

Optimal delay: distressed trading in 18th c. Amsterdam

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Abstract

Distressed sales (or purchases) often lead to a V-shaped pattern in asset prices. We investigate the underlying dynamics of this overshooting of the price in a unique historical setting. We present detailed transaction data for two cases of distressed trading in the Amsterdam stock market in 1772 and 1773. We show that there is an interesting disconnect between the realization of the shock and price overshooting on the one hand, and the actual distressed trading on the other. A large fraction of trades were delayed until the overshooting of the price had been corrected. Using qualitative sources we document significant *contemporary* uncertainty about the size of the shock. We argue that a model based on this uncertainty could potentially explain the disconnect between price overshooting and the timing of transactions.

1 Introduction

A V-shaped pattern in asset prices – and in particular, sharp price changes followed by gradual reversals – are common across a range of assets (Duffie 2010). A growing literature emphasizes limits to arbitrage as an explanation. For example, liquidity providers may need to be compensated for holding larger-than-average positions (Grossman and Miller 1988; Nagel 2011). As they slowly offload their positions, the initial price change will be reversed. Additional approaches in the same vein emphasize under-provision of risk capital due to frictions in financial intermediation (Shleifer and Vishny 1997; Gromb and Vayanos 2002; Brunnermeier and Pedersen 2008, He and Krishnamurthy 2010), inattention (Reis 2006; Duffie 2010), search frictions (Duffie, Garleanu and Pedersen 2005; Weill 2007), and the market power of participants (Brunnermeier and Pedersen 2005). Because detailed transaction data are often lacking, there is no consensus on which interpretation has more explanatory power in practice.

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In this chapter, we analyse two periods of price overshooting on the Amsterdam stock market in 1772 and 1773. In both cases, news reached the market that a big market participant had to close his position as a result of major losses. We examine the price path of the stock and document significant overshooting in the short term, similar to the pattern observed in modern-day data, and an eventual reversal. Because we have access to the actual trading position of the stricken investors, we can show that these short-term reversals occurred with very little distressed sales actually taking place. This suggests that a V-shaped price path can be observed without additional risk capital actually being used up.

We use a theoretical model related to Vayanos (1999; 2001) to explain these facts. The size of the distressed agent's shock is unknown to the rest of the market. We assume that this shock is big enough to move prices at a horizon that liquidity providers care about.¹ Liquidity providers are risk averse and will demand an additional premium to be compensated for this risk, which comes on top of the usual fundamental risk. The distressed party does not face this source of uncertainty and this implies a friction in the degree of risk sharing that he and the liquidity providers are willing to engage in. Effectively, the distressed trader faces an additional premium to gain access to risk sharing. As a result, he may choose to transact very little. In the mean time, the equilibrium price will adjust to reflect the arrival of the shock to the market. As time progresses and more information about the size of the shock is revealed, this source of uncertainty disappears and prices rebound.

In both episodes we discuss the centre stage is taken by the British stocks that were traded in both London and Amsterdam and which are discussed in the first two chapters of this thesis. The first episode we study takes place in June 1772. On June 9, London financier Alexander Fordyce defaults on his debtors. At "the time of his misfortunes" he has a large short position outstanding in the Amsterdam futures market in British East India Company (EIC) and Bank of England (BoE) stock. These short positions are managed by the Dutch bank Hope & Co. Because of the bankruptcy laws of the time, Hope has a clear incentive to cancel the short positions as quickly as possible. Any losses will be on account of Hope; any profits will have to be shared with the other creditors. Effectively this leaves Hope with the downside risks. After June 12, when the news of Fordyce's default reaches Amsterdam, we document a significant overshooting of the Amsterdam price of EIC and BoE stock as compared to stock prices in London. Mispricing lasts up to four weeks. Surprisingly, Hope hardly transacts during this period of mispricing. Instead the bank waits for Amsterdam prices to be restored to equilibrium before it offloads its position.

The second episode we study takes place immediately after Christmas 1772. A consortium of Dutch bankers, led by the brothers Van Seppenwolde, has been bulling EIC and BoE stock in Amsterdam for months. Their long position is

¹In the long run it is usually assumed that the demand curve for stocks is horizontal (Scholes 1972). In the medium run, however, the demand curve for stocks could be downward sloping. See the seminal contributions of Shleifer (1986), Harris and Gurel (1986) and related literature.

largely financed through repo transactions, i.e. they borrow large sums of money to invest in EIC stock, which they then use to collateralize the loans. When the price of EIC and BoE stock falls dramatically during the last months of 1772, the consortium is unable to meet lenders' margin calls and is forced to default. The collateralized EIC and BoE stock now becomes the property of the lenders, who again have a clear incentive to get rid of this position as quickly as possible. Any profits on the stock will go to the defaulters' estate; any losses are for their own account. Again we report serious mispricing. For several weeks Dutch EIC and BoE prices fall significantly below prices in London. At the same time repo haircuts on new contracts increase from about 20 to 30%. However, very little actual transactions take place. Most sales are delayed by weeks, sometimes even months.

This chapter is related to a growing literature on V-shaped patterns in asset prices (see Duffie 2010 for a recent overview), which was initiated by Scholes (1972). Most relevant for this chapter are papers discussing fire sales (see Shleifer and Vishny 2010 for a recent overview). Coval and Stafford (2007) look at fire sales of mutual funds and they study the impact on the prices of those assets that are held commonly by distressed mutual funds. Mitchell, Pedersen and Pulvino (2007) study three cases, merger arbitrage in 1987, the LTCM crisis in 1998 and the convertible bond market in 2005. In all three cases they identify distress selling and find a significant impact on stock prices. Other relevant studies dealing with non-financial assets include Pulvino (1998; airplanes) and Campbell, Giglio, and Pathak (2010; real estate).

More generally this chapter is related to papers studying the price impact of index rebalancing (e.g. Shleifer 1986; Harris and Gurel 1986; Kaul, Mehrotra and Morck 2000; Madhavan 2001; Wurgler and Zhuravskaya 2002; Blume and Edelen 2003; Chen, Noranha and Singal 2004, Greenwood 2005; Hrazdil 2009), block trades (Scholes 1972; Holthausen, Leftwich and Mayers 1990), change in ratings (Chen, Lookman, Schürhoff and Seppi 2010; Feldhütter 2010), merger announcements (Mitchell, Pulvino and Stafford 2004), debt issuance (Newman and Rierson 2004), and the predictable rolling over of future positions (Mou 2011). There is also a burgeoning literature on the impact of market maker inventories on V-shaped stock returns (Hendershott and Seaholes 2008; Andrade, Chang and Seaholes 2008; Hendershott and Menkveld; Rinne and Suominen 2010; Nagel 2011).

Finally this chapter has a number of parallels with the recent financial crisis. Mitchell and Pulvino (2011) look at the default of prime brokers on Wall Street and document significant subsequent mispricing. The impact of financial turmoil on repo haircuts has been documented by Gorton and Metrick (2010a, 2010b) and Krishnamurty (2010). Garleanu and Pedersen (2011) provide evidence on the impact of haircuts on mispricing.

Relative to this literature our contribution is twofold. First of all, we provide uniquely detailed information about two important episodes of financial distress. Most importantly, we have detailed information about the trading behaviour of the distressed parties and we can almost perfectly reconstruct how they settled their positions. Secondly, we provide evidence for a novel empirical finding,

namely that mispricing and distressed selling (buying) do not have to coincide in time.

The rest of this chapter is organized as follows. Section 2 provides more details about the two historical cases. In section 3 we provide evidence for significant mispricing right after the two events took place. In section 4, we document when exactly the distressed trading took place and we show that there is a disconnect between mispricing and actual transactions. In section 5 we first use historical sources to document the existing uncertainty about the size of the distressed agents' positions. We then present a simple model that uses this feature to explain the apparent inconsistency between the timing of mispricing and actual transactions. Section 6 concludes.

2 Two historical cases

2.1 Alexander Fordyce and Hope & Co.

The first historical case we discuss takes place in June 1772 and is focused around British investors Alexander Fordyce and Dutch banker Hope & Co. Fordyce was a notorious speculator. Of humble Scottish origin he had made a fortune speculating in EIC stock in 1766 (Stock Account Fordyce, SAA 735, 1510). Hungry for more, he kept speculating and in 1772 he decided to bet heavily against the EIC share price. This went awfully awry and Fordyce failed in June 1772 (Wilson 1939, p. 120-1). On June 9 he fled London to escape his creditors, the news of which must have arrived in Amsterdam on June 12, where investors responded with anguish at the news (Leydse Courant, June 17, 1772).

At the time of his bankruptcy, Fordyce had a short position in EIC stock in the Amsterdam market with a size of £ 57,000 nominal.² In addition, Fordyce held a short position in BoE stock of £ 22,000 nominal.³ These positions had been taken in the futures market and had been intermediated by the Anglo-Dutch banking house of Hope & Co. The short positions were to expire on August 15, 1772 (SAA, 735, 1510).

When Fordyce defaulted, Hope was stuck with considerable positions in EIC and BoE stock. At the time of default it was not clear to what extent any claims against Fordyce's estate could be recovered. Fordyce's flight probably suggested that his estate was in a very poor condition. This implied that Hope alone would be fully responsible for the losses that could be incurred on the position in the EIC stock. If, on the other hand, this position would turn out to be profitable, Hope would have to share the proceeds with all other claimants. This gave Hope a clear incentive to get rid of the short position as quickly as possible.⁴

²The total outstanding EIC stock amounted to £ 3,200,000 nominal. The average amount of stock that was transferred in the Company's transfer books in the month of June during the five preceding years amounted to £ 206,048, Bowen (2007).

³The total outstanding capital stock of the Bank of England amounted to £ 10,780,000, Andreades (1909 [1966]), p. 151.

⁴The London correspondent of Hope & Co argued that "it was not prudent to continue the risque of the stock rising by which a considerable loss might have happened which Mess Hopes

According to Hope, the market was aware of the fact that Fordyce had maintained a significant short position through Hope & Co. The market also realized that Hope would try to get rid of the position as quickly as possible. As a result the EIC stock price would rise, making the liquidation of the position very costly. In a letter to Fordyce dated October, 16, 1772 Hope wrote that:

“At the time of your misfortunes India was at 228 and upwards. The general knowledge of our having been sellers to [for] you [...] raised the expectation of a very important rise, on the supposition that we should immediately buy it in again” (SAA, 735, 1510).

It seems that the general public indeed knew that Fordyce had a significant short position in EIC stock. Right after Fordyce’s default, on June 13, 1772 the English newspaper the *Middlesex Journal* mentioned that

“It is said that the banker, who absented [Alexander Fordyce], had a difference of 10% to pay on a million and a half of India stocks, of which he had been a bear for many months past.”

In addition, the market, especially in Amsterdam, seems to have been fully aware of the implications of Fordyce’s default on the stock price. When Fordyce’s short position was closed, prices would probably have to rise. The London newspaper the *Public Advertiser*, published the following letter from Amsterdam on June 24th, 1772

“Sir,
There is a vulgar proverb which says that it is a bad wind which blows nobody good. The misfortune or misconduct of Mr. Fordyce, call it which you will, must be attended with this advantage to the real proprietors of East-India stock. The value of their property will now be ascertained, for it is known here, that by weight of metal this gentleman caused that stock to rise and fall at pleasure. Our opinion here is that you must shortly see it at 250.”
“H-S”, Amsterdam June 19, 1772.⁵

A few days later on June 27, 1772, the *Middlesex Journal* published an extract from another letter from Amsterdam dated June 23, which mentioned that stock prices in Amsterdam were higher than those in London. According to the author this showed that

standing the middle men between buyer and seller must have paid out of their pocket and could only have received back a dividend from Fordyces Estate”. In later court proceedings dealing with Fordyce’ default, it was acknowledged that “it cannot be reasonably contended that Mess Hopes were bound [...] to continue the engagement at their own risque to the rescontre [settlement date] in August” (Court Proceedings Fordyce’s Default, SAA 735, 1510).

⁵It is possible that this letter was sent to influence stock prices in London. It was signed by “H-S”, which probably stands for Hermanus van Seppenwolde, an Amsterdam financier who was part of a consortium of bankers that were trying to “pump and dump” the EIC stock in Amsterdam (see later in this section).

“we are not sorry that some rotten sheep in your pastures have been forced to fly away, and no longer infect the sound stock.”

In the next section we provide further evidence about price patterns.

