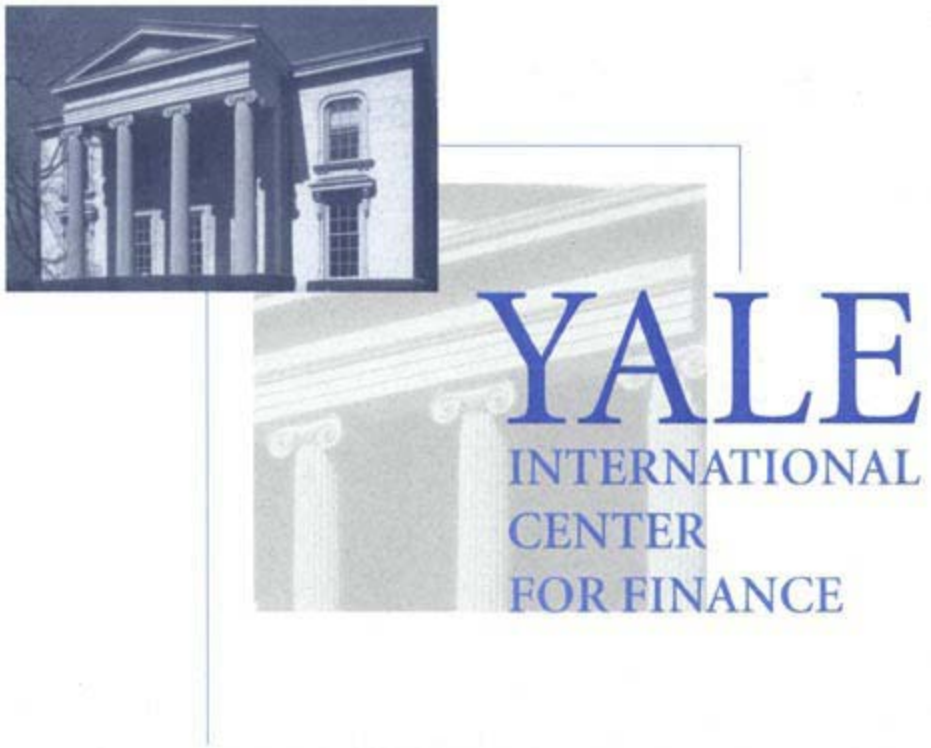

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New Evidence on the First Financial Bubble

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Abstract

The series of events in 1720 called the Mississippi Bubble,South Sea Bubble and the Dutch Windhandel represent the first and by some measures the largest global financial bubble in history. Stock prices of more than 50 companies rose by 100% to 800% in less than a year and then lost nearly all of their gains within two months. The question is: why? In this paper we hand-collect new, high-frequency, cross-sectional data from 1720 to test theories about market bubbles. Our tests suggest that innovation was a key driver of bubble expectations. We present evidence in contrast with the currently prevailing debt-for-equity conversion hypothesis and relate stock returns to innovations in Atlantic trade and insurance. We find evidence consistent with the innovation-driven bubble dynamics documented by Pastor and Veronesi's (2009) for new economy stocks.

Using detailed transactions data for one major bubble company in the Netherlands we also test recent clientele-based theories about bubbles. In contrast to results for the recent tech bubble, we find no evidence that the trades of either insiders or arbitrageurs were coordinated or that they triggered the Dutch 1720 crash. We also show little evidence of arbitrageurs liquidating their positions shortly after the price collapse.

JEL Classifications: G01, G15, N13, N23

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1. Introduction

Asset bubbles are important puzzles in financial economics – important because of their extraordinarily potential for disruption; puzzles because they defy standard notions of rationality. Recent research has highlighted the role of technological innovation in asset bubbles and makes some cross-sectional empirical predictions about security prices during periods of technological change.[1] Pastor and Veronesi (2006), for example, show how growth rates in innovative industries can appear irrational ex post and predict that stock prices for new technology stocks will sharply rise and then fall as uncertainty about technological innovation is resolved. They test these predictions on 19th century railroad securities listed on the New York Stock Exchange.

Other research on the tech bubble has focused on clientele models that separate investor types into arbitrageurs or informed investors on the one hand, and uninformed or noise traders on the other.[2] Abreu and Brunnermeier (2003) for example, model a group of rational, sophisticated investors who contribute to the bubble by "riding" it until bursts. Ofek and Richardson (2003) explain the tech bubble by restrictions on sales of new issues and the crash by the information and supply shock following the lifting of constraints.

In this paper we revisit one of the most famous events in financial history to test hypotheses of financial bubbles and crashes. Using new data from the South Sea Bubble and the Dutch "Windhandel" (literally *wind trade*) of 1720 we analyze a broad cross-section of stocks in the London and Amsterdam markets. These include financial firms, banks, insurance companies, international trading companies, manufacturing firms, mining companies, utilities and companies formed simply to pursue emergent business opportunities. Since some of these firms were engaged in novel ventures with high future prospects, they present an opportunity to test theories about the connection between asset bubbles and periods of innovation and more specifically to shed light on the causes of the first and largest of all international stock market bubbles. We find evidence that innovations in Atlantic trade and marine insurance were strongly linked to

[1] C.f. Hobijn and Jovanovic (2001), Nicholas (2008), Macleod (1986), Pastor & Veronesi (2006, 2009).
[2] Abreu and Brunnermeier (2003), Brunnermeier and Nagel (2004), Ofek and Richardson (2003).

share prices. We find little support for the debt-for-equity hypothesis which claims that investors were primarily enthusiastic about the large scale British government debt conversion.

Using new hand-collected transactions data for one bubble company in the Netherlands for which the buyers and sellers in each trade are identified by name, we are able to test clientele theories on the role of arbitrageurs or otherwise informed investor groups. Contrary to theoretical predictions, we find little evidence that either speculators or insiders liquidated their long positions before, during or immediately after the collapse in the firm's share price. This finding contrasts with previous findings for the bubble in South Sea shares (c.f. Temin and Voth, 2004) and with empirical studies of the tech bubble of the 1990's and suggests that, at least in some crashes, clientele-based explanations for sudden price declines are unnecessary.

1.1 Innovation

Although 1720 is not generally viewed as a period of technological novelty, we argue that there were several important innovations in that year; three of which were financial innovations; the other was a major potential shift in the configuration of global trade.

The first innovation was in government finance. Both the Mississippi Company in France and the South Sea Company in Britain – the two most famous firms in the bubble of 1720 – exchanged equity shares for government debt; in effect converting the national debt of their respective countries into corporate stock. This was clearly perceived at the time as a new financial technology. The 1720 bubbles have historically been attributed to these large scale debt-for-equity conversions.[3] However this attribution has never been formally tested. Only a few of the many companies trading in London, and none of those trading in the Netherlands were public debt conversion vehicles. This raises the question of whether the financial recapitalization schemes were the main drivers of investor expectations. The absence of a Dutch refinancing operation, and yet a dramatic spike in Dutch share prices, suggests that other factors must have been grounds for investor enthusiasm. Until now, the lack of Dutch security price data

[3] Cf. Kindleberger (1978), Neal (1990)

from the period has prevented researchers from examining the Dutch Windhandel in any detail. We discovered a previously unknown news source with detailed price data for Dutch stock markets in 1720 that allows us to do this. We use this new Dutch data to test the government re-funding hypothesis and alternative factors that may have caused the French, British and Dutch bubbles.

The second innovation around 1720 was a shift in global trade. There were several companies in the early 18th century set up to exploit trade in the Americas. The two largest were the Mississippi Company, which owned rights to develop the Louisiana territory, and the South Sea Company which owned the right to export African slaves to Spanish America and to establish trading stations in South and Central America. Both France and Britain hoped at that time to challenge Spanish control of the Atlantic trade. Spain's dominant position was weakened as a result of the War of the Spanish Succession [1701-1714], and the War of the Quadruple Alliance [1718-1720], opening the door to competition. These geopolitical conditions offered economic possibilities and it is logical to posit that they would be reflected in the prices of securities related to New World ventures. Contemporary printed images about the South Sea bubble and the Windhandel contain references to the Atlantic trade,[4] however this alternative hypothesis for the bubble has not yet been tested.

The third innovation concerned risk. Maritime insurance was an essential institution for risk-sharing, particularly for the empires founded on overseas trade such as Great Britain and the Netherlands. Prior to 1720, maritime trade was insured through a market that matched voyages with individual insurers or private syndicates. In 1720, Great Britain changed the *status quo* by chartering the first joint-stock insurance corporations and allowing them to raise capital by issuing shares. The Royal Exchange Assurance Company and the London Assurance Company immediately presented a novel institutional model of capital formation and risk-sharing as they made possible a larger capital base for underwriting. Kingston (2007, 2008) argues that this innovation changed the institutional equilibrium. Within months, the joint-stock company form for insurance

[4] See, for example Het Groote Tafereel der Dwaasheid (1720), and Frehen, Goetzmann and Rouwenhorst (2011).

underwriting took hold outside of Great Britain, spreading to the Netherlands, Germany and beyond. Many of the dozens of IPOs in the Netherlands in 1720 were to finance maritime insurance companies.

The fourth innovation was the short-lived attempt by corporations in Great Britain to pursue opportunities beyond their charter. Leading up to 1720, entrepreneurs had purchased chartered firms and repurposed them by using their rights to issue stock as a means of financing new enterprises. One such entrepreneur was Case Billingsley, the co-founder of the Royal Assurance Company, who, in 1719, purchased the York Buildings Company, a poorly performing London waterworks. He recapitalized it with the issuance of shares to the public and used the proceeds to purchase confiscated Scottish estates. These properties were intended to serve as income-producing capital to underwrite life annuities and life insurance policies.

The legitimacy of these and other attempts to expand the scope of corporations was examined by the Attorney General and debated by Parliament during the course of 1720. It ultimately resulted in the Bubble Act; an anti-speculative law that stopped the London boom in IPOs and the "mission-creep" of existing firms. The fluctuations in share prices of repurposed firms, or firms without clear Parliamentary charter, as well as the many IPOs that were ultimately banned by the enforcement of the Act were, among other things, a barometer of public expectations about the future powers of the corporation vs. the state. The effect of events surrounding the Bubble Act on firms other than the South Sea company has not previously been empirically examined by researchers.

Taken together, these four innovations form a much wider range of possibilities for explaining investor optimism during the first global stock market bubble. In this paper we test whether any or all of them drove expectations and whether changes in the future prospects for any of the innovations were associated with the crash.

