debt market in London. In any case, the size of the implied transaction costs would have dissuaded all but informed insiders from playing with the volatility of these securities. For normal investors, short-term investment strategies would not have been profitable. Colonial bonds provided no gain in return, which probably makes sense given their dependent status. However, the costs of transacting in colonial bonds were much higher than in the bonds of the colonial power—if you wanted to do so rapidly. As others have found, colonial government bonds were safe but fairly illiquid securities (Chavaz and Flandreau, 2017). Some of these differences in liquidity were due to intrinsic characteristics of the securities. But our model shows that the microstructure at the LSE reinforced these differences by creating the conditions for liquidity bifurcation. Overall, these results underline the difficulty of computing comparative rates of return over short or medium horizons when the underlying market microstructure generated such large differences in transaction costs.

A final instructive comparison is to benchmark the London turns and spreads against the bid–ask spreads in New York. The NYSE operated under a call auction mechanism, effectively a limit-order book. Unlike the LSE, this microstructure did not dissuade dealers-brokers from revealing their true bid–ask spreads, which were widely accessible in print (Davis and Neal, 1998). According to the historical evidence and our estimates, the width of the London Closing Quotations should be thinner than the true spreads. To test this prediction, we focus on US railway bonds, which were often cross-listed in London. All securities in the 'American dollar bonds' sub-market of the LSE were US railways. We therefore compare the distribution of printed turns in this sub-market against the bid–ask spreads reported for 'Miscellaneous railroad bonds' at the NYSE on October 19th 1877 and printed in the *Commercial and Financial Chronicle*. We compare NYSE spreads with two London quantities: the model estimates of counterfactual spreads and the printed turns for the 24 securities that the model predicts to be valuations.[29]

[27] For instance, we take the 12 colonial bonds with the highest likelihood of being dealer supported.

[28] The authors compute total returns for individual securities in the standard way: "Gross holding-period returns are calculated for two consecutive non-missing time periods by equally weighting the bid and ask prices at each point in time, adding any paid dividends… correcting for capital calls and stock splits" (Chabot and Kurz, 2010, 1061). They then aggregate them aggregate by security class.

Table 6
Comparison between London turns and NYSE spreads for US railway bonds.

Exchange	Min	30th percentile	Median	80th percentile	Max	N
London Est. Spreads	0.9%	4.7%	7.2%	14.9%	48.8%	36
London Valuations	0.9%	2.2%	2.7%	7.9%	28.6%	24
New York	0.3%	3.1%	7.4%	22.2%	75.0%	79

Notes: For the NYSE we report spreads over mid-price of miscellaneous railroad bonds collected from the *Commercial and Financial Chronicle* October 20th, 1877. For the LSE sub-market 'American dollar bonds' we report the model predicted spreads and valuations over mid price.

Table 6 lists the min, max, and three percentiles of the distributions of observed NYSE spreads and the spreads and valuations in London. The evidence in the table confirms the pattern we have already found: the New York spreads have a long right-tail with the largest spread reaching 75%. This is closely mirrored by the pattern of the predicted London spreads, which also rise steeply and match the US spreads accurately at the median, and become very large at the right tail. London spreads undershoot at the 80th percentile and above as the larger US sample includes a few very large spreads. This might be a consequence of the NYSE requiring daily settlement, which heightened counter-party risk (Gibson, 1889). In contrast, the London valuations are far too small and in this respect do not look like real spreads.

A broader interpretive point, highlighted by our findings, is that for most securities immediate execution was not obtainable at any price. Securities for which immediacy was not provided by dealers had to be traded via an agency model where dealers directly matched buyers and sellers. Saar et al. (2023) theorized that this shift away from market making has ambiguous effects on investor welfare, depending on the relative costs of market making (spreads) and matchmaking (fees) and on the investors' characteristics. In the 19th century, brokers complained of the unfair competition from dealers who acted as "brokers between brokers" while charging fees that were higher than the brokerage commission (RC, 1878a, 178).

The fact that it was difficult or costly to unwind positions in certain securities probably led to an endogeneous reaction by investors. Those with low liquidity preference would have concentrated their positions in otherwise less liquid investments, such as colonial bonds. This practice would reduce the implied cost of illiquidity to these investors, but would also reinforce the liquidity pooling we have identified. If such assets attracted mostly investors not interested in trading, dealers would have less of an incentive to provide liquidity in these asset classes, thus compounding the bifurcation outcome we identified.

This liquidity bifurcation also offers a new perspective on stylized facts about 19th century investment. The ubiquity of a buy-and-hold investment strategy and the preference for high dividend payouts over cumulated capital gains (Campbell and Turner, 2011) may reflect market microstructure as much as weak corporate governance (Guinnane et al., 2017). In their study of dividend-policy on the LSE Turner et al. (2013) hypothesized that share-buybacks were disfavored in the 19th century due to liquidity problems, and our findings support this interpretation.

7. Conclusion

In this paper we use historical evidence from the LSE to study the provision of market liquidity in a large and diversified stock market. Our findings broadly underline the difficulty in building functional securities markets in a context with large informational risks. The very *laissez faire* regulation of 19th century securities markets, and the general adherence to the principle of *caveat emptor* when it came to financial assets, made it difficult for dealers to make markets.

With respect to the specific LSE microstructure, we shed light on the internal mechanisms of information production at the LSE and how to interpret the printed Closing Quotations. We show that in most cases they were, at best, an optimistic proxy for liquidity. This then points toward the difficulty in interpreting returns across security types, as the true return to the investor net of transaction costs is unknown. These issues are under-explored in the historical literature and this paper stresses how neglecting this area of research can limit our understanding of financial markets in the 19th century.

Our results speak equally to the microstructure literature and the current debate about the consequences of liquidity bifurcation. The historical setting and our empirical design offer a cleaner setting than contemporary data to test the drivers of liquidity provision by market makers (Adrian et al., 2017). The evidence from contemporary markets is plagued by issues of mixed trading mechanisms, high entry costs and non-observability of the endogenous reactions of intermediaries to liquidity conditions. The LSE in the 19th century was a pure dealers market, with next-to-no barriers to entry, and the historical evidence we gathered exceptionally identifies the securities supported by market makers.

We show that professional dealers shifted their activity towards securities that appear from both their observable and unobservable characteristics to have been the most liquid and easiest to trade. These findings add force to research suggesting that liquidity can bifurcate between high-liquidity and no-liquidity equilibria. Our finding that dealers avoided securities with abnormally large spreads is consistent with theoretical models of information risks. In particular, it is consistent with the predictions of Glosten and Milgrom (1985) that dealers will not make a market when adverse selection is too intensive. It is also consistent with an explanation along the lines of Grossman and Miller (1988) in which inventory holding costs interact with order flow to make entry unprofitable.

[29] I.e. to be consistent with Branch's classification, we take the printed turns of the 24 American dollar bonds with the lowest probability of being dealt, as predicted by the selection part of the model. We estimate spreads for 36 out of the 44 securities in this group because of missing covariate information for 8 securities.

CRediT authorship contribution statement

Rui Esteves: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Gabriel Geisler Mesevage:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Supplementary material

Supplementary material covering historical background, estimation methods, and robustness checks can be found online at https://doi.org/10.1016/j.eeh.2025.101736.

Data availability

We have deposited the data with ICPSR.

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