2.2 Clifford and Sons and brothers Van Seppenwolde.

The second historical case we discuss takes place in January 1773. During 1772 a consortium of Dutch bankers speculated heavily on a rise in the EIC stock price. According to a contemporary Hermanus and Johannes van Seppenwolde, George Clifford and Sons and Abraham ter Borch and Sons formed a “cabale” or conspiracy to “take the entire EIC stock on their horns” or in other words to bull the market for EIC stock.⁶ Apart from EIC stock, the consortium also invested heavily in BoE stock (SAA, 5075, 10,593 – 10,613). The attempt to pump and dump the English stocks failed miserably. EIC stock prices, and to a smaller extent BoE stock prices, kept falling during the second half of 1772 and the Dutch consortium suffered considerable losses. In the end this led to the default of all three houses. Even Clifford and Sons, one of the most famous, largest and oldest bankers in Amsterdam, had to permanently shut its doors on January 1, 1773 (SAA, Stukken betreffende de Boedel van Clifford en Zonen, f. 1).

The long positions of the three houses were predominantly in the form of so-called “beleeningen”; securitized loans or more specifically repos.⁷ Especially the brothers Van Seppenwolde and Clifford & Chevalier, a subsidiary of Clifford and Sons, bought large amounts of EIC and BoE shares on credit. The purchased shares were then used to collateralize the loans. Shares were transferred to the account of the lender for the duration of the contract, usually 6 or 12 months (SAA, 5075, 10,593 – 10,613).

The loan amounted to less than the full value of the shares. A “surplus”, a margin or haircut, was maintained to protect the lender from a possible default. It was agreed that if the price fell below a critical threshold, the borrower had to transfer cash to pay back some of the loan or had to provide additional stock to increase the collateral. Note that the loan did not go under water when the stock price fell below this critical value. There was still a significant margin left at this critical price. With each price fall of 10% (of the nominal value of the underlying stock) additional margins were required (SAA, 5075, 10,593 – 10,613). When these margin calls could not be fulfilled, the contract gave the lender the unambiguous right to sell the collateral.

Clifford and Ter Borch actively supported the Van Seppenwoldes by lending money on security of these haircuts or margins. It is clear that these loans

⁶ “eenere Cabale, die de geheel Engelsche Oost op haare hoornen zou genomen hebben”, *De Koopman* 1772, pp 294-295. The Dutch saying “op de hoornen nemen” is derived from bulls who take dogs or people on their horns to throw them in the air, Ter Laan 2003, p. 148.

⁷ There is evidence that the consortium initially took their positions in the futures market. However, during the second half of 1772 they did not manage to continue their positions in the futures market (maybe due to an increase in counterparty risk) and they opted to continue through repo agreements (SAA, 5075, 10,593 – 10,613).

Table 1: Stock positions brothers Van Seppenwolde and Clifford and Chevalier around December 30, 1772 and subsequent margin calls

| | Stock position (PSt. nominal) | Margin calls (PSt. nominal) |
|---------------------------|--|--|
| East India Company | | |
| Hermanus van Seppenwolde | £ 87,000 | £ 55,500 |
| Johannes van Seppenwolde | £ 79,000 | £ 79,000 |
| Clifford and Chevalier | £ 44,500 | £ 33,000 |
| Total | £ 210,500 | £ 168,000 |
| Bank of England | | |
| Hermanus van Seppenwolde | £ 37,000 | £ 13,000 |
| Johannes van Seppenwolde | £ 17,000 | £ 0 |
| Clifford and Chevalier | – | – |
| Total | £ 54,000 | £ 13,000 |

Source: Notary Van den Brink, SAA 5075, 10,593 – 10,613

were effectively unsecured in case of a price fall and later court proceedings indicate that these agreements were quite irregular (NA, Staal van Piershil, 386, 396; OSA 3710; GAR, 90, 56). Effectively, Clifford, Ter Borch and the Van Seppenwoldes were in it together.

Table 1 shows the total nominal value of the stocks used in these repo transactions outstanding around December 30th, 1772 that were registered by one notary (Van den Brink). The table shows that the brothers Van Seppenwolde were heavily bulling the market for EIC and BoE stock.⁸ Clifford and Chevalier also held a considerable long position in EIC stock. These figures are from one notary only. Actual positions were likely to have been bigger, although a casual investigation of other notaries' archives suggest that the large majority of repos were registered through Van den Brink.

Most repo contracts stipulated that if the price fell below 200% additional collateral had to be posted. With every additional price fall of 10% margins were to be replenished. When, in the second half of 1772, the price of EIC fell below 200%, 190% and 180%, the consortium managed to fulfil these additional margin requirements, most of them were done in the form of posting additional stock as collateral (SAA, 5075, 10,593 – 10,613; NA, Staal van Piershil, 381; GAR, 90, 52).

New margins would be required if the EIC stock price fell below 170%. This happened during the end of November 1772. The consortium seems to have managed to postpone paying the margin calls. They were most likely helped by the fact that the EIC stock price did not fall any further and temporarily rose

⁸The total outstanding EIC stock amounted to £ 3,200,000 nominal, Bowen (2007). The total outstanding capital stock of the Bank of England amounted to £ 10,780,000, Andreades (1909 [1966], p. 151).

above 170% in the middle of December.

Between December 21 and December 27 there was a dominantly eastern wind on the North Sea and investors in Amsterdam did not receive any new information from London. In the mean time EIC prices in London had again fallen further to 168%. In addition, negative information about the state of the EIC was revealed (*Amsterdamsche Courant* December 29, 1772 and Harman to Hope, December 18, 1772, SAA 735, 115). When this news reached Amsterdam on December 28, the lenders of the securitized loans were not willing to wait any longer for the margin payments. From December 28 onwards a multitude of “insinuations” or official reminders were registered at the notary Van den Brink’s office urging the borrowers to pay up (Van Den Brink, 10,602, see also Wilson 1939). Table 1 gives an overview of all these official margin calls registered by notary Van den Brink.

The stock that was provided as collateral was already on the accounts of the lenders. By the rules of the repo contracts, when the margin calls could not be fulfilled, the economic property of the stock would also be transferred to the lenders. This meant that after December 28 the lenders were stuck with large amounts of stock that they did not have the intention of holding in the first place. The contracts gave them permission to sell the stock to avoid any future losses on their positions.

The contracts stipulated that the borrower would be responsible for any losses that the lender would incur. This implied that any benefits would also be for the account of the borrower (NA, Van Staal Piershil, 386; OSA 3710, 4583). In other words, lenders were only exposed to the downside. This gave the lenders an incentive to trade as quickly as possibly to get rid of this risk. This must have led to serious selling pressure on the Amsterdam exchange.⁹

These events were publicly known to the public in Amsterdam. Contributions in the Amsterdam periodical *De Koopman* indicate that the market was well aware that there was a large long position hanging above the market. This news was for example brought by *De Koopman* on December 29, 1772, only one day after the consortium finally failed to meet its obligations. Less than a week later, on January 3, 1773, *De Koopman* again had extensive coverage of the event.

3 Price patterns

What measurable impact did the two shocks have on the Amsterdam market? In this section we determine the impact on the EIC and BoE stock prices in Amsterdam. We use of a unique feature of the data. EIC and BoE shares were both traded in London and in Amsterdam (Van Dillen 1931; Neal 1990) and prices are available for both markets. In the first two chapters of this dissertation it is shown that, due to communication delays, the London and

⁹The average amount of stock that was transferred in the East India Company’s transfer books in the month of January during the five preceding years amounted to £ 174,815, Bowen (2007).

Amsterdam market were imperfectly integrated. This means that if we want to study the impact of certain events on stock prices in Amsterdam, we can use the London price as a counterfactual.¹⁰ Effectively we look at the difference between the stock price in Amsterdam and the stock price in London, as it was observed in Amsterdam. We will determine to what extent the two events in Amsterdam that we study led to a divergence of the Amsterdam and London stock price.

In the next section we study the trading behavior of the distressed agents in both events. Based on the archives of Hope & Co. we can largely reconstruct the way in which Hope settled the short position it inherited from Fordyce. In a similar way, we use notary records to determine how and when the stock position of Clifford and Sons and the brothers Van Seppenwolde was liquidated.

3.1 Main results

What was the impact of Fordyce' default on stock prices in Amsterdam? Figures 1 and 2 present the price series of EIC and BoE stock in Amsterdam and London around June 12, 1772. The Amsterdam price series are in real time, the London prices reported are those that were observed by the Amsterdam market on days the London news arrived.¹¹ Because Hope had to settle Fordyce's position in the futures market, we report futures prices.¹²

Figure 1 demonstrates that the EIC stock price rose significantly in both London and Amsterdam during the second half of May 1772. Fordyce's default can possibly be attributed to this price increase, which reduced the value of his short position. After Fordyce absconded on June 9 and this news reached Amsterdam on June 12, the Amsterdam EIC stock price was considerably higher than in London for the duration of three weeks. This is consistent with Hope's complaints that the EIC stock price in Amsterdam displayed overshooting after Fordyce's default. Only in the beginning of July did the two price series converge.

The pattern for the BoE stock price in figure 2 looks largely similar. After the news of Fordyce' default reached Amsterdam, the Amsterdam price for BoE stock was consistently above the London price for the duration of six weeks.

It is not unthinkable that these results are driven by broader underlying developments in Amsterdam or London. To check this alternative explanation we do the same analysis for the 3% Annuities, a widely traded British bond for which prices are widely available in both London and Amsterdam. The results in figure 3 indicate that Fordyce' default had no impact on price differences for the Annuities.

¹⁰For an earlier example of this approach see Klerman and Mahoney (2005).

¹¹To determine the London prices as they are observed in Amsterdam we use information on the sailing of packet boats that was used in chapters 1 and 2.

¹²For Amsterdam these come from the original sources (see chapter 1). For London we took the spot prices as they are reported by Neal (1990) and transformed them into futures prices using a cost-to-carry annual interest rates of 2.75% (Smith 1919). London prices are also adjusted for differences in ex-dividend dates.