2. Historical Background

The roots of the first major innovation discussed in this paper -- exchange of corporate stock for government debt -- was a direct result of the massive debts incurred by wars between France and Britain culminating in the War of the Spanish Succession [1701-1714]. The Bank of England was chartered in 1694 and granted exclusive rights as the nation's only joint-stock bank to issue paper money in return for a 1.2 million pound loan to the crown. Similarly, the South Sea Company was founded in 1711 to exchange the debts of soldiers, sailors and other government creditors with shares in the firm that had exclusive rights to trade in Spanish South America. In 1719 the South Sea Company bid aggressively for a large share of the government debt, which it financed with the public issuance of shares by subscriptions. South Sea Company share prices rose dramatically from January to June in 1720 along with the prices of other British companies and remained flat for most of the summer before falling in September. This event has since been termed the South Sea Bubble.

The Scotsman John Law brought the financial innovation of equity for government debt conversion to Paris where, in 1716 he founded a bank to support government finance. A year later he purchased a company holding royal patents to colonize the territory of Louisiana. Law's Mississippi Company acquired several other trading firms and, in 1720, merged with his Banque Royale to create a monolithic private company controlling most of the French fisc. Mississippi Company share prices rose by a factor of 10 in 1719 and early 1720. The Mississippi Bubble burst in the Spring of 1720 – well before the British and Dutch prices collapsed -- when Law set an aggressive exchange ratio between equity shares and bank-notes; effectively converting French money into equity shares.

It is somewhat surprising that the Netherlands did not follow suit with a government debt-conversion scheme in 1719 and 1720 since it had also incurred debts as a result of the War of the Spanish Succession, and likewise had a long tradition of exclusive patent rights extended to select chartered companies. Gelderblom and Jonker (2009) point out that attempts were made to import this financial innovation but these failed; perhaps because trading patents to the Americas and Asia were already held by corporations,

and a powerful central bank existed in the Wisselbank of Amsterdam. Nevertheless, the price of West Indies Company [WIC] shares rose dramatically in 1720. Its directors made an offering of new shares in mid-August, and a second in September. Prices of WIC shares were already falling by the time of the second subscription and had dropped to a fraction of their peak value by the end of October.

In addition to the seasoned offering of WIC shares there was an attempt in mid-1720 to launch a new firm – an insurance company – in the Netherlands. The floatation of an insurance company was heavily debated among Amsterdam merchants in the early summer of 1720. While recognizing the benefits, underwriters feared unequal competition and monopolies from the new companies. Hence, Amsterdam rejected the proposal to launch a firm. Shortly after this rejection, Rotterdam announced the founding of Stad Rotterdam, the first Dutch limited liability insurance company in July, 1720. It is telling that the charter of Stad Rotterdam mentions the competitive challenge of the new British insurance companies in motivating the need to launch the firm.[5] This suggests that the Dutch were worried about the power of new publicly issued insurance companies, but also excited about their potential.

The Rotterdam IPO set off a chain reaction. Many surrounding cities (such as Gouda and Schiedam) feared losing underwriting business and floated their own companies. Within weeks after the Stad Rotterdam IPO at least 30 Dutch companies have been proposed and rights offerings sold. Almost every prospectus states multiple lines of business, which is consistent with the British enthusiasm for the unconstrained corporation. Moreover, a large majority of the newly floated companies lists insurance among the intentional lines of business, which is in line with growing expectations of a new corporate form for marine insurance. Many of these new Dutch firms rose in price and contemporary accounts describe the sudden burst of speculation as "Windhandel" - trade in wind.

Despite some similarities among the bubbles of France, Britain and the Netherlands, there were also some important differences. In France, John Law consolidated many

[5] Anonymous, 1720, Het Groote Tafereel der Dwaasheid, p. 25.

previously independent companies into a monolithic firm. There is little evidence that, in Paris, investor enthusiasm for share speculation led to the funding of other companies. On the other hand, in both Great Britain and the Netherlands, the year 1720 was a high point in the launching of new projects funded by IPO subscriptions. In London, the rate of new equity subscriptions reached as many as 7 per day. In the Netherlands, there were roughly 30 or more new companies subscribed in a three-month period in 1720 from mid-July to mid-October. In addition, there were new firms launched in other countries including Germany and Portugal.[6]

The regulatory reaction to these new equity issues was mostly negative. The British Parliament passed the Bubble Act in June of 1720 to restrict the trade in joint-stock companies, and the Attorney General subsequently actively enforced this restriction in late August of that year. Similar regulatory constraints on issuance and trade in new companies occurred outside of Britain. On June 26th authorities in Hamburg curtailed the projected public issuance of two maritime insurance companies. Amsterdam sought to limit stock trading on October 6th by city ordinance. By the end of 1720, not only had stock prices in three major European countries risen and then collapsed, but the widespread use of new equity issues to fund enterprise had essentially disappeared in France, Great Britain and the Netherlands and did not reach the same levels until the 19th century.

In the remainder of this paper we examine this period of global investor enthusiasm in detail using share price data to test hypotheses about the specific grounds for investor expectations. The results shed light on how innovations in trade, finance and corporate rights can rapidly and radically alter public expectations about the future, and how these expectations can change just as rapidly by news about prospects for continued public funding of enterprise and governmental regulatory response to the innovations.

3. Data

[6] Cf. Amsinck (1894)

We collect prices reported for Dutch and British companies from the *Leydse Courant* (preserved in the National Library of the Netherlands in The Hague) over the period November 1719 through December 1720.[7] These include quotations for approximately 30 new Dutch Windhandel companies as well as London transactions of British companies, Paris prices for the Mississippi Company and even occasional prices for British firms on Dutch exchanges. We add these prices to those collected by Neal (1990), and to prices we hand collected from British price lists. While merging British and continental data, we account for the difference in calendar conventions between Great Britain and the continent. The trading dates for the British companies have been adjusted to the Gregorian calendar. Hereafter a [G] will indicate a Gregorian date used on the continent, and [J] a Julian date used in Great Britain. In our figures, we interpolate price quotes between trading days for expositional reasons.

Leydse Courant prices are not quoted in currency but expressed as a percentage of par value net of paid-in capital. Share issues at the time were offered as subscriptions that required an initial payment that secured the subscription rights. The initial payment was typically a small fraction (1% to 5%) of the par value of the share and came with requests to make future payments to the company over a period of time – sometimes on a monthly basis, but other times at irregular intervals. This quotation convention makes comparisons across companies straightforward, since it has the effect of normalizing the prices. We are able to verify this reporting convention by matching share loan transactions in the books of Stad Rotterdam with share quotes in the Leydse Courant. Appendix A explains the basis for this interpretation in detail.[8]

By similar means we are also able to verify that Dutch subscribers in shares were not obligated to meet future capital calls and held the right to forfeit their shares. The Dutch prospectuses clearly point out that future capital calls were non-binding and subscription

[7] Our database, including exchange rates as well as equity quotes is available online at: http://icf.som.yale.edu/south-sea-bubble-1720. More data including price quotes in different cities is available upon request.

[8] Although the convention is useful for interpretation of the economic scale of the events of 1720 in the Netherlands, it does not significantly affect the estimates of the bubble in share prices, since these are calculated as percentages normalized either to previous prices or previous quotes.

shareholders held the right to forgo their shares.[9] This freedom to walk away from capital calls on the shares is crucial in the interpretation of the bubble. If companies held the right to enforce commitments then subscription shareholders were, in effect, all highly leveraged and leverage could be a driver of the bubble. Shea (2007) presents evidence contradictory to the leverage hypothesis. He shows that after the collapse of the South Sea bubble, subscription shares were more expensive than their regular counterparts, whereas this relation was usually reversed. In times of falling prices the option to walk away became more valuable.

Prices in the Leydse Courant were typically quoted as a daily range, and we take the average of the range as the daily price. Prices for some companies are quoted in more than one city. In these cases we use the prices from the market with the most liquidity, defined as the market with the largest number of quotes during the period of study. Prices for the major British companies: The Bank of England, the South Sea Company, the East India Company, the Royal Exchange Assurance Company, the London Assurance Company, the York Building Company and a few others were also quoted in the Leydse Courant, suggesting that Dutch investors followed – and likely traded in – British shares. This is consistent with Neal's (1990) hypothesis that Dutch capital flowed into Great Britain in 1720, pursuing equity investment opportunities. News of the finances of France is also regularly reported in the paper, and prices of the shares and related financial claims on the Mississippi Company are quoted frequently. This suggests that Dutch investors were interested in the daily fluctuations of the French firm and may have been actively investing, at least in the year 1720. We are lacking price quotes before November 1719, so it is not possible to trace earlier Dutch investor interest through this periodical.

We augment the Neal data with daily quotation series from Castaing's *Course of the Exchange* and Freke's *Prices of Stocks* for the three major British insurance companies. Although not employed in our empirical analysis, we also augment Francois Velde's (2004) series of Mississippi Company prices with quotes from the Leydse Courant and make it available in a data supplement.

[9] Stad Rotterdam records contain only very few examples of shareholders actually forfeiting their shares.

In addition to time-series data we collect peak to trough data for 35 British companies from a satirical print from 1721 entitled “The Bubblers Mirror” which makes possible a cross-sectional analysis of the bubble by industry. Information about these firms is obtained from Scott (1912) and used to expand the empirical analysis of British firms beyond those for which times-series data survive.

Finally, in addition to price data, we collect all share transfers of the Stad Rotterdam company from the firm’s shareholder books for the period July, 1720 to January, 1721. This data set includes the names of individual investors and we are able to identify their roles as directors, city regents and in many instances their professions and affiliations with the Anglo-Dutch community. The records include both the transaction date and the number of shares transferred. An important advantage of this trading data is its completeness. The shareholder books of the Stad Rotterdam contains trading records for every individual investor, which enable us to determine the number of shares held by each investor at every single point in time. We use this to test clientele-based theories about the crash. The role of different investor groups is a key part of the theory about the tech bubble of the 1990’s however holdings and trading data for this recent bubble episode are incomplete. Tests of clientele theories about bubbles have had to rely on quarterly, long-only holdings of various types of institutional investors. The historical data we collect allows a detailed analysis of both the purchases and sales of clienteles on a daily basis. In this respect it adds substantially to the current research on the tech bubble.

4. Analysis

4.1 Cross-sectional Differences in the South Sea Bubble

A historical reference to the South Sea Bubble suggests a singular episode of stock market volatility exemplified by the spectacular rise and crash of the South Sea Company in Britain. To the extent that other countries such as the Netherlands similarly experienced price increases and declines during 1720, these are often considered to be part of the same temporal period of irrational investor exuberance. Closer inspection of

the data casts doubt on this view, because, as we will show, there was considerable heterogeneity between companies, not only across countries and sectors, but also in terms of the timing of major price fluctuations. Any difference in the timing of the crash across countries and sectors is potentially problematic for the view of a single bubble event, because other research has shown (e.g. Koudijs (2009)) that markets were generally highly efficient in transmitting information across geographical boundaries.

Interestingly, shares of the South Sea Company neither experienced the largest price increase during 1720, nor were they the first to crash in the British market. Figure 1 compares the stock price growth of eight major London companies regularly quoted in The Course of the Exchange and Freke's Prices of Stocks Etc*.,* the other major price list, over the period from November, 1719 through December, 1720. The prices are normalized to 1 at the start of each series, and plotted on a logarithmic scale to allow comparison on a percentage basis.[10] There are three striking features of the graph. First, during the year 1720 almost all firms experienced, at a minimum, a doubling of their share price. However, for four companies the prices at the end of the year were at or below their beginning of year levels.[11] For these firms the increase in share price during the first part of 1720 was a purely temporary phenomenon, while for the others the run-up had a permanent component. Secondly, there is considerable cross-sectional variation in the extent of price run-up. A few firms "bubbled" more dramatically than the South Sea Company, when measured by price appreciation. In particular, the two marine insurance companies, Royal Exchange Assurance and London Assurance rose to much higher multiples of their beginning of the year prices during 1720. The Royal African Company (which, like the South Sea Company, was engaged in the Atlantic slave trade) rose as high as the South Sea Company in percentage terms. By contrast, the two banks, Bank of England and Million Bank, and the East India Company (engaged in the South Asia trade) appreciated much less.

[10] Quotes for two companies, Royal Exchange Assurance and London Assurance began January 1st, 1720 under different names.

[11] Since quotations for the York Building Company only begin in June, we do not know whether it finished up or down for the year, however we know that the increase in the market price from late 1719 was more than 20 times.

The exact timing of the rise and subsequent decline in prices also differs across companies. There were broadly measured two periods of price run-up. A large subset of more established companies peaked in early summer, while a smaller group of younger, predominantly insurance companies reached their highs almost two months later. The share price of the Royal African Company reached a high of 190 on June, 13, 1720. The 4 major stocks of the British market, the South Sea Company, Bank of England, Million Bank, and the East India Company all peaked three weeks later during the 3-day period from July 4 to 6.[12] This period of high prices was relatively brief – with the exception of the Million Bank, all these stocks would fall by more than 10% from their highs during the subsequent week. Despite this decline, there was no crash: prices would remain above their levels reached on the last day of June, due to the sharp run-up in the weeks leading up to the peak. Figure 1 shows that July marks the beginning of a price plateau for this segment of the market.

The insurance business did not participate in the early July rally. And while the rest of the British market drifted down during the summer of 1720, the two insurance companies more than doubled in value between July 4th and August 26th – the day when both insurance companies as well as shares of the York Building Society reached their maximum price for the year. By that time, the South Sea Company was trading 23% off its early summer high; the Bank of England, Royal African Company and East India Company were off by 15%, 31% and 16% respectively.

The two British insurance companies both fell significantly during the four trading sessions following August, 26. The crash in Royal African Company shares began three weeks later on September 14th [G] while the crash in South Sea Company shares began on September 19th [G]. The unraveling of prices in the British market therefore unfolded over a 3-week period, and the South Sea Company was among the last firms to fall. Not only did the bubble develop in stages, but it also gradually deflated before it finally burst. This raises the important question of whether a single factor or coordinating

[12] After dropping from its June 13 high of 190, the Royal African Company traded at 105 on June 28, but rallied again to 170 on July 4th to record its 3rd highest price of the year.

event can explain the (rise and) decline, or whether multiple shocks hit the market during a relatively short period of time, that eventually overwhelmed all valuations.

While Figure 1 clearly shows that the bubble and crash occurred at different times for different groups of stocks, we test this proposition more formally by using a factor analytic approach. Although the limitations of factor analysis for the determination of the number of factors in stock returns have been well studied, factor analytics can provide some quantitative measure of the in-sample significance of the contrasting patterns observed in the London market. It is well-known that in the presence of multiple factors, factor analytic methods can lead to the identification of one dominant factor. This would potentially bias away from rejection of a single factor driving returns in 1720.

We perform a factor analysis on the daily London data, without the York Buildings Company, which has a much shorter price data series and without the secondary issue of the Royal African Company, which essentially tracked the primary issue. Table 1 reports the results of the factor analysis that identifies two factors. Consistent with the visual interpretation of Figure 1 and our analysis of the peaks and periods of greatest declines, the first factor loads heavily on the East India Company and the South Sea Company both of which achieved their high points in the bubble in June. The second factor loads heavily on the Royal Exchange Assurance and London Assurance, and to a much lesser extent on the Million Bank and the South Sea Company. We reject the null of a Chi squared test that the number of factors equals one with a p-value of 8.36e-11 and find that the second factor explains more than 15% of the variance in stock returns. This suggests that at least two factors are needed to explain the differences in returns among the stocks on the London Exchange over the period.

Figure 2 shows the two factors from the factor analysis on the London stock returns. Factor 1 peaks early in the sample period and at a lower level than factor 2, and shows the familiar plateau in prices over the summer of 1720. Factor 2 peaks much later and at a higher level and thus resembles the insurance companies in Figure 1.

We also perform a principal components analysis on the correlation matrix of London stock returns. By scaling the weights to sum to one, we are able to interpret the loadings as relative portfolio weights. As often documented with principal component analysis on stock returns, the first component is roughly an equal-weighted index. The orthogonal, second component is positively weighted on the insurance companies and negatively weighted on all other firms. This evidence is also in line with multiple factors driving share prices in the British stock market of 1720, one factor being the insurance companies.

Taken together the factor analysis and principal component analysis suggest that there were two separate factors influencing the dynamics of stocks in the London market in 1720. One of these is clearly associated with, or at least dominated by, the two insurance companies, while the other is more associated with the South Sea Company and the East India Company. This evidence is in strong contrast with the debt-for-equity hypothesis, which predicts that the South Sea Company is a singular, or at least a dominant factor reflecting the speculation about the profitability of the large scale conversion. The dynamics suggest it shares a common component not only with financial institutions, but also with another Atlantic trade company which was not a conversion vehicle.[13]

4.2 The Fundamentals of Atlantic Trade

To the extent that the two lines of business of the South Sea Company were subject to different information shocks and shifts in investor expectations through time it is tempting to interpret Figure 1 – in which the South Sea Company shares move more closely with Royal African Company shares – as evidence that the South Sea Bubble was primarily about Atlantic trade. Along the same line, the difference between the high growth of the South Sea Company and Royal African Company on the one hand, and

[13] This notion is further corroborated by a clustering analysis on the returns series. Allowing for two clusters to be formed, the London Assurance is treated as a singleton and all other companies are grouped in the second cluster. If we form three clusters, both insurance companies are singletons and the other companies are clustered together. The results are available on request.

the modest growth of the East India Company on the other may reflect expectations about the prospects of Atlantic trade as opposed to the South Asian trade. The newly discovered Dutch price data give us an opportunity to test this. If there were different causes of the price run-ups in Figure 1, reflecting differential expectations of investors about the relative fortunes of companies trading with the East versus the West, then these differences are likely to show up in the Dutch market as well. On the other hand, if the price run-ups of share prices in London were largely idiosyncratic, or due to a different factor entirely, then it is unlikely we would find a similar pattern overseas.

Figure 3 shows the rise and fall of share prices of the Dutch East Indies Company and the West Indies Company over the period of January, 1720 through December, 1720. The data are reported three times per week. The similarities between the Dutch and London markets are striking. First, the run-up in the Dutch market was much larger for the West Indies Company than the East Indies Company. Second, the relative top-to-bottom variance of prices is strikingly similar in both markets. The Dutch West Indies Company bubbled on the same scale as the South Sea Company and the Royal African Company, rising by a factor of 7 over a very short interval. By comparison, the price of the Dutch East Indies Company did not double and, like its British counterpart it fell below its beginning of year value by the end of 1720. The similarity of the Dutch evidence therefore suggests a structure to the bubble, whereby investors distinguished between the expected fortunes of companies based on the fundamentals of international trade. This does not answer questions about the justification of these expectations, but is in sharp contrast with the contemporaneous accounts of random speculation during the 1720s.

The commonality in the patterns of price run-ups in Amsterdam and London suggests a high degree of financial integration between these markets.[14] However, as noted above, the West Indies Company rose later than the South Sea Company or the Royal African Company. Part of the difference can simply be attributed to the eleven-day difference between the older Julian calendar used in London and the newer Gregorian calendar

[14] See also Neal (1990) for a discussion between the integration of Dutch and British stock markets in the 18th century.

used on the continent. But even accounting for this time lag, there remains at least a month difference in the beginning of the bubble trend. This suggests that any spill-over in the run-up ran from Britain to the Netherlands, not vice-versa.

The Dutch data is also interesting from the viewpoint of the timing of the crash. To the extent that the future development of international trade required a well-functioning insurance market, the Atlantic trade factor can be expected to be a common driver of company valuations in these two sectors. The close coincidence of the peak and decline of the British insurance companies and the WIC discussed in the next section lends support this hypothesis. However, other empirical evidence is inconsistent with a single factor explanation of the bubble. Not only did the run-up of insurance company shares in Britain occur when the Atlantic trade sector in Britain had already plateaued, the inception of the decline of the Atlantic trade companies in Britain and the Netherlands does not mirror the close coincidence of the peaks of the WIC and the insurance sector in Britain. This suggests the presence of an additional contributing factor to the bubble and motivates a more detailed examination of the events surrounding their peaks and crashes.

4.3 Events Associated with the International Stock Market Crash

As we have seen, share prices in several companies rose dramatically in 1720, but the timing of their take-off and decline differed. In this section we further examine the timing of the crash. Figure 4 shows the Dutch West Indies Company, Stad Rotterdam, South Sea Company and the two British insurance companies. The trading dates for the British companies have been adjusted to the Gregorian calendar.