Figure 1: EIC prices in Amsterdam and London around Fordyce' default

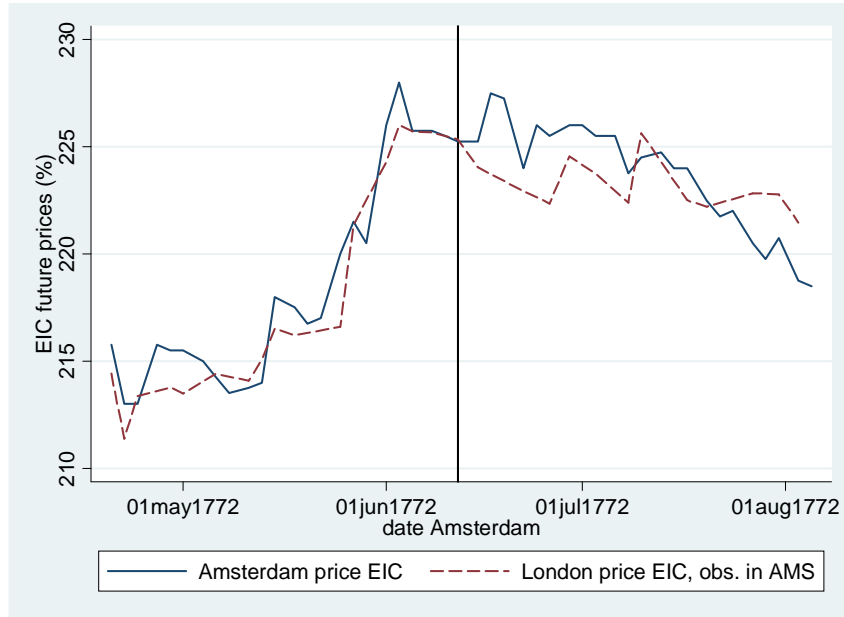


Figure 2: BoE prices in Amsterdam and London around Fordyce' default

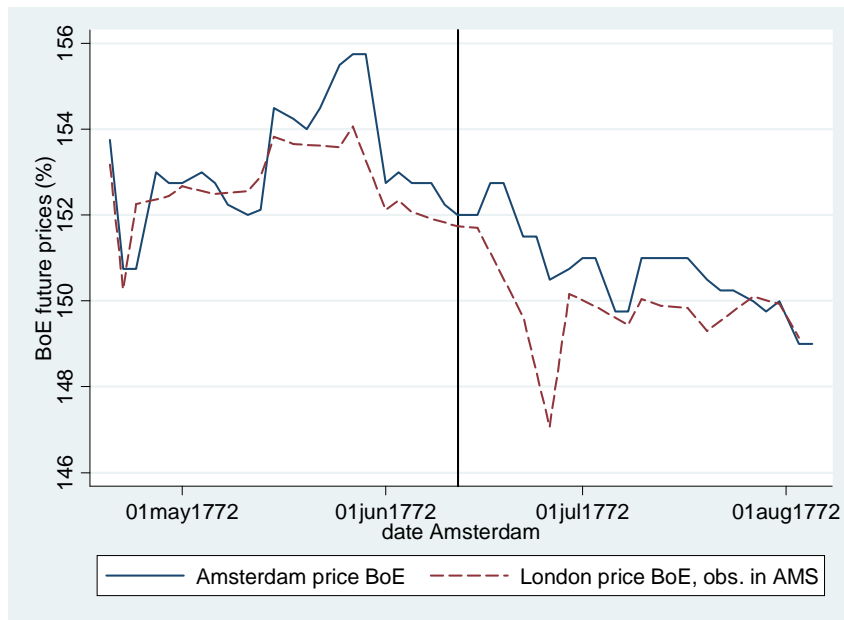
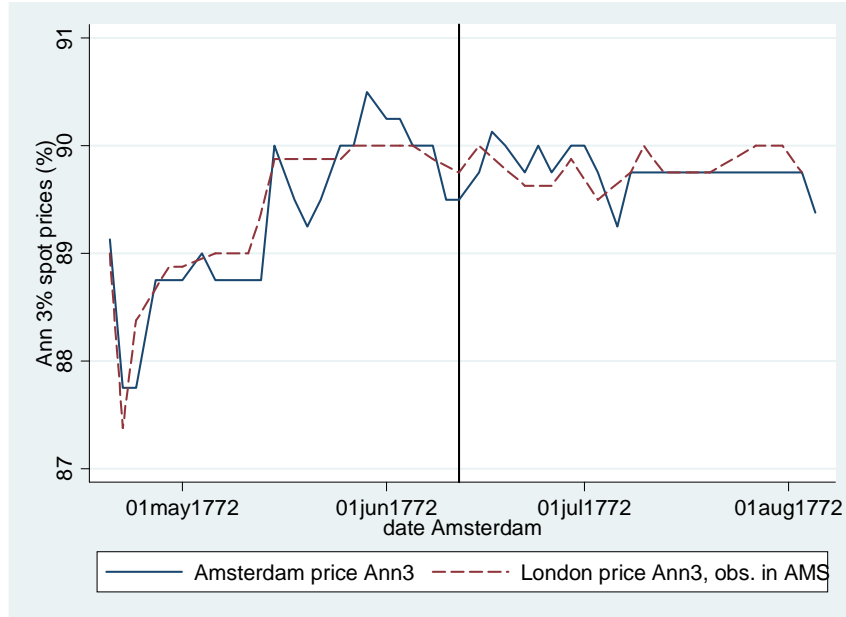


Figure 3: Ann 3% prices in Amsterdam and London around Fordyce' default



To what extent is the divergence of the EIC and BoE price series after Fordyce's default economically and statistically significant? To answer this question we accumulate the differences between the Amsterdam and London price series after Fordyce's default for a number of different periods (2, 4, 6 and 8 weeks). We then compare these Event Cumulative Differences (ECD) with the Sample Cumulative Differences (SCD). This is the average cumulative difference between EIC stock prices in Amsterdam and London calculated over periods of similar length between September 1771 and December 1777.¹³ We do this analysis for the EIC and BoE price series and the 3% Annuity price series. Results are presented in table 2.

The table shows that the cumulative differences between EIC and BoE stock prices in Amsterdam and London for periods of 2, 4 or 6 weeks were far above the average. Statistical significance is tested in two ways. First of all a standard t-test is performed, of which the p-values are reported. Secondly, following Barber, Lyon, Tsai (JF 1999), we calculate the empirical probability that the ECD is equal to the SCD. To do this we draw (with replacement) 1000 random periods from the period September 1771 and December 1777. Based on these 1000 draws we construct a distribution of cumulative differences and check at what percentile the value of the ECD is located. This gives us the empirical p-value.

The table shows that the ECD for EIC stock over 2 and 4 weeks is statistically

¹³The sample period is driven by data constraints.

Table 2: Cumulative differences in stock price AMS-LND. Fordyce (ECD) vs Full sample (SCD)

| Weeks after event | 2 | 4 | 6 | 8 |
|---------------------|-------|-------|-------|-------|
| EIC | | | | |
| ECD | 15.51 | 22.32 | 23.82 | 7.45 |
| average SCD | -0.76 | -1.56 | -2.28 | -3.12 |
| P-value (t-test) | 0.016 | 0.022 | 0.056 | 0.260 |
| P-value (empirical) | 0.018 | 0.019 | 0.063 | 0.230 |
| BoE | | | | |
| ECD | 9.79 | 13.62 | 20.25 | 19.31 |
| average SCD | -0.23 | -0.57 | -0.68 | -1.14 |
| P-value (t-test) | 0.016 | 0.041 | 0.031 | 0.089 |
| P-value (empirical) | 0.034 | 0.069 | 0.084 | 0.082 |
| Ann 3% | | | | |
| ECD | 0.52 | 0.53 | 0.53 | -0.60 |
| average SCD | -0.85 | -1.72 | -2.55 | -3.45 |
| P-value (t-test) | 0.217 | 0.240 | 0.224 | 0.257 |
| P-value (empirical) | 0.212 | 0.269 | 0.238 | 0.246 |

ECD stands for Event Cumulative Differences. These are the accumulated differences between the stock price series in Amsterdam and London (as observed in Amsterdam) for periods of 2, 4, 6 or 8 weeks. The SCD are the Sample Cumulative Differences which are calculated for similar of 2, 4, 6 or 8 weeks over the entire sample between September 1771 - December 1777.

P-values for the null hypothesis that the ECD equals the SCD are calculated in two different ways. First of all, a standard t-test is performed. Secondly, a empirical p-value is calculated following Barber, Lyon and Tsai (1999). We draw (with replacement) 1000 random periods of the length of 2, 4, 6 or 8 weeks between September 1771 and December 1777. Based on these 1000 random periods we construct a distribution of Cumulative Differences and check at what percentile the ECD is. This gives us the empirical p-value.

Figure 4: EIC prices in Amsterdam around Clifford et al.'s default



significant at the 5% level. The EIC ECD is significant at the 10% level for a period of 6 weeks. Results for BoE stock differ according to which distribution is used. Using the t-distribution, the ECD is significant at the 5% level up to a horizon of 6 weeks. Using the empirical distribution, the ECD is only significant at the 5% level for a period of 2 weeks. For periods of 4 and 6 weeks we detect statistical significance at the 10% level. For the 3% Annuities cumulative differences are not significant at any horizon.

Figures 4 and 5 present the developments of EIC and BoE stock prices in Amsterdam and London around December 28, 1772. The lenders to Van Sepenwolde et al. had to liquidate the collateral in the spot market. We therefore report spot prices.¹⁴ The figure shows that after the defaults Amsterdam prices of both EIC and BoE stock fell considerably under those in London. This situation continued for three weeks for both stocks. As in the Fordyce case, prices in Amsterdam deviated considerably from those in London. Looking at price differences for the 3% Annuities in figure 6 we also observe some divergence between Amsterdam and London. However the resulting price difference is quite small.

Table 3 tests whether the cumulative differences between Amsterdam and London prices are statistically significant. The procedure is the same as in table

¹⁴London spot prices come directly from the original sources (Neal 1990), Amsterdam spot prices are calculated from future prices using a cost-to-carry interest rates of 2.75% (Smith 1919).

Figure 5: BoE prices in Amsterdam around Clifford et al.'s default

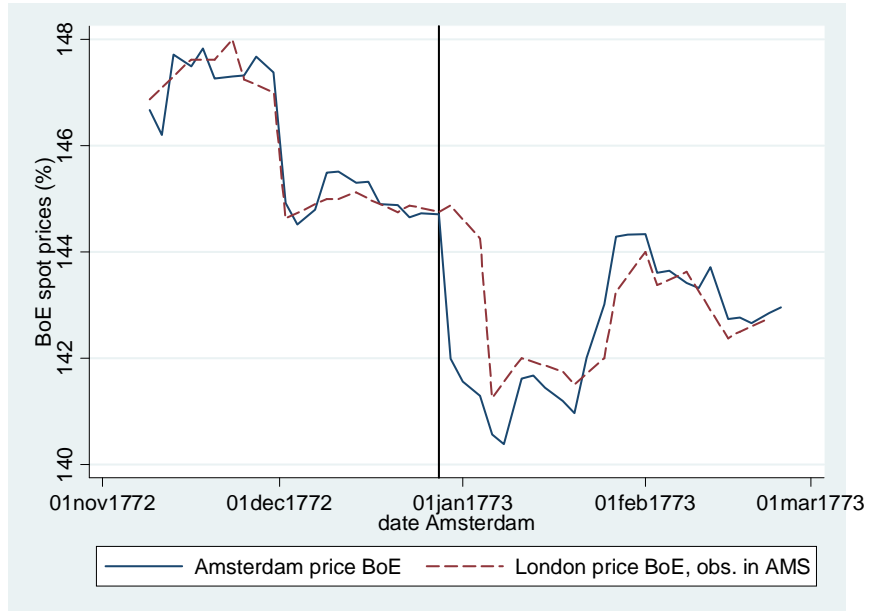
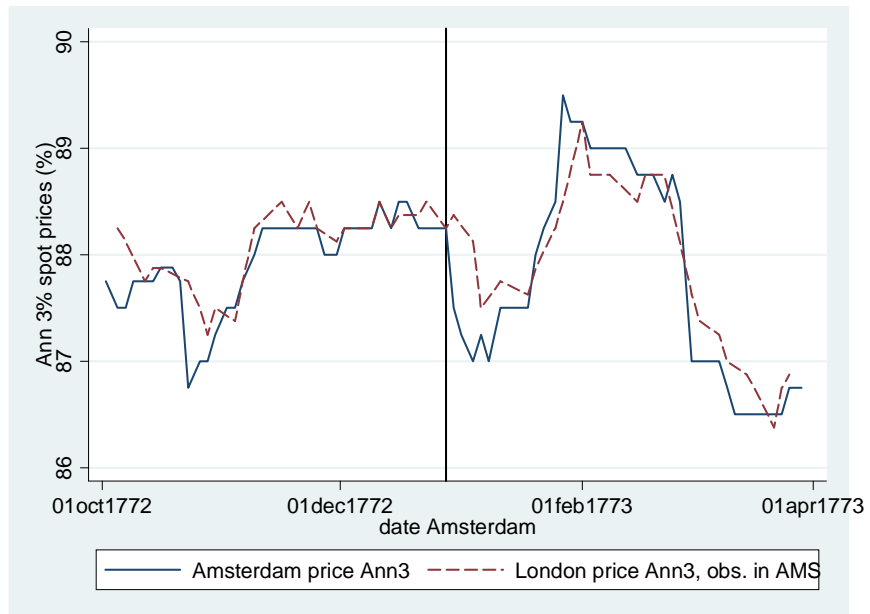


Figure 6: Ann 3% prices in Amsterdam around Clifford et al.'s default



2. The table shows that the cumulative price differences between Amsterdam and London for EIC stock are consistently large and negative and for periods of 2 and 4 weeks they are highly statistically significant at the 1% level. The ECD for BoE stock over a period of 2 weeks is also statistically significant at the 1% level. The ECD over a period of 4 weeks is significant at the 5% (t-distribution) or 10% (empirical distribution) level. The price difference of the 3% Annuities is slightly significant at the 10% level for the initial period of 2 weeks, but insignificant over longer horizons. This suggests that the shock of the consortium’s default mainly had an impact on the Amsterdam prices of EIC and BoE stock, and to a lesser degree affected the price of the 3% Annuities.

Table 3: Cumulative differences in stock price AMS-LND. Clifford et al. default (ECD) vs Full sample (SCD)

| Weeks after event | 2 | 4 | 6 | 8 |
|---------------------|--------|--------|--------|-------|
| EIC | | | | |
| ECD | -29.14 | -36.72 | -13.67 | -2.86 |
| SCD | -0.76 | -1.56 | -2.28 | -3.12 |
| P-value (t-test) | 0.000 | 0.000 | 0.234 | 0.486 |
| P-value (empirical) | 0.003 | 0.003 | 0.208 | 0.487 |
| BoE | | | | |
| ECD | -10.78 | -12.64 | -8.69 | -8.34 |
| SCD | -0.23 | -0.57 | -0.68 | -1.14 |
| P-value (t-test) | 0.007 | 0.059 | 0.238 | 0.292 |
| P-value (empirical) | 0.019 | 0.051 | 0.225 | 0.294 |
| Ann 3% | | | | |
| ECD | -3.89 | -4.26 | -1.76 | -0.76 |
| SCD | -0.85 | -1.72 | -2.55 | -3.45 |
| P-value (t-test) | 0.054 | 0.193 | 0.596 | 0.702 |
| P-value (empirical) | 0.068 | 0.163 | 0.570 | 0.705 |

To sum up, the two events had an economically and statistically significant impact on stock prices in Amsterdam. Price differences with London increased and remained high for a number of weeks after the events. In the next section we will discuss to what extent these price patterns are related to the actions of the distressed agents.