As mentioned, the two British insurance companies and the York Building Society reached their peak on the same day – August 26th [G], and began their drop on the 27th [G]. They fell significantly over the following four trading sessions. The Dutch West Indies Company reached its peak on August 28th [G] and began its drop on the following trading day, August 31st [G]. It, too, continued to fall significantly over the following several trading sessions. Together, these four firms – aside from the Mississippi

Company in France – were the first major companies to crash in price in 1720. Since late August seems to have been the important turning point in the London and Dutch stock markets, a natural question to ask is what happened around August 27th [G], or August 16th [J]?

The Leydse Courant reported news about both the British insurance companies in its edition of August 28th [G] noting that, on the 23rd of August [G] the Royal Assurance Company was planning a new issue of shares for the following week, presumably to raise the 50,000 pounds payment to the Exchequer promised by September 11th [G]. This payment was a condition of their charter granted as a result of the Bubble Act.[15] The London Assurance Company was also required to deliver the same sum on that date. The news also noted cryptically that the London Assurance Company "kept silent and sought to learn the secrets of the other firm" presumably alluding to some scandal.[16] This suggested that there was some asymmetric information of potential importance to investors.

Not reported in the Leydse Courant, but known from the *London Gazette* of August 23rd [J] is that the Attorney General issued a writ of *scire facias* on August 18th [J] against four firms (including the York Buildings Company) which were seeking to expand into businesses beyond their charter.[17] This writ represented a serious risk to firms seeking broad latitude. News of the writ could have reached the market shortly before its public promulgation.

The two insurance firms and the York Buildings Company were also ordered to appear before Parliament and present their case for being allowed to issue new shares, as opposed to calling capital from existing shareholders. They made arguments before Parliament on August 23rd [J].[18] This is the same week the Royal Assurance Company had planned a new share offering. Arguments to allow this share issuance were ultimately unsuccessful. Thus, as a result of Parliamentary decisions, current shareholders faced the prospect of a capital call.

[15] Supple (1970), p. 37.
[16] Leydse Courant, vol. 121, p. 2, July 28th, 1720.
[17] Scott (1912) p. 427 identifies the writ as a major factor in the fall of share prices.
[18] Noted in the letter book of Charles Delafaye, secretary to the Earl of Stanhope, Beinecke Library.

Non-legal factors may also have come into play around this time. The Leydse Courant of September 4 [G] reported news from London dated August 30th [G] that a fleet of twelve ships from Jamaica had been lost which were insured by the London Assurance Company for 72,000 pounds.[19] It also noted the burglary of the home of one of the directors of the company. The insurance claim from the fleet and possibly the burglary might have raised concerns about the capability of the firm to meet its September payment deadline.

Thus, over the course of four days in late August, 1720, adverse financial and regulatory news about the two marine insurance companies and the York Buildings Company hit the market and thus represent plausible triggers for the correlated, rapid decline in price for all three firms. Over the course of a week, the three firms declined by roughly 30%. This decline is large enough to have caused financial distress to speculators on margin. In this way it may have led to a broader financial crisis caused by borrowers liquidating securities to cover obligations.

Because they are reported in the Leydse Courant, we can track the dates on which these same news items reached the Netherlands. The lag of three to four days between the crash of London insurance companies and the Dutch West Indies Company is not surprising. Koudijs (2009) calculates that the average 18th century travel time of packet boats between London and Amsterdam was about three or four days. Likewise, the lag of three to four days is confirmed by the Leydse Courant's dated bylines versus publishing dates for London news. We might expect, however, that some reports reached the Dutch capital markets through other channels.

Thus, through public information sources, Dutch investors in the British bubble companies as well as the Dutch West Indies Company would have likely known by August 29th [G] about the financial plans and troubles of the British insurance firms.

[19] The date of this event is incorrectly reported in Postlethwayt (1757) as occurring in October.

They may also have known through private information sources that the Jamaica fleet was wrecked.[20]

It is not clear whether these reports were good news or bad for Dutch investors. The West Indies Company was not engaged in the insurance trade, and the only value-relevant news about the New World (apart from the shipwrecks) might have been the August 30 [G] report in London of the discovery of gold in Jamaica, reported in the September 2 [G] Leydse Courant. Investors may have believed that the development of the Atlantic trade would require an expansion of the insurance industry, but this is inconsistent with the fact that the share prices of the Royal African Company and the South Sea Company remained unaffected for several weeks.

The most likely source of propagation of the crash is through the channel of financial distress. Investors in the West Indies Company who held British insurance shares on margin might have had to raise cash by selling their Dutch assets. The Leydse Courant reported the prices of Royal Exchange Assurance and the London Assurance intermittently for the trading days July 6 [G] to August 24th [G], and for the York Buildings Company from July 19th [G] to August 17th [G]. It seems reasonable to interpret this as evidence of speculative interest in these securities among Dutch investors. Interestingly enough, shares in Stad Rotterdam jumped by 15% from August 28th to August 31st. Since the firm was created to compete with the British insurance companies, the problems of its rivals might have been viewed as an opportunity. Stad Rotterdam did not crash until the end of September. The coincidence of the price peaks for three British firms and the West Indies Company seems best explained by the onset of a liquidity crisis in the international stock markets – a crisis that overwhelmed the capital markets in the following two months. The enforcement of the scire facias writ limiting British companies to their charters and constraining their ability to raise external funds seems to be the leading culprit in the events that sparked the crash, although negative news about one of the British insurance firms also likely played a role.

[20] The Amsterdam insurance market would have had the same capabilities of learning about Caribbean shipwrecks in a timely manner as the London market, since these affected underwriting decisions regardless of who insured the ships.

Beyond the micro-question about what sparked the global financial crash, the one thing we can determine from the time-series of various stock prices is that, while British and Dutch firms rose at different times over the course of the first eight months of 1720, September and October were terrible months for all stocks, including Stad Rotterdam. The crash overwhelmed all stocks regardless of whether investor expectations were based on prospects of Atlantic trade, insurance or banking. Indeed one potential measure of the scale of the bubble is the extent to which non-speculative stocks fell. Under the assumption that firms such as the British East Indies Company and the Bank of England were not driven by speculative factors, then their rise itself represents a puzzle. One possible explanation for the rise of stocks unrelated to innovations is a demand for diversification by investors profiting during the run-up in speculative shares. Figure 1 provides some support for this hypothesis. Shares in the East Indies Company, Million Bank and Bank of England did not begin to rise until after large increases in shares in the South Sea Company and the two insurance firms.

An additional conclusion supported by the rise in Dutch share prices is that government re-funding could not have been the major basis for the British bubble. No Dutch firm was launched to imitate the financial operations of the Mississippi Company or the South Sea Company. The fact that other types of firms bubbled – including the West Indies Company – suggests that the Mississippi and South Sea bubbles were not primarily due to speculation about the debt-equity swap as a financial innovation.

4.4 Cross-sectional Evidence from New Company Issues

The price bubbles in 1720 were accompanied in Britain and the Netherlands by a wave of new company issues. The Leydse Courant provides price information for many of the new firms launched in the Netherlands, however regular price quotations for the new companies in London have not survived. Nevertheless, some information remains to allow an analysis of the cross-sectional differences in the magnitude of the run up in individual share prices. A satirical British print, *The Bubbler's Mirror*, appeared in 1721. It lists a number of the well-known London issues along with the price at issue of the

shares and the maximum percentage price increase achieved during the bubble.[21] This information is sufficient for us to further quantify the cross-sectional differences noted for the larger firms and to determine the extent to which differences observed across industries – i.e. Atlantic trade, insurance and banking -- carry through more generally. We categorize companies listed in the Bubbler's Mirror into several industries and Table 2 shows the average growth by industry. The first column includes the large traded firms previously studied. In the second column, to alleviate the potential data-snooping issue, we removed the Bank of England, the Million Bank, the South Sea Company, the Royal African Company, the Royal Exchange Assurance, York Buildings Company and the London Assurance from the calculations. The one exception is the inclusion in both columns of the East India Company as a basis for comparison.

In order to test the hypothesis that the British firms associated with the Atlantic trade reached higher premiums over par values, we performed a t-test on the log growth rates of the Atlantic trade firms and tested the null that the growth rate for the East India Company was drawn from the same distribution. Despite the few degrees of freedom, we were able to reject the null with greater than 85% confidence. The test was performed for two specifications: simple growth rates and logged growth rates. In growth rates, the t-value was 4.25 on 3 df. For log growth the t-value was 6.15 on 3 df. The important caveat is that the small sample and its unknown distributional properties potentially limit the interpretation of parametric tests.

Table 2 shows that the insurance sector experienced the largest price growth during 1720. Five of the top seven firms ranked by growth were insurance companies. Column 3 shows that excluding the Royal Exchange Company, York Buildings Company and London Assurance Company reduces the scale of the bubble in insurance firms, but does not change its top rank. This is due to the fact that two firms (General Insurance and British Insurance) bubbled on a comparable scale to their more widely traded cousins.

[21] Reported in Scott (1912) vol. 1 p.410. We manually categorized the firms in industries based on their names and firm descriptions.

This cross-sectional industry-level evidence suggests that the exuberance of London investors was greatest for certain industries. Although the Atlantic trade is the obvious candidate given the fame of the South Sea Company, the data suggest that there was perhaps even a larger bubble in insurance. The prominent position of the insurance companies in the bubble was noted by contemporary observers; most famously, John Aislabie, Chancellor of the Exchequer who took a bribe of 20,000 pounds of South Sea stock in return for his political support of the firm. In his unsuccessful defense before the House of Lords, Aislabie exclaimed of the two insurance firms: "these two projects were founded in greater iniquity and contributed more to the publick calamity than anything else." [22]

An interesting feature of the Bubble Act of June 9, 1720 [J] which asserted governmental control over chartering companies for limited purposes is that it did not directly concern the South Sea Company. Rather, it chartered the London Assurance and the Royal Exchange Assurance companies and explicitly limited the chartering of competitors.[23] It also restricted the issuance of shares and trade in companies not chartered by Parliament. The restrictions on share issuance also affected "repurposed" firms such as York Buildings Company, although not necessarily trade in their shares, since price quotes appear in the press in June and continue from then onwards – with an exception of a few days' hiatus after the writ of scire facias and the August crash. It thus makes sense to look at the bubble in 1720 through the lens of financial innovation in the insurance sector as much as from the perspective of an event driven by massive government debt conversion, or indiscriminate speculation in company shares.[24] The dynamics of the York Buildings Company is particularly instructive because, unlike the two chartered insurance firms, its growth prospects depended crucially on a lax interpretation or enforcement of the Bubble Act. The fact that it plunged so dramatically suggests that the prospects for unconstrained corporate enterprise were dramatically reduced by the writ.

[22] Mr. Aislabie's second speech on his defense in the House of Lords, London (1721) p. 14 quoted in Scott (1912) p. 405.
[23] This may account for some of the spread observed within the insurance industry.
[24] For a view of the effect of the Bubble Act on business organization, see Harris (1994) and Harris (2000).

4.5 Consequences of the Crash

The crash in the equity markets in 1720 was a significant setback for financing of enterprise. The success of the public insurance corporation depended on the external demand for shares and the availability of public investment capital. These dried up with the global contraction of securities markets following the crash in Great Britain. Had the global crash not occurred, public investment in marine insurance underwriting at least in the Netherlands might have continued. After 1720, many of the new Dutch firms closed and returned shareholder capital (or issued financial substitutes such as life annuities). A few firms survived and prospered. The Middelburg commerce company became a major player in the Atlantic economy – including the slave trade – in the late 18th century. Stad Rotterdam also fulfilled the promise of the potential of a publicly capitalized insurance corporation. It survived and prospered to become one of the largest insurance companies in continental Europe, eventually merging into the financial giant Fortis.

The survival of Stad Rotterdam, London Assurance and Royal Exchange Assurance into the modern era proved the long-term viability of incorporated insurance companies. Given that the average trough to peak price increase for most of the Dutch companies was comparatively modest, it is difficult to view investors in 1720 as wild speculators. The underlying rationale for investing at the time – i.e. innovation in the financing of marine insurance underwriting and the pursuit of other business opportunities using the corporate form does not appear to have been unreasonable.

5. Testing theoretical predictions

Bubble theories broadly fall into two categories: theories about innovation and theories about clientele behavior and crashes. The first strand of literature attributes bubble-like patterns in share prices to changes in expectations potentially as a result of large scale innovations. By contrast, clientele-based studies categorize traders into groups whose coordinated actions have significant price effects. Many theories are motivated by, and empirically tested on, recent examples of bubbles and crashes such as the tech bubble,

although some authors have also utilized stock prices from bubbles in earlier eras.[25] This reliance on recent data sets, which is a direct consequence of data availability, raises concerns about the generality of the outcomes. Do modern theories also fit other classical examples if bubbles, such as the South Sea Bubble? A second drawback of recent studies is the testability of clientele-based theories. As a result of the exponential growth in number and frequency of trades over the last centuries, modern data sets contain only a tiny fraction of the spectrum of trades and traders during a bubble episode. This makes clientele-based theories, relying on a categorization of traders in groups difficult to test.

Our historical data provide an excellent opportunity to contribute to the bubble literature by testing recently proposed bubble theories out-of-sample. Our tests thus shed light on the degree to which current theories are able to capture share price and trading dynamics in earlier bubble episodes. Moreover, the much smaller universe of traders and lower frequency of trading, allow us to focus on one of the major Dutch bubbling shares and track every single trade and trader for that company. As a consequence, we are able to more powerfully test both types of theory during one of the classical examples of a bubble.

5.1 Innovation theories

Pastor and Veronesi (2009) suggest that the dynamics of the Nasdaq bubble may reflect a natural process of learning around the introduction and adoption of a technological innovation. They distinguish two stages. In the first stage investors learn about the benefits of a new technology, and the associated new economy stock prices rise rapidly with expectations about increasing future cash flows. This stage is characterized by learning and gradual adoption of the new technology, expected growth in future productivity, idiosyncratic price increases and high relative volatility of new economy stocks. With broad adoption, these stocks become central to the economy, and their risks become more systematic which drives up their betas and discount rates.

[25] Brunnermeier and Nagel (2004), Pastor and Veronesi (2006) and Ofek and Richardson (2003).

In the latter stage, the effect of the increase in discount rates eventually overtakes the initial effect of an increase in expected cash flows, which results in a decline of the prices of new economy stocks. In its most general terms, the model predicts that a new technique or method appears, experiences a developmental phase, and then culminates in widespread adoption, manifested by large-scale capital investment based on expected future cash flows, and finally it experiences a decline in capitalization due to a discount-rate effect. The Pastor and Veronesi model further predict that the firms employing the new technique will have specific risk characteristics. In particular, the model predicts that in the early stage, the volatility of stocks rises with uncertainty about productivity gains, but that the increase in volatility of new economy stocks exceeds the increase for old economy stocks. In the later stage the model predicts an increase in the beta and a decrease in price for new economy stocks. We examine these empirical predictions in our 1720 sample, and find results that are consistent with the theory.

5.2 Clientele theories

Clientele theories posit that certain sub-sets of investors play a major role in bubbles. Abreu and Brunnermeier (2003) show how coordination failures can explain the persistence of asset bubbles even when rational arbitrageurs know stocks are over-valued. Lacking market power, arbitrageurs choose to ride the bubble until they can coordinate their selling. A synchronizing event like a large price drop can serve as a coordination trigger and cause immediate liquidation by arbitrageurs. The Abreu and Brunnermeier model predicts that rational or informed traders will liquidate positions immediately following a large price decline and not re-invest. They stay out of the market because they had prior knowledge that prices were inflated. Brunnermeier and Nagel (2004) and Griffin, Harris, Shu and Topaloglu (2011) test the theory using 13F institutional ownership data, and find that hedge funds appeared to ride the tech bubble around the peak of the Nasdaq market in 2001. Temin and Voth (2004) use trades by wealthy individuals during the South Sea Bubble and find evidence consistent with Brunnermeier and Nagel (2004) for this group.

Ofek and Richardson (2003) propose a different clientele theory of the tech bubble. They link asset bubbles to short sales constraints and the expiration of lock-up agreements on insiders. A bubble can occur in a market with short-sales constraints because optimistic investors can buy but pessimistic investors cannot short. When short sales restrictions are removed, pessimistic investors can express their beliefs and prices decline. Ofek and Richardson (2003) argue that lock-up agreements following IPOs serve as short sales constraints on informed institutional investors. They find that previously constrained investors massively sold after their lock-up period expired, resulting in a strong negative relation between insider selling decisions and stock returns in the days after the beginning of the selloff.

We test these hypotheses using the company trading records of Stad Rotterdam during the collapse of share prices in the Netherlands in 1720.

5.3 Innovation tests

In practice it is difficult to precisely test the Pastor and Veronesi (2009) theory when there are multiple overlapping innovations for which the timing of the inception and adoption of each may not be clearly identifiable. In 1720, we identify a number of innovations which may be dependent on each other, resulting in a period of dynamic change on multiple fronts. Despite these empirical challenges, in this section we test some of their predictions. The first major prediction is that there is a new technique, method or opportunity with the potential to change the economy and that it is adopted by some firms and then grows to prevalence. The second proposition states that the betas of new economy firms increase before the widespread adoption and then drop with the discount rate effect taking over. A third prediction is that the new economy volatility is larger than the old economy volatility.

To perform these tests we define a time-frame over which the new economy technologies were likely to have been adopted. Prices for Atlantic trade stocks extend for several years prior to 1720, while prices for insurance company stocks commence only in 1720. Over these time-frames we construct indexes of cumulative returns of

London old and new economy stocks using daily time-series trading data on London stocks beginning in 1715; adding firms into their respective indexes as price data become available.

Following Pastor and Veronesi, we classify British and Dutch firms into new and old economy firms. The British old economy is composed of the Bank of England, Old East India Company and Million Bank and the British new economy consists of the York Building Society, Royal African Company, New African Company, South Sea Company, Royal Exchange Assurance and London Assurance. The Dutch old economy consists of the Dutch East India Company and the Dutch new economy includes all remaining firms for which we observe price quotes. The British new world index is comprised of the Royal African Company, New African Company and South Sea Company and the Dutch new world index is represented by the Dutch West Indies Company. The York Building Company, Royal Exchange Assurance and London Assurance make up the British insurance index. The Dutch insurance index contains all firms which indicate insurance as a line of business.[26] The indices are value-weighted by nominal capital and a firm enters the index when the first price quote is observed.

As indicated above, the innovations we empirically study fall into three categories. First one set of firms captures the investment opportunities associated with the Atlantic trade. Second, the maritime insurance companies in Britain and Holland capture the innovation in risk sharing. This innovation was indeed novel but its profitable expectations may have been driven by the fundamentals of Atlantic trade. The third innovation was the freedom of the corporation asserted by entrepreneurs during the year 1720. This may also have been related to the other two innovations. In Holland, for example, we see that virtually all the new firms named maritime insurance as one of multiple lines of business. However, in Britain the last innovation was nipped in the bud by the Bubble Act, which was perceived by investors as a prohibition of conducting business outside the charter.

[26] Of the 26 Dutch companies for which we retrieved data, only 8 do not state insurance as a possible line of business: WIC, OIC, Middelburg Commercie, Edam, Naarden, Hoorn, Veere, Brielle and Brielle. We refer to the online database for the complete set of Dutch companies: http://icf.som.yale.edu/south-sea-bubble-1720

We test Pastor and Veronesi's proposition that new economy firms become a substantial part of the British economy by examining the relative size of old and new economy shares.[27] Figure 5 displays the market capitalization of value-weighted indices of old economy, new world and insurance companies.[28] The figure shows that Atlantic trade companies gradually increased their market share after a public offering by the Royal African Company in August 1719. By June 1, 1720 [G], firms trading with the new world have outsized the old economy and thus become a substantial part of the British economy. The time series of insurance companies' relative market share differs markedly from their Atlantic trade rivals. Not only is their relative size much smaller throughout the bubble months, the insurance sector also integrates much later. Marine insurance companies enter the British market after the floatation of the Royal Exchange and London Assurance in early 1720. Consistent with the findings of our factor analysis in Table 1 and patterns observed in Figure 1, the insurance business reaches its peak in terms of market share, in late August 1720 [G]. By that time, the value-weighted market capitalization of the insurance sector is about 40% of the size of the old economy. The fast integration of both industries into the old economy is in line with Pastor and Veronesi's hypothesis of new technology risk slowly turning from idiosyncratic into systematic.

Pastor and Veronesi also predict that new economy stocks will be more volatile. We test this using Levene's test for equality of variance in Table 3.[29] We reject equality of variance for old and new economy stocks in both Britain and the Netherlands, consistent with the prediction about the relative risk of old vs. new economy stocks. This finding is also in line with Schwert (1990), documenting a jump in volatility around crises and crashes. Our results are not changed by definitions of new economy shares, which is consistent with multiple innovations changing the British economy.