3.2 Direction of news

In this analysis we make the assumption that events in Amsterdam have no impact on prices in London. Under this assumption we can identify the impact of the two shocks on Amsterdam prices, but how realistic is it? If this assumption

does not hold, and events in Amsterdam do have an impact on London, our identification strategy would break down. In that case, our London benchmark would just reflect the old price and is not so relevant.

The first thing to note is that over the entire sample of 1771 – 1777 there is compelling evidence that relevant information originated in London and not in Amsterdam (see the results in chapter 1). However, it is possible that, during the two of periods of financial distress that we analyze, events in Amsterdam do have an impact on London. The number of price observations available during the two episodes is too small to test this statistically. We therefore move to eye-ball econometrics. In figures 11, 12, 13, and 14 (Appendix B) we present EIC and BoE stock prices in London around the two events, and the Amsterdam stock prices as they were observed in London.¹⁵ If events in Amsterdam have an impact on London, we should observe this through a reaction of London prices to observed Amsterdam prices. Throughout stocks and periods this does not seem to be the case. London prices do not respond to Amsterdam.

3.3 Arbitrage and interpretation

How should we interpret these results? If the cumulative difference between Amsterdam and London stock prices is significant over a period of x weeks, what does this mean exactly? Suppose that no arbitrage whatsoever could take place between Amsterdam and London. In that case we could interpret the two events we study as two local shocks, specific to the Amsterdam market. As these shocks dissipate over time their effect on prices disappears. Prices in Amsterdam move back to the equilibrium levels observed in London. The time it takes for this to happen would tell us how long it takes the Amsterdam market to fully absorb the shock.

However, from qualitative evidence (see for example in the next section) we know that arbitrage between Amsterdam and London was very well possible. If market participants used these arbitrage opportunities, Amsterdam prices would move back to London prices much quicker than the time it took for the shock to dissipate. This means that the time it takes for the price in Amsterdam to move back to the London price is actually a lower bound estimate of the time it takes for the Amsterdam market to absorb the shock. Rather what we measure is the time it takes before arbitrage opportunities between Amsterdam and London disappear.

¹⁵To determine the Amsterdam price as it was observed in London we use information on the departure of mail packet boats from Hellevoetsluis to Harwich from the *Rotterdamsche Courant*. We use the average sailing time to determine on what day what news must have arrived in London.

4 Trading patterns

4.1 Alexander Fordyce and Hope & Co

In what way did Hope & Co. settle the short position in EIC and BoE stock that they effectively inherited from Alexander Fordyce's bankrupt estate? The easiest way to settle was by buying off-setting long positions in the future market with the same expiry date of August 15, 1772. As we explained before, Hope had a clear incentive to do this as quickly as possible as they alone were responsible for the downside, but the upside had to be shared with all the other creditors of Fordyce's estate. Did they indeed settle immediately after June 12? The available evidence shows that, even though stock prices in Amsterdam responded immediately, Hope actually waited a few weeks before it finally settled the positions.

In Hope's letter to Alexander Fordyce of October 16, 1772 they had mentioned that "the general knowledge of our having been sellers to [for] you, raised the expectation of a very important rise, on the supposition that we should immediately buy it in again." In addition they indicated that

"[this] left us the prospect and apprehension of a very great deficiency. But by delaying a few weeks and waiting the occasion of sellers, we gradually realized the whole of the India Stock and Bank without loss, and soon to a small profit".

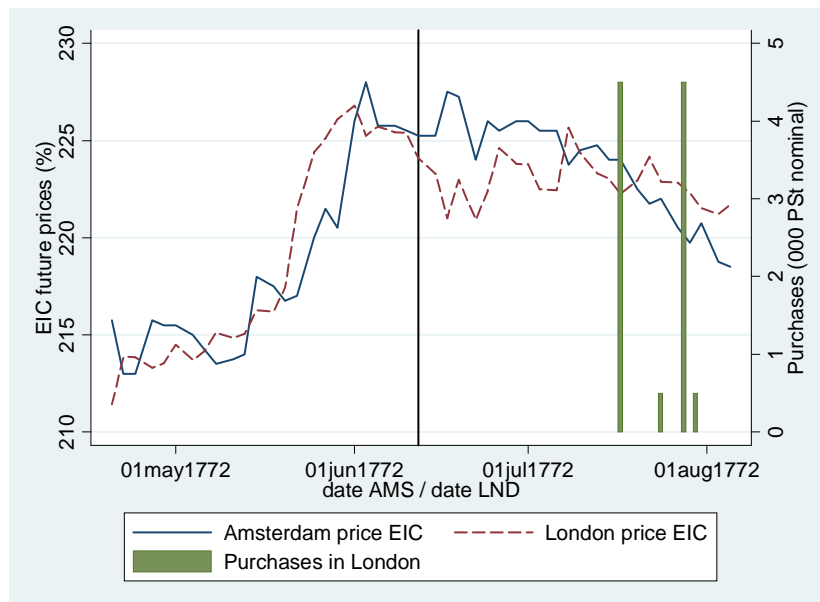
To which they added that "you may easily conceive with a pernicious effect would have attended a timid and hasty realization of such a large amount" (SAA 735, 1510). In other words, when Hope tried to buy English stocks to settle the existing short positions, they faced serious buying pressure in Amsterdam. As a consequence they delayed the purchases by a few weeks and these were executed in a gradual way.

The specifics can be reconstructed from a number of archival sources.¹⁶ £ 47,000 of the total short position of £ 57,000 EIC stock was indeed settled in the Amsterdam future market by buying offsetting futures expiring on August 15, 1772. It is unknown at what dates this was done exactly. However, we do know that the average price at which the future purchases were made was 225.36% of nominal value. The price of EIC stock only fell below 226% after July 3 (see figure 1). So this must imply that Hope indeed waited a number of weeks before it actually made any purchases.

Hope settled £ 10,000 of Fordyce's position in London. We know the exact dates of these transactions: they took place between July 17 and July 30, with most purchases transacted on July 17 and July 28. This is between a month and a month-and-a-half after Fordyce's default.

¹⁶Hope's *Grootboeken* and *Journalen* (general and day to day accounting books) (SAA 735, 894 and 1155), Alexander Fordyce's stock account with Hope (Stock Account Fordyce, SAA 735, 1510) and the court proceedings after Fordyce's default (Court Proceedings Fordyce's Default, SAA 735, 1510).

Figure 7: Hope's purchases of EIC stock in London, July 1772



The reason for transacting in the English market was that “the price in London was under ours” (SAA 735, 1510). In other words, Hope tried to actively arbitrage between Amsterdam and London. A closer look at the details of these transactions reveal why this type of arbitrage between Amsterdam could be troublesome, even for a sophisticated investor with good connections in London like Hope & Co.¹⁷ Figure 7 presents the Amsterdam and London future prices of EIC stock and the London purchases that were made (in this figure both price series are in real time). The figure shows that the first £ 4,500 purchased in London was indeed bought at a time at which the London price was still below that in Amsterdam. However all the remaining transactions took place over a period when London prices were above prices in Amsterdam. A reason for this might have been that Hope’s agents in London had limit orders to buy EIC stock.¹⁸ When the stock price in London fell, they immediately bought the stocks, not yet having received the news that prices in Amsterdam had fallen even further.

Problems of this sort might explain why Hope did not settle the entire position in London. Another reason may have been that a developed futures market in London was missing. Hope was therefore forced to buy in the spot market. This implied that they had to sell this position again around August 15, to avoid

¹⁷Hope’s agent in London was the banking house Gurnell, Hoare and Harman, SAA 735, 115 and 1510.

¹⁸In the rule, Dutch investors wishing to trade in the London market used “limitte” orders, see for example NA, Staal van Piershil, 356 and GAR, 199, 5.

any additional risks.¹⁹ Using spot transactions instead of forward transactions meant a significant capital outlay, which had to be borrowed or, if financed with own capital, implied a opportunity cost. Secondly, settling through spot transactions implies that a stock has to be transacted twice. At both instances there is a risk that the market moves against the seller or buyer. Finally, there were additional transaction costs involved with transacting twice in London which in total amounted to 1.7% of nominal value (instead of 0.625% of transacting once in Amsterdam).²⁰

Finally, the short position in £. 22,000 BoE stock that was outstanding was not settled before the future contract expired. It was only settled around the expiration date of August 15 at a price of 148%. So this risky position was left on Hope's books for over 2 months.

To sum up, both short positions (£. 57,000 EIC and £. 22,000 BoE stock) were only settled after a delay of between 3 weeks and 2 months, even though Hope faced considerable downside risk and no upside. Only £. 10,000 EIC stock was settled in London. Due to various problems this was not a success either and Hope hardly benefited from higher prices in London.

4.2 Clifford and Sons and brothers Van Seppenwolde

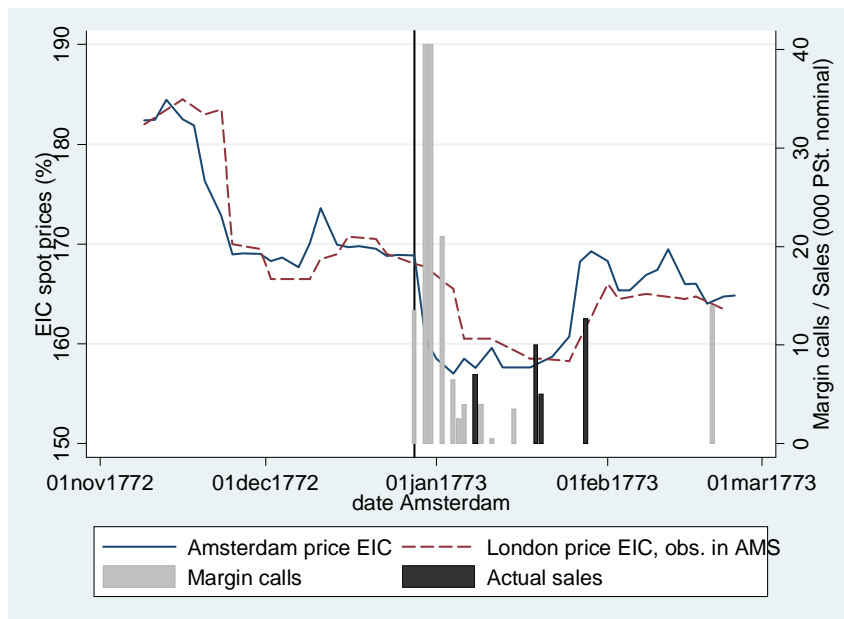
In a similar way we reconstruct the trading activity after the default of Clifford and Sons and the brothers Van Seppenwolde. As we explained, the lenders of the repo contracts had every reason and right to sell the English stocks that were surrendered as collateral as quickly as they could. Just as with Hope & Co., they only faced downside risk and no upside at all.

From the records of notary Van den Brink we can reconstruct the dates at which "insinuations" or official reminders of margin calls were made against the consortium. In addition, there is data available on the dates at which the collateral was actually sold (SAA, 5075, 10,593 – 10,613). This information is presented in figures 8 (EIC stock) and 9 (BoE stock). The first thing to note is that there is a strong correlation between the divergence of stock prices in London and Amsterdam and the timing of margin calls. Prices in the Amsterdam market responded instantaneously to the degree of distress in the market. This is the case for both EIC and BoE stock. The second thing to note is that there is a disconnect between mispricing and margin calls on the one hand and actual transactions on the other. Most sales were postponed to a later period in

¹⁹After the introduction of Barnard's act in 1734 derivative trading in London was officially banned. There is an ongoing debate about whether these official regulations indeed stopped the derivative trade from taking place (Neal 1990, Harrison 2003). In the Dutch archives there are some indications that people in London could engage in future transactions (NA, Staal van Piershil, 379). However, this market seems to have been quite thin and market participants frequently used the futures market in Amsterdam to get future positions (SAA, 735, 894, 895, 1155, and 1166 ; NA, Staal van Piershil, 379; OSA, 3710).