[27] We restrict this analysis to the British market since the Dutch economy merely consisted of the East and West Indies companies before the Stad Rotterdam IPO in July 1720. Moreover, the East India Company was many times larger than its Western counterpart and thus dominated the market.

[29] For specification of Levene's test and analysis of its robustness see Levene (1960) and Thorpe and Holland (2000).

Table 4 tests the key predictions of Pastor and Veronesi about discount rates and their effect on stock prices. It reports results of Chow-tests of structural breaks in betas of each index with respect to a value-weighted index of all firms. We specify 27 August, 1720 as the British break date and 1 October, 1720 as the Dutch break date. The first set of columns report beta before and after the break date for each set of firms. Columns labeled 'F-Stat Chow' and 'p-val Chow' report the F-statistic and p-value of the Chow test under the null of beta equality before and after the break date. The set of columns named 'Wald' and 'p-val Wald' display the Wald-statistic and corresponding p-value on the equality of beta over the sample periods before and after the break date.

The results show that betas for Dutch and British new economy sectors were different before vs. after the crash. In Britain, all new economy portfolios had higher betas after the crash, consistent with the Pastor and Veronesi prediction, while old economy stocks had significantly lower betas. On the other hand, the opposite pattern is observed for most Dutch indexes, insurance being the exception. The betas of the new economy stocks drop rather than rise. The evidence in support of the Pastor and Veronesi theory about discount rates during periods of financial innovation is thus mixed. We find structural changes in the market betas in both markets, larger bubbles and crashes for the new economy indexes, but only for Britain do we find the change in beta to be in the direction predicted by Pastor and Veronesi. This mixed evidence may be due to the fact that, for Britain, we have a longer data set of prices observed at daily frequency, while for the Netherlands we have three-times per week data over a much shorter horizon. Moreover, as a result of the monopolies on Eastern and Western trade held by two large corporations, there is little variation within the new world and old economy sectors.

5.4 Clientele theory tests

In this section, we address the theoretical predictions of Abreu and Brunnermeier (2003) and Ofek and Richardson (2003) about clientele-based determinants of market crashes. Using individual trading records of one of the Windhandel companies, we test whether arbitrageurs and informed traders purchased stock in Stad Rotterdam as its price rose

in 1720, and whether they coordinated their selling around the major price decline in October. Finally we examine whether they closed out their positions following the bursting of the bubble. To do this we hand-collected all trades in Stad Rotterdam in the year 1720 from the shareholder register and the share transfer books that were maintained by the company. Stad Rotterdam was unquestionably one of the major speculative companies of the Windhandel. It had the highest peak-to-trough value of all newly issued Dutch shares in 1720 and the company recorded more than 3,000 transfers through December of that year. This makes it an ideal candidate for testing theories about bubbles and crashes.

Previous studies of clientele share transactions in British shares during the bubble include Carlos, Moyen and Hill (2002) who study the trade in Royal African Company shares in 1720 and Temin and Voth (2004) who examine investor trading by a single organization, Hoare's Bank, in South Sea Company shares during 1720 and found evidence of successful market timing. We apply a similar approach to Temin and Voth, however instead of a single trading institution, we have 534 traders who in sum recorded 3,010 transfers in the books of the company. While there may also have been secondary trading activity and brokerage that occurred between these recorded transactions, we have a very rich sample with which to explore commonalities among investor behavior and test the proposed theories about clientele causes of bubbles and crashes.

We use two approaches to sorting investors into clienteles. The first method uses information about their investors' identities, such as their profession, political position, inclusion in the Anglo-Dutch community of cross-Channel merchants, and their position in shares at the end of the year 1720. These groupings allow us to examine the potential effects on trading behavior of asymmetric information via political and mercantile connections. The second method uses a clustering algorithm to group investors based on their trading behavior. This approach lumps together investors who traded in the same direction on the same day and allows us to differentiate which ones were buying and which were selling on key days when the market moved. We then

examine the trading behavior of these groups around the crash and ask whether their trades resemble the predictions of the clientele models, in particular whether any of the groups appeared to ride the bubble, whether the actions of any group appeared to trigger major price declines, whether any group sold out when the bubble burst and finally whether any group exhibited timing ability. This approach allows the data to identify groups which may have existed but which differ from the exogenous classifications indicated above.

Ideally, for comparison to modern theories about bubbles, we would like to identify a group that behaved like modern hedge funds or arbitrageurs. However, there is no natural classification way to isolate "arbitrageurs". Instead, we rank shareholders by trading activity during the period from July to December, 1720 and define the top 25 shareholders in terms of number of transactions as "arbitrageurs."[30] We exclude company directors from this ranking because they may have longer-term objectives. We separately examine the trading activities of directors and ask whether their trading appears "informed" and study whether directors acted as an informed clientele that potentially triggered the selloff.[31] The trading data allow us to test the main empirical prediction of Abreu and Brunnermeier's synchronization theory.

It is helpful to provide some background on the groups trading in the stock of Stad Rotterdam. The firm had 12 directors and some of these traded relatively frequently. Directors were elected by shareholders from a slate of proposed 36 candidates. This identification allows us to test whether the actions of insiders triggered a price decline. We also identify 63 Rotterdam regents in the sample. Regents were essentially members of a mercantile-patrician class who *de facto* ruled Dutch cities. They were heavy subscribers to the Stad Rotterdam IPO and Slechte (1972) indicates that they were given preferential allotments in the IPO at its initial issue price which resulted in great paper profits for this group at the peak of the bubble.

[30] We have performed the same tests on the top 10, top 50 and top 100 and found similar results. We have also performed tests using a different definition of an arbitrageur, i.e. define an arbitrageur as a trader who executes buying and selling orders on the same day. Results are available on request and in line with the evidence presented here.

We presume that regents were relatively well informed through their personal connections about prevailing market conditions affecting security prices including financial distress of related institutions and financial market participants. Given their large positions and their large unrealized gains at the height of the Stad Rotterdam bubble, the regent group was highly motivated to lock in profits by selling prior to a market decline.

The third major clientele identified in our sample is a group of 43 Anglo-Dutch investors. Rotterdam was the major port for trade between Holland and Britain and it was organized and partially controlled by merchant families of British heritage who sent sons across the channel. The British navigation acts effectively conferred a monopoly on the Atlantic trade with New World British colonies to British merchants, giving the Anglo-British traders in Holland a relative advantage. We would expect this clientele to have some informational advantage about economic events and trends in the British markets which they might share among themselves. We identified 43 Anglo-British investors in the books of the Rotterdam company.

Finally, a number of investors – the initial subscribers to the firm -- are identified by profession. While this seems promising for the analysis of clienteles, most of the active traders are identified as merchants who presumably engaged in business that relied on insurance and the other stated lines of business of the Stad Rotterdam company. In addition, they were the most likely group of traders to be part of an information network of business contacts. In short, it is unlikely that well-off merchants whose occupations involved trading and banking acted as uninformed noise traders during the 1720 bubble. Rather, to the extent that any speculators had superior information, they probably belonged to the merchant class. On the other hand, merchants were so prevalent compared to any other classification that this identification failed to sufficiently divide the trading clienteles for our purposes.

Figure 6 shows the positions of each group by number of shares over the period from June 30th through the end of the year. It also shows the share price of the Stad Rotterdam company. While the section below will discuss statistical tests about these dynamics, Figure 6 shows a few key things. First, none of the groups appears to have unloaded their positions following the crash. The only exception is a group we ex post identified as "sell-outs" i.e. those investors who had a zero position in the stock at the end of the year. This group appears to have sold out half of its position in the month following the IPO, prior to the peak and crash, when prices were mostly rising. Thus even the sell-out group does not fit the model of a group of arbitrageurs who ride a bubble and sell out triggering a crash. The holdings in Figure 6 are also inconsistent with Ofek and Richardson's hypothesis of investor groups being short sale constrained. Investor groups with a preferred short position in the Stad Rotterdam share would naturally close their current position.

On the other hand, the "arbitrageur" group increased its position during rising prices but also increased its position during the period of declining prices and notably on the day of largest price decline. Most importantly for our test, the group held more shares at the end of the year than at the time of the IPO. Arbitrageurs did not sell out after the bubble burst. The only group that exhibited a drop in position around the crash is the regents – i.e. members of the Rotterdam ruling class whom we presume to be politically connected. However their position through the end of the year rose again to where it started at the time of the IPO.

In Table 5 we more formally document the trading activities of these groups. The first panel of the table shows the holdings on June 30 and December 31, 1720. Apart from those who sold out, the only group whose position declined over the six months was the infrequent traders, and even their position declined only by 15%. The minimum positions do not suggest a major decrease in holdings within the year, either. The average size of the trades for each group indicates that the infrequent traders were also those trading relatively small quantities compared to the active traders whose average trade size was about 40 to 50 shares. This may be explained by the active traders

serving as brokers, however we observe similarly large trades by directors and Anglo-Dutch investor groups.

In panel II of Table 5, following Temin and Voth, we test for investor timing skill. We also test for momentum behavior – both characteristics of arbitrageurs identified by Abreu and Brunnermeier. We aggregate the holdings of each group into a portfolio and test whether the net change in holdings each day is inter-temporally related to past or future ten-day return of the Stad Rotterdam share price. We apply the Henriksson-Merton [HM] timing test for known predictions, where the sign of the position change on a given day is interpreted as either a positive, negative or neutral signal. We make an adjustment for serial dependent stock returns and forecasts following Tavaré and Altham (1983). The HM test can be used equally well for testing for significant trend-chasing behavior or timing ability, depending on whether past or future stock returns are used as a dependent variable. Panel II indicates that the arbitrageurs displayed significant trend-chasing; i.e. a positive change in share position tended to follow positive ten-day past returns. This was true for no other group.

The HM test for market timing shows evidence of timing ability by directors and by Anglo-Dutch investors, and marginal ability by Regents (significant at the 10% level). The aggregate portfolios of arbitrageurs, sell-outs and infrequent traders showed no evidence of timing skill. The positive timing results for two of the clienteles is of course interesting and raises a question of whether their particular information networks led to prior information about a price drop, or a different opinion about the probability of a crash. Given that the financial crisis propagated across the channel from Britain, perhaps the Anglo-Dutch traders were more attuned to the possibility of a price decline. This hypothesis cannot be tested without further historical documentation.