²⁰In the bankruptcy proceedings after Fordyce' default we find complaints about this. It was even argued that Hope should pay "the extraordinary expenses of making purchases and delivering the £. 10,000 India stock in London" out of their own pocket, since "the stock could have been purchased with less expense, as for instance in Holland" (SAA, 735, 1510).

Figure 8: EIC prices, margin calls and sales around Clifford et al.'s default



time. Very little transactions in EIC stock actually took place during the period for which we can identify a significant divergence between the Amsterdam and London price.²¹ Within the time frame of figure 9 literally no transaction in BoE stock took place. The first sale that we find was on May 17, 1773 (for £. 15,000).

In addition to this quantitative evidence, we found a number of accounts detailing how certain lenders liquidated the collateral that was surrendered to them after the default of the consortium. The first example comes from the archives of the Rotterdam Society for Insurance, Discounting and Securitised Lending (Maatschappij van Assurantie, Discontering en Beleening der Stad Rotterdam). The Society had lent f. 57,000 and f. 38,000 guilders to Hermanus and Johannes van Seppenwolde on the security of EIC stock, which amounted to £ 3,400 and £ 2,400 respectively. Both contracts had stipulated that if the EIC stock price would fall below 170%, additional collateral had to be provided. When the Van Seppenwoldes were unable to fulfill this requirement in January 1773, the Society had the right to liquidate the entire collateral. In addition, the margins on the repo agreements were sufficient to cover the loan amount and liquidation would have been loss-free. However, in the end the Society decided to liquidate only half of the Van Seppenwoldes' position. Initially, this

²¹Some of these transactions actually took place in the Amsterdam futures market, possibly to avoid serious price pressure in the spot market. The estate of the deceased Dionis Mulman for example settled a position of £. 1,000 this way on January 28, SAA, 5075, 10,605.

Figure 9: BoE prices, margin calls and sales around Clifford et al.'s default



was sufficient to cover the margin on the remaining repos that were based on EIC stock amounting to £ 1,700 and £ 1,200 respectively.

In March 1773 the Society decided to roll over the repo contracts for an additional year. Ex post this was not a wise decision. After March 1773 the EIC stock price kept falling. The margins implicit in the repo agreements with the brothers Van Seppenwolde evaporated before the Society could sell the remaining collateral. The Society did not want to liquidate the positions when they were under water and it continuously rolled over the repo agreements. It would take until 1778 before the Society finally decided to liquidate the positions, which they did at a small profit (OSA 4583; GAR 199, 5, 40).

The second example comes from the archives of Widow Meerman, a rich member of the Dutch elite. She had lent an amount of f. 100,000 guilders to Johannes van Seppenwolde on the collateral of £ 6,000 India stock. The repo contract was to expire on February 15, 1773. On that day the EIC price was 166%. Widow Meerman could have forced Van Seppenwolde to repay the loan, but at this time Van Seppenwolde would most likely have been unable to accommodate this. This left her two options: either sell the collateral, which at a price of 166% would have more than covered the amount loan. Alternatively she could have agreed with renewing the position.

She chose the latter. This is all the more remarkable since the conditions of this prolongation were riskier to her than before. The contract expiring on February 15, 1773 stipulated that below 170% Van Seppenwolde had to

supply additional margin. However, Van Seppenwolde never paid up and he succeeded in renewing the contract without this stipulation. In other words, Van Seppenwolde succeeded in effectively lowering the haircut on the contract.²² Ex post, it was not a great decision and it took until July 15, 1774 before everything was finally settled (NA, Staal van Piershil, 379, 386).²³

The third example involves the City of Rotterdam that had lent Hermanus van Seppenwolde f. 300,000 guilders on collateral of £ 21,000 BoE stock (OSA 3710). This repo contract ended on Feb 1, 1773. Van Seppenwolde wanted to roll over the repo contract but the City refused. When Van Seppenwolde did not manage to repay the loan on Feb 1, the City of Rotterdam ordered the BoE stock to be sold. They decided to do this in London. However doing so was not easy. Their agents in London, Gerard and Joshua van der Neck, were worried that “the sale of such a considerable position in the spot market cannot take place without markedly depressing the price” (OSA 3710).²⁴ The Van der Necks did manage to sell £ 13,000 in the London spot market on February 6 and February 8, but because of the serious price pressure £ 8,000 was sold through the Amsterdam futures markets.

In these first two examples the lenders chose to actively accommodate the Van Seppenwoldes. The Rotterdam Society only liquidated half of the collateral and Widow Meerman even settled on a new contract that provided her with a smaller margin than she had negotiated before. Apparently there was great reluctance to liquidate the collateral. An important reason behind this could have been that market conditions in the beginning of 1773 were far from favorable. Reports in Dutch periodical *De Koopman* indicate that selling collateral in the beginning of 1773 was not an easy task. One commentator argued that new repo agreements were very costly to obtain.²⁵ In addition, he argued that if stock was to be sold directly, this would be at a big discount (*De Koopman*, 1773, pp. 395, March 3, 1773).²⁶ Another commentator argued that there was sufficient

²²This is quite striking as haircuts on new repo contracts increased dramatically in the beginning of 1773, see figure 10.

²³As EIC prices kept falling in the first half of 1773, the repo contract with Van Seppenwolde threatened to go under water. Again, instead of liquidating the position on the premise that Van Seppenwolde had supplied insufficient margins, she chose to settle amicably. They agreed that Van Seppenwolde would take over the EIC stocks at a price a 151% (a price at which the loan could more or less be recovered, including a small margin). Van Seppenwolde would then take the responsibility of selling the position. (Archival evidence indicates that he tried to settle another position of £ 7,000 EIC in the same way.) He managed to do so for the first £ 3,000, which he bought from Meerman on October 15. However by the time he was to take up the remaining £ 3,000, the EIC stock price has fallen below 151%. Since the bankrupt Van Seppenwolde did not have the cash to make up the difference he refused to fulfill his side of the transaction. It would take until July 15, 1774 before the EIC had risen sufficiently above 151% before Van Seppenwolde liquidated the final £ 3,000.

²⁴“Dog dewijl den verkoop van soo een aensienelijke somme als L. 21,000 Bank Actiën niet wel voor Contant geld kan geschieden sonder de prijs merklijk te drukken, zullen wij genoodzaakt zijn, soo niet het geheel, een goed gedeelte voor de naebijzijnde rescontres te verkoopen, die heeden aght dagen van Holland afkoomen & hier circa den 24 a 25e deeser worden geliquideert”

²⁵Quantitative evidence of this will be provided in figure 10.

²⁶“Veelen wilden niet beleenen als tot een schreeuwenden interest, andere weigerden het in

capital available to accommodate trading demands but that the deep pockets of the market did not want to burn their fingers (*De Koopman* 1773, pp. 396-397, March 3, 1773). Under these conditions it may have seemed optimal to delay liquidating the asset and to keep the responsibility of liquidating the collateral with the main stake holders, the brothers Van Seppenwolde.

In this third example, the collateral was immediately liquidated. However, the sources indicate that doing so without seriously depressing the price was not an easy task. Interestingly enough, the largest part of liquidation from the third example took place in London. The information from notary Van den Brink (SAA, 5075, 10,593 – 10,613) suggests that this was an exception. All transactions recorded by Van de Brink took place in Amsterdam through the intermediation of well-known Amsterdam brokers. Widow Meerman of the second example even explicitly indicated that she wished to settle everything in the Netherlands (NA, Staal van Piershil, 379, 386).

To sum up, the positions in EIC and BoE stock that were seized after the defaults of the brothers Van Seppenwolde and Clifford and Sons, were mostly sold with a delay and in a gradual way. Because of price impact it was difficult to liquidate these positions right away. Most of the transactions actually took place outside of the period for which we observe significant price differences between Amsterdam and London. This confirms the view from the Fordyce case that there was a disconnect between the timing of the distress, the reaction of stock prices in Amsterdam (immediate) and the settlement of positions (delayed).

5 Optimal delay?

What can explain this disconnect between price impact and actual transactions? In the first part of this section we review some of the evidence that we uncovered from the historical sources. We show that surrounding both events there was significant uncertainty about the exact size of the distressed shock. Hope & Co actually motivated their delayed trading by pointing to this uncertainty. The market seems to have taken seriously into account that the size of the shock was so big, that it would significantly affect prices in the near future. As a result prices responded dramatically, and it became very costly for distressed agents to trade. This markedly reduced the amount of trading they were willing to do.

In the second part of this section we formally model this mechanism in a rational expectations setting and we show that the model can generate the disconnect that we find in the data between the timing of distress and the resulting mispricing on the one hand, and the timing of actual transactions on the other. This model uses the framework of Kyle (1989) and it is directly related to the work by Vayanos (1999; 2001).²⁷

het geheel, maar wilden wel half te geef koopen”

²⁷Vayanos develops two infinite horizon models in which endowment shocks are private information. His models are very similar to our framework. Our work differs in two respects. First of all, we look at a very simple 3 period setting where consumption only takes place in

5.1 Historical evidence

In its letter to Alexander Fordyce dated October 16, 1772, Hope & Co. explained the reasons for why they had waited a few weeks before they finally settled Fordyce' position.

“The general knowledge of our having been sellers to [for] you, and the report of its being for at least 5 times the [true] amount, which was industriously propagated, raised the expectation of a very important rise” (SA, 735, 1510).

In other words, the market thought that Fordyce' short position was a lot larger than it actually was. Even if this was an exaggeration on the part of Hope, it does suggest that, at least, there was uncertainty in the market about the size of Fordyce' position that was held by Hope.

This statement is corroborated by other sources. The quote from the *Middlesex Journal* on June 13, 1772 on page 5 states that Alexander Fordyce held a short position of “a million and a half of India stocks”. This is a lot more than it actually was. With a stock price of 225% this translates into a nominal value of £ 666,666 which is almost 12 times as much as Fordyce' actual position. Again, even if this was an exaggeration it does suggest that there was uncertainty in the market about Fordyce' position.

What do the events of January 1773 tell us? In the Dutch periodical *De Koopman* we find similar evidence that market participants thought that a large long position was hanging over the market. Although we are not sure what the entire position of the consortium was (remember that the information from table 1 is only based on the information from notary Van den Brink only), these estimates, again, seem to be far too large. More importantly, they are not consistent with each other. This implies that there was great uncertainty about the size of the shock.

On December 29, 1772, only one day after the consortium finally failed to meet its obligations, *De Koopman* suggested that the total outstanding position in the English stocks may have amounted to about f. 40 million guilders. This translates into a position of EIC stock of £ 2 million nominal and a position of BoE stock of £ 0.5 million nominal.²⁸ If this were true it must have been the case that the consortium only handled 10% of their repos through notary Van den Brink; 90% must have been handled through different notaries. Casual investigation of other notary archives suggest that this can never have been the case.

Less than a week later, on January 3, 1773, it was suggested that f. 3.3 million guilders had already been paid to fulfill the margin requirements of the

the third period, instead of every period. Secondly, we constrain the behavior of the distressed agent so that he can only trade in the first two periods (compare Admati and Pfleiderer 1988).

²⁸De Koopman 1772, p. 295. Suppose that people thought that the position of the consortium in EIC stock was 4 times as big as the position in BoE stock, just as in table 1. Using Amsterdam prices for December 29, we arrive at these figures.

securitized loans, which probably referred to earlier margin calls (*De Koopman* 1772, p. 310).²⁹ These margin calls must have been based on repos for EIC stock and this translates into an EIC stock position of £ 1 million nominal.³⁰ Again this seems to be an exaggeration. Most importantly, it is half of which was reported in the same periodical less than a week before. This suggests that there was great uncertainty about the size of the shock.

There is additional evidence supporting this view. Figure 10 presents the EIC stock price in Amsterdam and London and the haircuts implicit in the new repo contracts that were signed. The figure clearly shows that after the consortium’s default, repo haircuts increased dramatically from about 20% to 30%. By March 1773 they returned to normal levels of 20% again. This is consistent with uncertainty about the size of the consortium’s position. If this turned out to be bigger than expected, the EIC stock could fall even further than it had already done. As a result additional margins were demanded. Over time, possibly when more precise information about the size of the shock was revealed, repo haircuts fell towards normal levels.

5.2 Model

The setup of the model is summarized in table 4. There is a single risky asset and a risk-free savings technology for which we normalize the interest rate to zero. The model features three periods. The terminal value of the risky asset in $t = 3$ is given by

$$v = v_0 + \eta + \varepsilon$$

η and ε are i.i.d. normally distributed disturbances with zero mean and variances σ_η^2 and σ_ε^2 , i.e. $\eta; \varepsilon \sim N(0, \sigma_\eta^2; \sigma_\varepsilon^2)$. η is realized in $t = 2$ and ε is realized in $t = 3$.