In panel III of table 4 we follow the specification of Temin and Voth to separately analyze the purchases and sales of each clientele. If arbitrageurs purchased shares ahead of positive price changes, this would lead to a positive slope coefficient in a

regression of future stock returns on a constant and a dummy variable $D_{Buy,t}$ that equals 1 on days when arbitrageurs bought shares and zero otherwise,

$$\frac{\ln(P_{t+\tau})}{\ln(P_t)} = \alpha_{Buy} + \beta_{Buy} D_{Buy,t} + \varepsilon_{t+1}, \qquad (1)$$

where τ measures the return horizon over which we study the relation between trading decisions and stock returns (10 days). Likewise, the successful timing of price declines by arbitrageurs would lead to a negative slope coefficient in a regression of future returns on a constant and a dummy $D_{Sell,t}$ which takes on a value of 1 on days arbitrageurs sell shares and a value of 0 otherwise:

$$\frac{\ln(P_{t+\tau})}{\ln(P_t)} = \alpha_{Sell} + \beta_{Sell} D_{Sell,t} + \omega_{t+1}. \qquad (2)$$

The intercept term α_{Buy} in the first regression estimates the mean return for the next ten-day period following a day on which no net purchase by that group took place, and likewise for the second regression the α_{Sell} estimates the mean return on days for the next ten-day period following a day on which no net sale by that group took place. We chose July 27, 1720 as the start date for the regressions as to exclude the purchase of shares that are associated with the initial subscription.[32] For the two clienteles who exhibited timing ability in panel II, Directors and the Anglo-Dutch, the slope coefficients are more significant for sales than for purchases. Combining the evidence of Panels I-III, we conclude that while some clienteles were able to time the returns of the Stad Rotterdam, they did not match the prediction of the clientele models of selling and staying out after the burst of the bubble.[33] On the other hand, the clientele that did sell out, traded in a random fashion and did not display any timing ability as measured by standard tests.

[32] The first recorded trade price of 2800 guilders likely exceeds the unknown subscription price by a wide margin, but we would not want to confound arbitrageur profits from the IPO with the profits that stem from successful market timing of the crash.

[33] As a robustness test we perform ran the timing ability tests with non-intepolated price series. This did not materially change our results.

Panel IV of Table 5 calculates the internal rate of return for each clientele portfolio. The first row measures the IRR derived solely from the period over which we have active trading information. There is a three week gap between the IPO date and the first recorded market prices during which the price increased substantially. Having no market prices for this period, we are unable to determine the effects of these early trades on investor portfolios. The first line in panel IV thus ignore the potential profits from the IPO "pop" but fairly measures returns to active trading. What it shows is that the arbitrageur group was among the least profitable, while the infrequent traders were the most profitable. This evidence is contradictory to the hypothesis of active traders profiting from superior skill or access to information.

However, omitting the early trading days from our analysis most likely introduces a downward bias in profitability figures since prices went up in this stage. To correct for this lost profit, we assume that initial subscribers bought shares at a price of 250 and we smoothly interpolate prices until the first observed price quote in the last two lines of panel IV.[34] Including the profits from the initial IPO allocation, under the assumption of a 250 guilder subscription price shows that most clienteles – except the group that sold out -- were profitable over the year despite the extreme volatility. Comparing lines one and two in Panel IV corroborates the fact that most gains were realized during the first three weeks after the IPO.

In Table 6 we repeat the same set of tests for groups formed through a clustering procedure. As indicated above, this is motivated by the possibility that a group of active arbitrageurs who rode the bubble and then sold out near the top may actually exist in the data, but does not correspond to ex ante specified clientele. We limit the analysis to the 124 investors with at least ten trades in the period. This provides sufficient dimensionality to estimate robust clusters. We form clusters by converting each investor trading record into a time series of positive 1, 0 or -1 depending on whether the

[34] 250 guilders is an absolute lower bound on the assumed IPO price since we are able to track, in the company books, that each share holder at least paid in 250 guilders over the course of the year 1720.

trader position increased, stayed the same or decreased in that day. We throw out days the market or the company transfer books were closed. We calculate a Euclidean distance matrix for the set of traders and apply a nearest-neighbor hierarchical clustering algorithm.[35] We then choose a level to cut the hierarchical tree into groups that divides the bulk of the traders into a few differentiated sets. Ten clusters is sufficient to generate four groups of ten traders or more.

A Chi-square test of the table rejects the null of random sorting of investor groups into clusters. [36] Clusters 6 and 8 have a high fraction of Anglo-Dutch, Directors and Regents. Clusters 3, 4, 6 and 10 have significant positive HM timing measures. Cluster 10 is a singleton. Cluster 6 is consistent with evidence that Anglo-Dutch investors and Directors as a group exhibited positive timing skill. However, all groups with positive timing skill had higher holdings at the end of the period, which is inconsistent with the existence of arbitrageurs who rode a bubble and then close their positions. The trades of each of these groups are large relative to their initial and final positions, indicative of active change of position during the period, but in no case did the positions decline to zero and in three of the cases the minimum holding was equal to the initial holding. As with the investor groups in the previous table, the IRRs based on trading decisions absent the initial allocations are all negative.

6. Conclusion

In this paper, we re-examine the view that the 1720 bubbles in Britain and the Netherlands were the result of large scale debt-for-equity conversion programs fueled by irrational exuberance. Our analysis of a large cross-section of British and Dutch share prices suggests a structure to the stock price movements of 1720 where investors appear to distinguish between companies based on the prospects of international trade and insurance. This view is supported by a factor and principal component analysis, showing the presence of two factors, none exclusively related to debt-for-equity conversion risk.

[35] The function 'hclust' in the R statistical language.
[36] The Chi-square statistic has a value 44.53 on 27 degrees of freedom. This corresponds to a p value of 0.018.

The difference between the stock price behavior of British companies trading with the East versus the West suggests that expectations about the Atlantic trade represented one of the factors driving the bubble. These British results are mirrored by similar differences in the range of price variation of the Dutch East and West Indies Companies in the Amsterdam market. Our conjecture about the importance of Atlantic trade is further supported by a principal component analysis which attributes equal weights to companies trading with the West, rather than separating the South Sea Company as a conversion vehicle.

Events surrounding the speculation in insurance companies were responsible for a second and separate important factor contributing to the bubble. The chartering and incorporation of insurance companies in the early 18th century was an important financial innovation, because it extended the features of limited liability and access to public capital markets to firms that dealt in risk. The new, liquid stock markets allowed public insurance firms the capacity to increase their capital base and to diversify their risks. These features may have been perceived as valuable financial innovations at the time. Perhaps surprisingly, the insurance sector experienced larger peak-to-trough price fluctuations than the companies involved in Atlantic trade, or any other sector for that matter. The hypothesis that insurance companies were an important and distinct factor contributing to 1720 bubbles, is further supported by a principal component analysis, loading heavily on the two insurance companies while taking negative positions in all other firms. Like the Atlantic trade factor, a time series analysis also sets the insurance companies apart from the other firms. The insurance bubble gains strength when the other bubbling companies have reached their peak and start to deflate. As a result, the insurance companies peak two months later, bearing remarkable similarity to one of the factors from the factor analysis.

Innovation and the emergence and adoption of new technologies play an important role in the theory of bubbles proposed by Pastor and Veronesi (2009). We sort our sample of companies into portfolios of old and new economy stocks and find support for several predictions of their theory. First, the size of the bubble and the volatility of insurance companies and corporations trading with the new world exceed their old economy

counterparts. Second, the British Atlantic trade and insurance sectors gradually expanded their relative market capitalization, and became large enough in size to affect market betas and potentially the structure of discount rates. In contrast, we do not find the predicted shifts in betas in the Dutch market, perhaps because the new economy sector never attained the same relative capitalization and importance as was the case in Britain.

In addition to innovation-based bubble theories, we examine the role of investor clienteles as a contributing explanation of the bubble of 1720. As emphasized by Abreu and Brunnermeier (2003), lack of market power by informed traders can sustain a bubble. However, tests of clientele based theories of recent financial bubbles pose an empirical challenge for researchers to identify the various trader groups when the number of investors, securities, and trades are very large. In contrast, we are able to collect data on all share holdings, share transfers, and the identity of all investors in the Stad Rotterdam Company – the most important insurance company in the Netherlands in 1720 which played a central role in the Amsterdam market. By sorting investors into clienteles based on characteristics such as directorship, membership of the regent class, trading frequency, or ties to the British community, we examine whether coordinated trading of these clienteles could have contributed to the bursting of the bubble.

We are unable to identify clienteles that behave according to the theory, which predicts coordinated selling around the peak of the bubble and full divestment from the market following the burst of the bubble. We find that arbitrageurs did not liquidate their positions before or immediately after the collapse in Dutch prices – nor did any other group for that matter. Instead, they re-invested or maintained and often even increased their holdings. And inspection of the trading behavior of those investors who had liquidated their position by the end of 1720, reveals no coordinated selling around the peak of the bubble. We conclude that frequent traders were not restricted by short sale limitations or lacked coordination to attack the bubble. This finding is remarkable given the widespread belief that shares were overvalued, and in light of the earlier decline of the Mississippi and South Sea companies.

In sum, the dual episodes of the rise and decline of share prices in Britain and the Netherlands in 1720 provide support for an innovation-based explanation for the famous bubble in Britain. The evidence for the role of innovation in the Netherlands is also strong given the coincidence of the transplantation and adoption of new risk-sharing technology and open corporate mandates from Great Britain, although the specific theoretical model we test on the Dutch data is not fully supported.

Our analysis poses a further puzzle. While the decline of public equity issuance in Great Britain can be attributed in part to regulations brought on by the bubble in share prices, the same factors cannot explain the disappearance of the IPO market in the Netherlands, where there was no Bubble Act. The success of Stad Rotterdam demonstrated the viability of public equity financing, as did the sustained faith that most clienteles had in the firm. In general, few of the original subscribers in the other Windhandel companies lost money, although speculators who invested at peak prices clearly did. Why, then, did new equity issuance, and for that matter active trade in shares of Windhandel firms, come to such a dramatic close in the Netherlands at the conclusion of 1720? The boom in Windhandel companies was the last significant episode of new equity issuance in the Netherlands until the 19th century. We can only speculate that the new issue market was a casualty of the crash itself. Despite its obvious benefits for capital formation and risk sharing, the new issue market proved to be a fragile institution that could disappear as quickly as it sprang up, evidently rejected as a failed financial experiment.