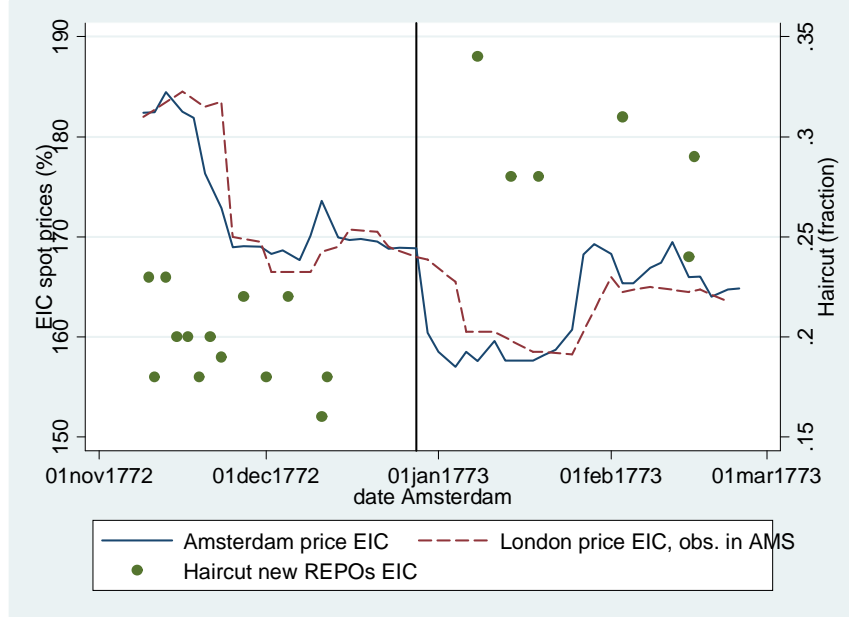
Central to the model is a distressed agent, who receives an endowment w in the asset at the start of period $t = 1$. This endowment is privately observed. w is the realization of a normally distributed random process with zero mean and variance σ_w^2 , i.e. $w \sim N(0, \sigma_w^2)$. The distressed agent must trade away its entire endowment over periods $t = 1$ and $t = 2$. There are no further constraints on the distressed agent’s trading activity, which are indicated by x_1 and x_2 .

In the first period a mass M^A of infinitely small liquidity providers are present, with whom the distressed agent can engage in risk sharing. These type A liquidity providers remain in the model throughout and are joined by an additional mass of infinitely small liquidity providers M^B in $t = 2$. The type

²⁹ “Men spreekt van 33 tonnen aan rescontres [afrekeningen] van één die al betaald zijn en van nog ongelijk meer die nog moeten volgen en betaald worden.”

³⁰ In the second half of 1772 no additional margin was put up for repos in BoE stock. Most of the original repo contracts for EIC stock had stipulated a critical stock price of 200% below which additional margin or collateral had to be paid up and the consortium had managed to pay up additional margin (at 10%) three times for the price falls below 200%, 190% and 180%. With margin payments of 3.3 million guilders, this suggests that the total outstanding EIC stock amounted to 11 million guilders nominal, which is approximately £ 1 million.

Figure 10: EIC prices and REPO haircuts around Clifford et al.'s default



A agents absorbs all trading demands in $t = 1$ and can off-load some of this in $t = 2$ onto the new batch of type B liquidity providers. Trading activity by the liquidity providers in $t = 1$ is indicated by y_1^A ; trading activity in $t = 2$ by y_2^A and y_2^B . By the end of $t = 2$ the entire free float of the risky asset must be in the hands of the liquidity providers. We assume that $M^A > 0$ and $M^B \geq 0$.

Both the distressed agent and the liquidity providers have exponential utility functions with CARA A . We assume that the risk bearing capacity of liquidity providers in $t = 2$ is sufficiently large, i.e.

$$M^A + M^B \geq A(\sigma_\eta^2 + \sigma_\varepsilon^2) \quad (1)$$

In $t = 1$ there is an additional noise trading shock, $u \sim N(0, \sigma_u^2)$. We show in Appendix A that as a result, the equilibrium price in $t = 1$ will never fully reveal the realization of w . This is a crucial element of the model. It implies that the liquidity providers of type A face uncertainty about p_2 , the equilibrium price in $t = 2$. In this period, the type A agents expect to off-load some the position they have absorbed in $t = 1$ onto the type B liquidity providers. If the price at which they can do this is uncertain, they effectively have to hold additional risk. This makes liquidity provision in $t = 1$ extra costly. This is the key friction that we will analyze in the remainder of this section.

Markets clear through a Walrasian auctioneer. This means that the distressed agent and the liquidity providers submit demand schedules to a central auctioneer who then sets prices so that markets clear. The distressed agent is

Table 4: Setup of the model

| time | t = 1 | t = 2 | t = 3 |
|---------------------|---------------------------|--------------------------------|------------------------|
| liquidity providers | mass M^A | mass $M^A + M^B$ | |
| risk | risks η, ε | η realizes | ε realizes |
| distressed trades | x_1 | $x_2 = -(w + x_1)$ | |
| noise trading | u | 0 | |
| liquidity provision | $M^A y_1^A = -(x_1 + u)$ | $M^A y_2^A + M^B y_2^B = -x_2$ | |

relatively large with respect to the market as a whole and will take the impact of his own trading activity on equilibrium prices into consideration. The type A and B liquidity providers are all infinitely small and are price takers.

The distressed agent wants to minimize trading costs, or, equivalently, maximize the proceeds from liquidating its position. The liquidity providers act competitively and submit trading demands such that they are compensated for taking on the associated risks.

Proposition 1 *A linear Rational Expectations Equilibrium exists in which the actions of the distressed agent and the liquidity providers are jointly optimal and in which the equilibrium in $t = 1$ will only partially reveal the distressed's endowment w and noise trading shock u .*

Let $q = w - u$, $\bar{q} = E[w - u | p_1]$, and $\sigma_q^2 = \text{var}[w - u | p_1]$

Optimal demands are given by

$$x_1 = -\bar{\alpha}_2 w + \bar{\alpha}_3 u \quad (2)$$

$$x_2 = -(w + x_1) \quad (3)$$

$$y_1^A = \bar{\gamma}_1 w - \bar{\gamma}_2 u \quad (4)$$

$$y_2^A = \frac{q}{M^A + M^B} - y_1^A \quad (5)$$

$$y_2^B = \frac{q}{M^A + M^B} \quad (6)$$

And equilibrium prices are given by

$$p_1 = v_0 - \delta_1 w + \delta_2 u \quad (7)$$

$$p_2 = v_0 + \eta - \frac{q}{M^A + M^B} A \sigma_\varepsilon^2 \quad (8)$$

Where

$$\bar{\alpha}_2 = \frac{A\sigma_\varepsilon^2 + (M_A + M_B) A\sigma_\eta^2}{(M_A + M_B) (2\lambda_1 + A\sigma_\eta^2)} \quad (9)$$

$$\bar{\alpha}_3 = \frac{A\sigma_\varepsilon^2 - \lambda_1 (M_A + M_B)}{(M_A + M_B) (2\lambda_1 + A\sigma_\eta^2)} \quad (10)$$

$$\bar{\gamma}_1 = \frac{\bar{\alpha}_2}{M_A} \quad (11)$$

$$\bar{\gamma}_2 = \frac{1 + \bar{\alpha}_3}{M_A} \quad (12)$$

$$\delta_1 = \lambda_1 M_A \bar{\gamma}_1 \quad (13)$$

$$\delta_2 = \lambda_1 M_A \bar{\gamma}_2 \quad (14)$$

$$\lambda_1 = \frac{(M_A + M_B) (A\sigma_\eta^2 + A\sigma_\varepsilon^2 \chi)}{M_A [M_A + M_B - A\sigma_\varepsilon^2 (1 - \chi) \rho_{w-u}]} \quad (15)$$

$$\chi = \frac{A^2 \sigma_\varepsilon^2 \sigma_q^2}{(M_A + M_B)^2 + A^2 \sigma_\varepsilon^2 \sigma_q^2} \quad (16)$$

$$\rho_{w-u} = \frac{\delta_1 \sigma_w^2 - \delta_2 \sigma_u^2}{\delta_1^2 \sigma_w^2 + \delta_2^2 \sigma_u^2} \quad (17)$$

$$\sigma_q^2 = (1 - \rho_{w-u}) (\sigma_w^2 + \sigma_u^2) \quad (18)$$

Proof. See Appendix A ■

The shape of equilibrium in $t = 2$ is quite standard. By the end of the period, the entire endowment w minus the first period's noise trading shock u are held by the type A and B liquidity providers. These agents are risk averse and act competitively and the expression for price p_2 (8) reflects this.

The equilibrium in $t = 2$ is slightly more complicated. Let's start with the expression for x_1 in (2). The distressed agent off-loads some of his position in $t = 1$. The extent to which he does so is measured by $\bar{\alpha}_2 > 0$. The distressed agent also responds to the noise trading shock u .³¹

Expression (4) for y_1^A shows that the type A liquidity providers will absorb both the noise trading trading shock u and the distressed demand x_1 . The accommodation of these trading demands is translated into price p_1 according to (7), in which aggregate demand is multiplied by the slope of the aggregate demand curve λ_1 .

λ_1 is a critical parameter in this model. It measures the price impact of the distressed's demand, i.e. by how much the equilibrium price will move in

³¹ $\bar{\alpha}_3 > 0$. This results from the fact that the distressed agent, based on his observation of shock u , can partly predict p_2 and he will try to benefit from this.

response to his trades. As such it measures the trading cost faced by the distressed agent. According to the following lemma, this trading cost is increasing in σ_q^2 .

Lemma 2 $\frac{\delta\lambda_1}{\delta\sigma_q^2} > 0$ if condition (1) is met

Proof. See Appendix A ■

This is a key result of the model and follows from the fact that the equilibrium in $t = 1$ is not fully revealing about the actual values of w and u . The equilibrium price in $t = 2$ is largely driven by $q = w - u$ (see expression (8)) and the type A liquidity providers care a lot about the exact realization of p_2 . As long as $\delta_1 \neq \delta_2$ in $t = 1$, the liquidity providers do not directly observe q (although they do receive a noisy signal about its value through equilibrium price p_1). This means that the realization of price p_2 is uncertain. Consequently, the liquidity providers will demand an additional risk premium for absorbing trading demand in $t = 1$. This additional risk faced by liquidity providers is proportional to σ_q^2 . The following two lemmas show how this σ_q^2 affects the equilibrium in $t = 1$.

Lemma 3 $\frac{\delta\bar{\alpha}_2}{\delta\sigma_q^2} < 0$

Proof. See Appendix A ■

This lemma shows that the distressed agent will submit less of his endowment to the market if uncertainty about q increases. His price impact is increasing in σ_q^2 , and this makes liquidity provision more expensive.

Lemma 4 $\frac{\delta\delta_1}{\delta\sigma_q^2} > 0$

Proof. See Appendix A ■

This lemma shows that at the same time, the price impact of endowment w is increasing in σ_q^2 . Liquidity providers face uncertainty about q and request a larger premium to accommodate liquidity demand. Taken together these lemmas imply that even when the distressed submits **less** of his endowment to the market in $t = 1$, price p_1 responds **more** to the endowment shock. In other words, when σ_q^2 increases, more distressed trade will be postponed to $t = 2$, while the sensitivity of price in $t = 1$ to this distressed trade increases.

To clarify this point, let us start from the situation in which $\sigma_u^2 = 0$ and consequently $\sigma_q^2 = 0$. It can be shown that in this case

$$\begin{aligned}\bar{\alpha}_2 &= \frac{M_A}{2 + M_A} \\ \delta_1 &= \frac{A\sigma_\varepsilon^2(2 + M_A) + A\sigma_\eta^2(M_A + M_B)}{(M_A + M_B)(2 + M_A)}\end{aligned}$$

The fraction of its endowment w that the distressed agent submits to the market (measured by $\bar{\alpha}_2$) fully depends on the size of mass M_A . Suppose that $M_A = 2$, in that case, the distressed agent will submit half of its endowment in $t = 1$ and the other half in $t = 2$. If we now increase σ_q^2 from zero, Lemma 3 shows that $\bar{\alpha}_2$ will fall. The distressed agent will submit less of his endowment. At the same time we know from Lemma 4 that δ_1 will increase, in other words, the price in $t = 1$ becomes more responsive to the distressed agent's endowment. In other words, the degree of mispricing will increase. In the limit, when σ_q^2 approaches ∞ , virtually no distressed trading will take place in $t = 1$, while mispricing in this period becomes very big.

To summarize, this model, which features short run uncertainty about the exact size of the distressed's endowment shock, can accommodate a situation in which there is a disconnect between the timing of distress, the price response (immediate) and the distressed's trading activity (delayed).

6 Conclusion

In this chapter, we analyse two periods of price overshooting on the Amsterdam stock market in 1772 and 1773. In both cases, news reached the market that a big market participant had to close his position as a result of major losses. We examine the price path of the stock and document significant overshooting in the short term and an eventual reversal. Because we have access to the actual trading position of the stricken investors, we can show that these short-term reversals occurred with very little distressed sales actually taking place. This suggests that a V-shaped price path can be observed without additional risk capital actually being used up.

We use a theoretical model related to Vayanos (1999; 2001) to explain these facts. Key to the model is uncertainty about the size of the distressed positions; a feature that is clearly borne out by the historical evidence. This uncertainty effectively increases the risk premium distressed agents have to pay to obtain liquidity. At the same time this increases the price impact of the shock and reduces the amount of trading.

These findings can possibly be extrapolated to more recent events of financial distress. During the LTCM crisis, for example, there was considerable uncertainty about the LTCM's positions (Mitchell, Pedersen and Pulvino 2007). Similar uncertainty existed in the recent financial crisis (Mitchell and Pulvino 2011).

7 Bibliography

HISTORICAL NEWSPAPERS:

- Amsterdamsche Courant, City Archive Amsterdam
- Opregte Haerlemsche Courant, Dutch Royal Library, The Hague
- Rotterdamsche Courant, City Archive Rotterdam

London Chronicle, Burney Collection, British Library
Middlesex Journal, Burney Collection, British Library
Public Advertiser, Burney Collection, British Library

CITY ARCHIVE AMSTERDAM:

Hope & Co, SAA 735, 894; 895 (Grootboeken); 1155; 1156 (Journalen) and 78;
79;115 and 1510 (letterbooks)
Notarial protocols Van den Brink, SAA 5075; 10593-10613

CITY ARCHIVE ROTTERDAM:

Stukken betreffende de kasgeldlening groot fl. 300.000 ... [Documents regarding the loan of f. 300,000 guilders ...] OSA 3710
Stukken betreffende de door Van Seppenwolde beleende effecten ... [Documents regarding the securitized loans of Van Seppenwolde ...], OSA 4582
Kuyt's Fundatie, GAR 90, 52; 56
Maatschappij van Assurantie, Discontering en Beleening der Stad Rotterdam (Rotterdam Society of Insurance, Discounting and Securitized Lending), GAR 199, 5; 40

NATIONAL ARCHIVE THE NETHERLANDS:

Archive of the family Van der Staal van Piershil, 1636-1904. NA 3.20.54; 379-395

LITERATURE

Admati, A.R. and P. Pfleiderer, 'A theory of intraday patterns: volume and price variability', in *The Review of Financial Studies* 1-1 (1988).
Andrade, S.C., C. Chang and M.S. Seasholes, 'Trading imbalances, predictable reversals, and cross-stock price pressure', in: *Journal of Financial Economics* 88 (2008).
Andrades, A. (1909 [1966]), *History of the Bank of England, 1640-1903*, Cass & Co., Oxon.
Blume, Marshall. E. and Roger M. Edelen (2003), 'S&P 500 Indexers, Delegation Costs and Liquidity Mechanisms', working paper
Bowen, H.V. (2007), 'The East India Company: Trade and Domestic Financial Statistics, 1755-1838', UK Data Archive
Brunnermeier, Markus, and Lasse H. Pedersen (2005), 'Predatory trading', in: *The Journal of Finance*, 60-4, pp. 1825-1863
Brunnermeier, Markus, and Lasse Heje Pedersen, 2009, 'Market liquidity and funding liquidity', in: *Review of Financial Studies* 22, pp. 2201-2238.
Campbell, John Y., Stefano Giglio, and Parag Pathak (2011). "Forced Sales and House Prices." *American Economic Review*.
Chen, Z., A.A. Lookman, N. Schürhoff and D.J. Seppi (2010), 'Why Ratings Matter: Evidence from Lehman's Index Rating Rule Change', working paper
Chen, Honghui, Gregory Noronha and Vijay Singal (2004), 'The Price Response to S&P 500 Index Additions and Deletions: Evidence of Asymmetry and a New Explanation' in: *The Journal of Finance*, 59-4, pp. 1901-1929
Coval, J. and Erik Stafford (2007), 'Asset fire sales (and purchases) in equity markets', in: *Journal of Financial Economics* 86, pp. 479-512.

- Duffie, Darrell, Nicolae Garleanu, and Lasse H. Pedersen (2005), ‘Over-the-counter markets’, in: *Econometrica*, 73-6, pp. 1815–1847
- Duffie, Darrell (2010), ‘Asset Price Dynamics with Slow-Moving Capital’, in: *The Journal of Finance*, 65-4
- Feldhütter, Peter (2010), ‘The same bond at different prices: identifying search frictions and selling pressures’, working paper
- Garleanu, Nicolae and Lasse H. Pedersen (2011), ‘Margin-Based Asset Pricing and Deviations from the Law of One Price’, working paper
- Gorton, Gary, and Andrew Metrick (2010a), ‘Haircuts’, working paper
- Gorton, Gary, and Andrew Metrick (2010b), ‘Securitized banking and the run on repo’, working paper
- Greenwood, Robin (2005), ‘Short- and long-term demand curves for stocks: theory and evidence on the dynamics of arbitrage’, in: *Journal of Financial Economics*, 75, pp. 607–649
- Grossman, S.J., and M.H. Miller, ‘Liquidity and market structure’, in: *The Journal of Finance* 43-3 (1988).
- Harris, Lawrence and Eitan Gurel (1986), ‘Price and Volume Effects Associated with Changes in the S&P 500 List: New Evidence for the Existence of Price Pressures’, in: *The Journal of Finance*, 41-4, pp. 815-829
- Harrison, Paul (1998), ‘Similarities in the distribution of stock market price changes between the eighteenth and twentieth Centuries’, in: *The Journal of Business*, 71-1
- He, Zhiguo and Arvind Krishnamurthy (2010), ‘A Model of Capital and Crises’, working paper
- Hendershott, T. and M.S. Seasholes, ‘Market maker inventories and stock prices’, in: *AEA Papers and Proceedings* 97-2 (2007).
- Hendershott, T. and A.J. Menkveld, ‘Price pressures’, working paper (2010)
- Holden, C.W. and A. Subrahmanyam, ‘Risk aversion, imperfect competition, and long-lived information’, in: *Economics Letters* 44 (1994).
- Holthausen, Robert W., Richard W. Leftwich and David Mayers (1990), ‘Large-block transactions, the speed of response, and temporary and permanent stock-price effects’, in: *Journal of Financial Economics* 36, pp. 71-95.
- Hrazdil, Karel (2009), ‘The price, liquidity and information asymmetry changes associated with new S&P 500 additions’, in: *Managerial Finance*, 35-7, pp. 579-605
- Kaul, A., V. Mehrotha and R. Morek (2000), ‘Demand Curves for Stocks Do Slope Down: New Evidence from an Index Weights Adjustment’, in: *The Journal of Finance*, 55-2
- Krishnamurthy, Arvind (2010), ‘How Debt Markets Have Malfunctioned in the Crisis’, in: *Journal of Economic Perspectives*, 24-1, pp. 3–28
- Kyle, A.S. (1989), ‘Informed Speculation with Imperfect Competition’, in: *Review of Economic Studies*, 56-3, pp. 317-55
- Madhavan, Ananth (2001), ‘The Russell Reconstitution Effect’, working paper
- Mitchell, Mark, Todd Pulvino and Erik Stafford (2004), ‘Price Pressure around Mergers’, in: *The Journal of Finance*, 59-1, pp. 31-63
- Mitchell, Mark, Lasse Heje Pedersen, and Todd Pulvino (2007), ‘Slow Moving Capital’, in: *American Economic Review Papers and Proceedings*, 97-2

- Mitchell, Mark, and Todd Pulvino (2011), ‘Arbitrage Crashes and the Speed of Capital’, working paper
- Mou, Yiqun (2011), ‘Limits to Arbitrage and Commodity Index Investment: Front-Running the Goldman Roll’, working paper
- Nagel, Stefan (2011), ‘Evaporating liquidity’, working paper
- Neal, L., *The Rise of Financial Capitalism*, Cambridge: Cambridge UP (1990).
- Newman, Yigal S. and Michael A. Riersen (2004), ‘Illiquidity Spillovers: Theory and Evidence From European Telecom Bond Issuance’, working paper
- Pulvino, Todd. (1998), “Do Fire-Sales Exist? An Empirical Study of Commercial Aircraft Transactions”, in: *The Journal of Finance*, 53-3, pp. 939–978
- Reis, Ricardo (2006), ‘Inattentive consumers’, in: *Journal of Monetary Economics* 53, pp. 1761–1800
- Rinne, Kalle, and Matti Suominen (2010), ‘Short-Term Reversals, Returns to Liquidity Provision and the Costs of Immediacy’, working paper
- Scholes, Myron S. (1972), ‘The market for securities: substitution versus price pressure and the effects of information on share prices’, *The Journal of Business*, 45-2, pp. 179-211.
- Shleifer, Andrei (1986), ‘Do Demand Curves for Stocks Slope Down?’, in: *The Journal of Finance*, 41-3.
- Shleifer, Andrei, and Robert Vishny (1997), ‘The Limits of Arbitrage’, in: *The Journal of Finance*, 52-1, pp. 35–55.
- Shleifer, Andrei, and Robert Vishny (2010), ‘Fire Sales in Finance and Macroeconomics’, *Journal of Economic Perspectives*, 25-1, pp. 29–48.
- Smith, M.F.J., *Tijd-affaires in effecten aan de Amsterdamsche beurs*, The Hague: Martinus Nijhoff (1919).
- Van Dillen, J.G., ‘Effectenkoersen aan de Amsterdamsche Beurs 1723-1794’, in: *Economisch Historisch Jaarboek* 17 (1931).
- Vayanos, Dimitri (1999), ‘Strategic Trading and Welfare in a Dynamic Market’, in: *The Review of Economic Studies* 66-2, pp. 219-254.
- Vayanos, Dimitri (2001), ‘Strategic Trading in a Dynamic Noisy Market’, in: *The Journal of Finance* 56-1, pp. 131-171
- Weill, Pierre-Olivier (2007), ‘Leaning against the wind’, in: *Review of Economic Studies* 74, pp. 1329–1354
- Wilson, C., *Anglo-Dutch commerce & finance in the eighteenth century*, Cambridge, Cambridge University Press (1941,1966).
- Wurgler J. and E. Zhuravskaya (2002), ‘Does Arbitrage Flatten Demand Curves for Stocks?’, in: *Journal of Business*, 75-4

Appendix A: mathematical proofs

Proof. of proposition 1.

Start in $t = 2$. The distressed agent has to submit $x_2 = -(w + x_1)$. The only optimization problems of interest are those of type A and B liquidity

providers. Following the usual trick for exponential utility functions, the optimization problem for a type A agent is given by:

$$\max_{y_2^A} (y_1^A + y_2^A) \{E_2[v] - p_2\} - \frac{A}{2} (y_1^A + y_2^A)^2 \text{var}_2[v]$$

When we substitute $E_2[v] = v_0 + \eta$ and $\text{var}_2[v] = \sigma_\varepsilon^2$ this results in

$$y_2^A = \frac{v_0 + \eta - p_2}{A\sigma_\varepsilon^2} - y_1^A \quad (19)$$

Remember that mass M^B only enter in $t = 2$, so in similar fashion we can write

$$y_2^B = \frac{v_0 + \eta - p_2}{A\sigma_\varepsilon^2} \quad (20)$$

For markets to clear in $t = 1$ and $t = 2$ we must have that

$$x_1 + M^A y_1^A + u = 0 \quad (21)$$

$$x_2 + M^A y_2^A + M^B y_2^B = 0 \quad (22)$$

Let $q = w - u$. Plugging (3), (19), (20) and (21) into (22) we obtain expressions (5), (6) and (8).

Proceed to $t = 1$ and start with the optimization problem of the liquidity providers of type A . The total return to these agents can be written as

$$\Pi^A = \frac{q}{M_A + M_B} (v_0 + \eta + \varepsilon) - p_1 y_1^A - p_2 y_2^A$$

Plugging in (8) and (5) and rewriting we obtain

$$\Pi^A = \frac{q\varepsilon}{M_A + M_B} + \frac{q^2}{(M_A + M_B)^2} A\sigma_\varepsilon^2 + y_1^A \left(\underbrace{v_0 + \eta - \frac{\bar{q}}{M^A + M^B} M_A + M_B - p_1}_{p_2} \right)$$

Under the assumption that the equilibrium in $t = 1$ is not fully revealing, q will be a random variable with $q \sim N(\bar{q}, \sigma_q^2)$. This means that Π^A includes three random variables (η , ε , and q), with a square of random variable q and an interaction between random variables ε and q . Consequently the usual trick for exponential utility functions cannot be used. Instead we repeatedly apply the Law of Iterated Expectations (using the fact that η , ε , u , and w are independent) and the following rule (Holden and Subrahmanyam 1994, Lemma 1):

Let $Z \sim N(0, \sigma_Z^2)$. In that case

$$E[\exp(aZ^2 + bZ)] = \exp\left(\frac{b^2\sigma_Z^2}{2(1 - 2a\sigma_Z^2)}\right) \sqrt{\frac{1}{1 - 2a\sigma_Z^2}}$$

We arrive at the following optimization problem

$$\max_{y_1^A} EU [\Pi^A] = \max_{y_1^A} \left[\begin{array}{l} \bar{q}^2 \frac{A\sigma_\varepsilon^2}{2(M_A+M_B)^2} - \bar{q} \frac{A\sigma_\varepsilon^2}{M_A+M_B} y_1^A - \frac{A}{2} (y_1^A)^2 \sigma_\eta^2 + y_1^A (v_0 - p_1) \\ - \frac{A}{2} (A\sigma_\varepsilon^2)^2 \left(y_1^A - \frac{\bar{q}}{M_A+M_B} \right)^2 \sigma_q^2 \left[(M_A + M_B)^2 + A^2 \sigma_\varepsilon^2 \sigma_q^2 \right]^{-1} \end{array} \right]$$

which results in the optimal demand schedule

$$y_1^A = \beta_1 (v_0 - p_1) - \beta_2 \frac{\bar{q}}{M_A + M_B} \quad (23)$$

where

$$\beta_1 = \frac{1}{A\sigma_\eta^2 + A\sigma_\varepsilon^2 \chi} \quad (24)$$

$$\beta_2 = \frac{A\sigma_\varepsilon^2 (1 - \chi)}{A\sigma_\eta^2 + A\sigma_\varepsilon^2 \chi} \quad (25)$$

and where χ is given by (16).

From the perspective of the type A liquidity providers the equilibrium in $t = 1$ is partially revealing. This is only the case if $\delta_1 \neq \delta_2$. Later on we will shown that this is indeed the case. What is $E[(w - u) | p_1] = E[q | p_1]$? First guess the pricing rule in $t = 2$ is as in equilibrium (this will later be confirmed)

$$\hat{p}_1 = v_0 - \delta_1 w + \delta_2 u$$

We can write the signal that the type A agents observe as $v_0 - p_1 = \delta_1 w - \delta_2 u$. Using the usual rules for normally distributed variables we get

$$E[(w - u) | p_1] = \rho_{w-u} (v_0 - p_1) \quad (26)$$

where ρ_{w-u} is given by (17). σ_q^2 is given by (18). Plugging in (26) into (23) we obtain expression

$$y_1^A = \bar{\beta} (v_0 - p_1) \quad (27)$$

For now we write

$$\bar{\beta} = \beta_1 - \frac{\beta_2 \rho_{w-u}}{M_A + M_B} \quad (28)$$

Now move to the optimization problem of the distressed agent in $t = 1$. The total return to the distressed agent can be written as

$$\Pi^D = (w + x_1) p_2 - x_1 p_1$$

The distressed maximization problem can be written as

$$\max_{x_1} \left\{ (w + x_1) E[p_2] - x_1 p_1 - \frac{A}{2} (w + x_1)^2 \sigma_\eta^2 \right\}$$

where $E[p_2] = v_0 - \frac{q}{M_A + M_B} A\sigma_\varepsilon^2$, with $q = w - u$. Remember that the distressed agent takes his own impact on the equilibrium price into consideration. Because

he is forced to liquidate his entire position in $t = 2$, and because p_2 does not depend on a specific mix of x_1 and x_2 , he can ignore his price impact in $t = 2$. However, the price impact in $t = 1$ does matter crucially. Guess (this guess will later be confirmed) that from the perspective of the distressed $t = 1$ prices can be written as

$$p_1 = \tilde{p}_1 + \lambda x_1$$

where λ measures the price impact of trade x_1 . Plugging this into the maximization problem we arrive at the following optimal demand schedule in $t = 1$

$$x_1 = \alpha_1 (v_0 - p_1) - \alpha_2 w + \alpha_3 u \quad (29)$$

with

$$\alpha_1 = \frac{1}{\lambda_1 + A\sigma_\eta^2} \quad (30)$$

$$\alpha_2 = \frac{A\sigma_\varepsilon^2 + (M_A + M_B) A\sigma_\eta^2}{(M_A + M_B) (\lambda_1 + A\sigma_\eta^2)} \quad (31)$$

$$\alpha_3 = \frac{A\sigma_\varepsilon^2}{(M_A + M_B) (\lambda_1 + A\sigma_\eta^2)} \quad (32)$$

We can now calculate the equilibrium in $t = 1$. Plugging in (29) and (23) into (21) we arrive at expression (8). For now we write δ_1 and δ_2 as

$$\delta_1 = \frac{\alpha_2}{M^A \bar{\beta} + \alpha_1} \quad (33)$$

$$\delta_2 = \frac{1 + \alpha_3}{M^A \bar{\beta} + \alpha_1} \quad (34)$$

Using the equilibrium price in $t = 1$ we can calculate the equilibrium demands of the distressed and type A agents.

Before doing so, two crucial elements are still missing: the derivation of λ_1 and proof that $\delta_1 \neq \delta_2$. Write market clearing in $t = 1$ from the perspective of the distressed:

$$x_1 + M^A \underbrace{\bar{\beta}(v_0 - p_1)}_{y_1^A} + u = 0$$

This can be rewritten as

$$p_1 = v_0 - \underbrace{\frac{u}{M^A \bar{\beta}}}_{\tilde{p}_1} + \underbrace{\frac{1}{M^A \bar{\beta}}}_{\lambda_1} x_1$$

This means that

$$\lambda_1 = \frac{1}{M^A \bar{\beta}} \quad (35)$$

Plugging in for (28), using (24), and (25), we arrive at expression (15). Also note that

$$\bar{\beta} = \frac{1}{M_A \lambda_1} \quad (36)$$

With this expression for $\bar{\beta}$ in hand we can reformulate expressions (33) and (34) for δ_1 and δ_2 and write them in terms of λ_1 . Using (30), (31) and (32) we arrive at

$$\delta_1 = \frac{\lambda_1 [(M_A + M_B) A \sigma_\eta^2 + A \sigma_\varepsilon^2]}{(M_A + M_B) (2\lambda_1 + A \sigma_\eta^2)} \quad (37)$$

$$\delta_2 = \frac{\lambda_1 [(M_A + M_B) (\lambda_1 + A \sigma_\eta^2) + A \sigma_\varepsilon^2]}{(M_A + M_B) (2\lambda_1 + A \sigma_\eta^2)} \quad (38)$$

These expressions clearly show that $\delta_1 \neq \delta_2$ if $\lambda_1 > 0$.³²

We can now calculate the equilibrium demands submitted by the distressed agent and the type A liquidity providers in $t = 1$. Start with the expression for x_1 in (29). Plugging in (7) and using expressions (30), (31), (32), (33), (34) and (36), we arrive at (2), with (9) and (10).

Remember that market clearing in $t = 1$ is given by (21). Plugging in for the equilibrium demand of the distressed agent (2), we arrive at (4) with (11) and (12). Multiplying the the equilibrium liquidity supply (4) with the slope of the aggregate demand curve λ_1 and market capacity M^A , we arrive at the final expressions for δ_1 and δ_2 in (13) and (14). ■

Proof. of Lemma 2.

It can be shown that $\frac{\delta \lambda_1}{\delta \sigma_q^2} > 0$ if $M^A + M^B > A \rho_{w-u} (\sigma_\eta^2 + \sigma_\varepsilon^2)$. Since $0 < \rho_{w-u} < 1$ this condition is always met if $M^A + M^B > A (\sigma_\eta^2 + \sigma_\varepsilon^2)$ (see expression (1) on page 26). ■

Proof. of Lemma 3.

$$\frac{\delta \delta_1}{\delta \sigma_q^2} = \frac{\delta \delta_1}{\delta \lambda_1} \frac{\delta \lambda_1}{\delta \sigma_q^2}$$

From Lemma 2 we know that $\frac{\delta \lambda_1}{\delta \sigma_q^2} > 0$ under condition (1). Now look at $\frac{\delta \delta_1}{\delta \lambda_1}$. Using (37) we get that

$$\delta_1 = \frac{A \sigma_\varepsilon^2 + (M^A + M^B) A \sigma_\eta^2}{M^A + M^B} \frac{\lambda_1}{2\lambda_1 + A \sigma_\eta^2}$$

It is easy to show that $\frac{\delta \frac{\lambda_1}{2\lambda_1 + A \sigma_\eta^2}}{\delta \lambda_1} > 0$. ■

Proof. of Lemma 4.

$$\frac{\delta \bar{\alpha}_2}{\delta \sigma_q^2} = \frac{\delta \bar{\alpha}_2}{\delta \lambda_1} \frac{\delta \lambda_1}{\delta \sigma_q^2}$$

From Lemma 2 we know that $\frac{\delta \lambda_1}{\delta \sigma_q^2} > 0$ under condition (1). It is easy to show that $\frac{\delta \bar{\alpha}_2}{\delta \lambda_1} < 0$. ■

³²In the case that $\lambda_1 = 0$, both δ_1 and δ_2 will be equal to zero and price p_1 will still not reveal any information about q .

Appendix B: direction of news

Figure 11: EIC stock price around Fordyce' default, London perspective

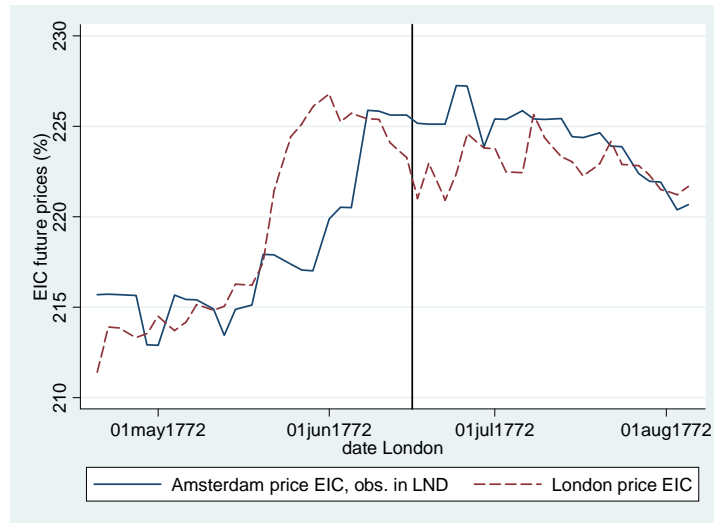


Figure 12: BoE stock price around Fordyce' default, London perspective

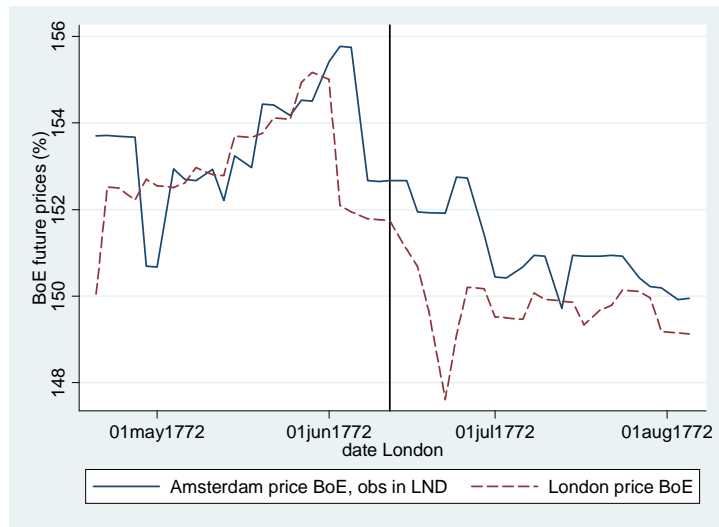


Figure 13: EIC stock price around Clifford et al.'s default, London perspective



Figure 14: BoE stock price around Clifford et al.'s default, London perspective