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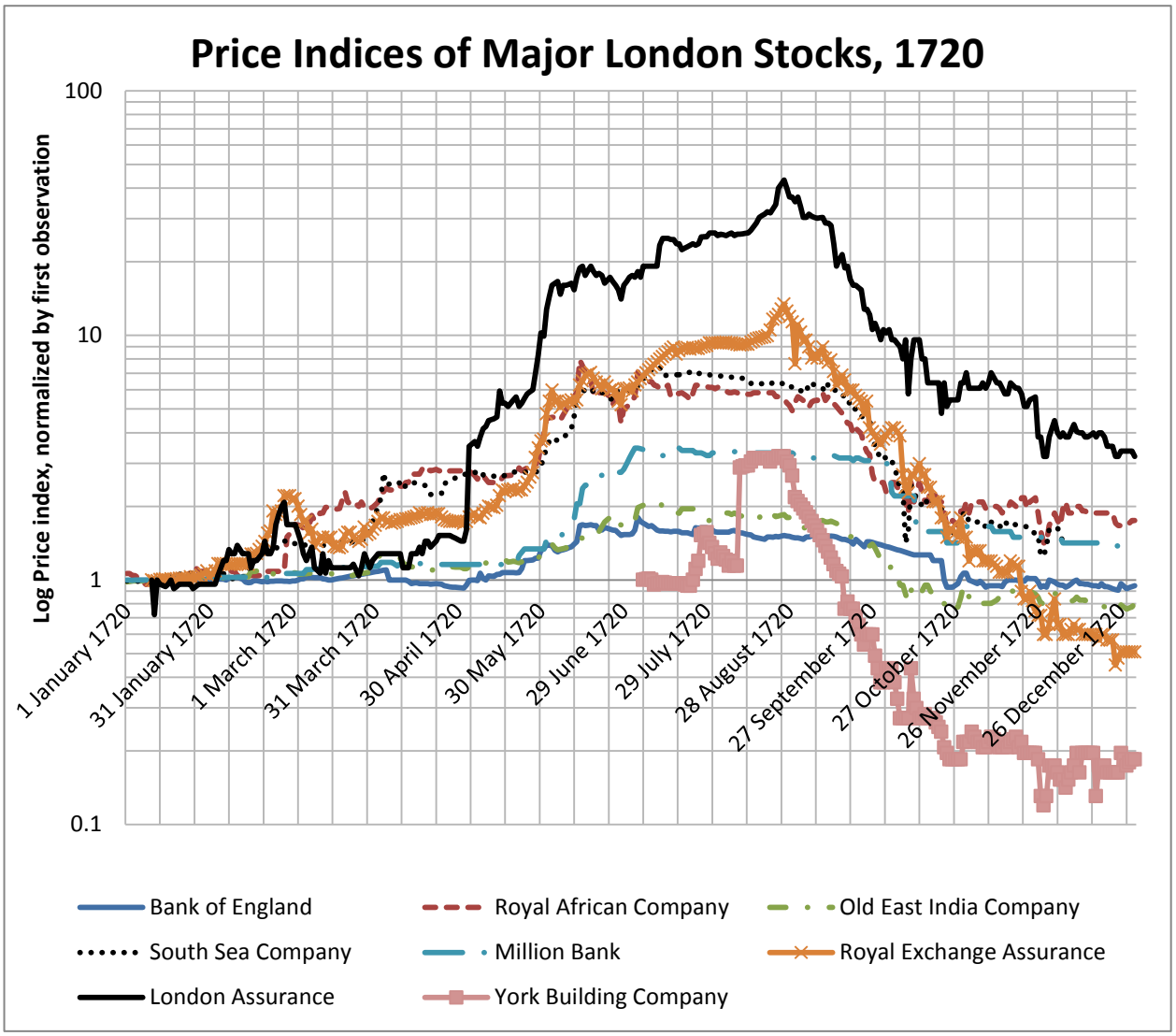

Figure 1: Price Indices of Major London Stocks, 1720. Daily price indices on a Julian calendar for the major stocks trading on the London market, from January 1, 1720 to December 31, 1720. Major stocks are Bank of England, Royal African Company, Old East India Company, South Sea Company, Million Bank, Royal Exchange Assurance, London Assurance and York Building Company. Prices are divided by the January 1st value for all series except the York Building Company, where prices are divided by the first available data point (June 28, 1720 [J]). Price indices are plotted on a logarithmic axis. Prices are interpolated between trading days.

Table 1: Factor and Principal Component Analysis of London Stock Market Returns

	Weights for Factors		Weights for Components	
	Factor 1	**Factor 2**	**Pr. Com. 1**	**Pr. Com. 2**
Bank of England	0.5896	0.2766	0.1615	-0.5449
Royal Afr. Company	0.5264	0.3417	0.1603	-0.2707
East India Company	0.6398	0.2458	0.1611	-0.3945
South Sea Company	0.7622	0.1803	0.1701	-1.2122
Million Bank	0.4705	0.0443	0.1143	-2.2624
Royal Exchange Assurance	0.1576	0.7402	0.1240	2.7167
London Assurance	0.1633	0.5116	0.1087	2.9679
Variance Explained	26.97%	15.68%	42.16%	15.86%
Cumulative Explained	26.97%	42.65%	42.16%	58.02%

Table 1: Factor and Principal Component Analysis of London Stock Market Returns. This table displays results of a factor analysis on the return series and principal components analysis on the correlation matrix of the returns series of 7 British stocks listed in column 1 over the period January 10, 1720 [G] to December 31, 1720 [G]. We apply the 'varimax' rotation algorithm in the factor analysis and reject the Null of a chi squared test for the number of factors being equal to 1 with a p-value of 8.36E-11. 'Factor 1' and 'Factor 2' are the two factors from the factor analysis. 'Pr. Com. 1' and 'Pr. Comp. 2' are the weights on every single stock, scaled to sum to 1. We report two principal components for the correlation matrix of stock returns of all companies listed in column 1 for the period the period January 10, 1720 [G] to December 31, 1720 [G]. We do not report more than two principal components since the explanatory power of the third component is less than 14%, the percentage expected if all components have equal explanatory power. In the lines labeled 'Variance Explained' and 'Cumulative Explained' we display the variance and cumulative variance explained by the (set of) column factors and principal components.

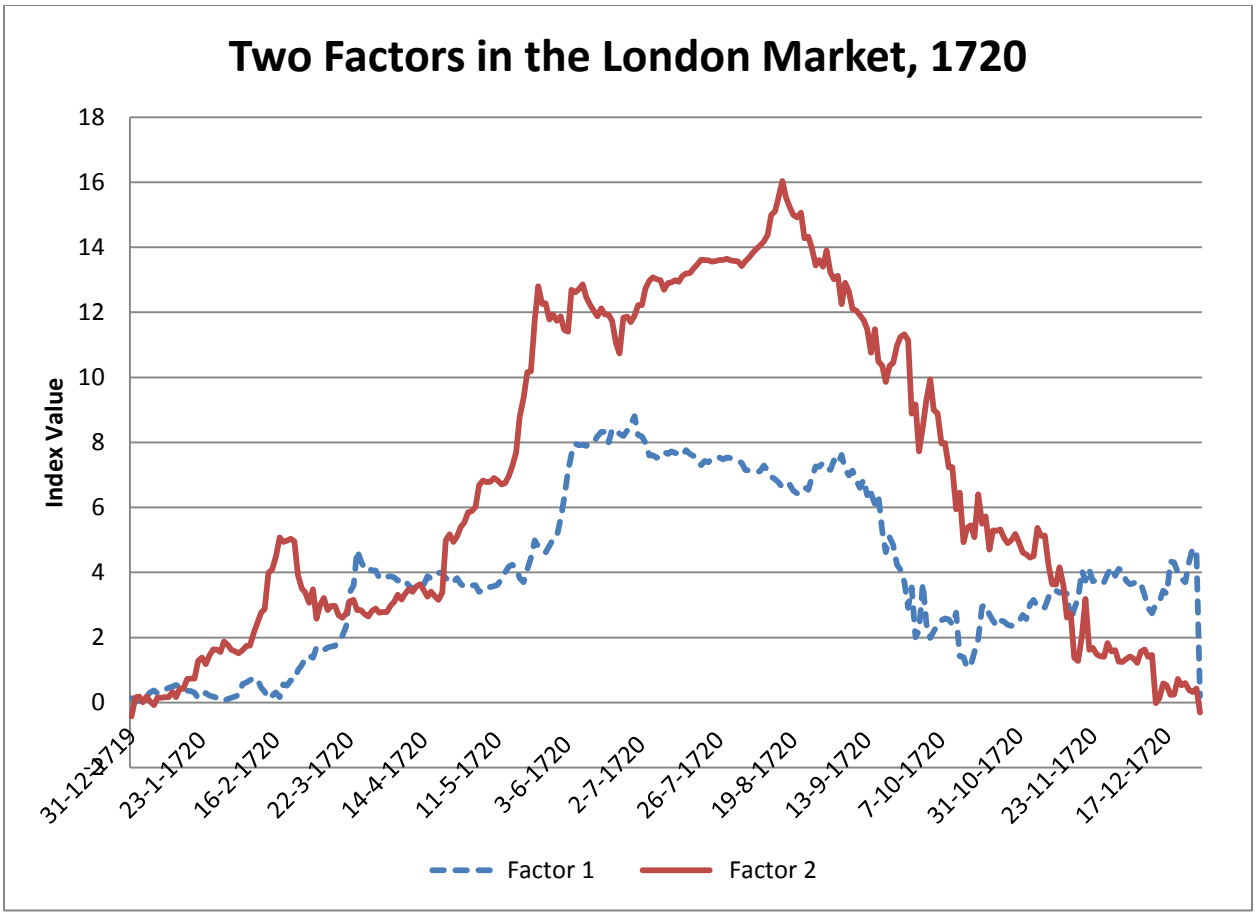

Figure 2: Two factors in London Market, 1720. This figure shows the time series of the index value of two indices comprising the scaled rotations of a factor analysis on 7 stocks in the London market over the period January 10, 1720 [G] to December 31, 1720 [G]. We perform a factor analysis on the daily return series for the Bank of England, Royal African Company, East India Company, South Sea Company, Million Bank, Royal Exchange Assurance and London Assurance using the 'varimax' rotation algorithm. 'Factor 1' displays the time series for the first factor and 'Factor 2' for the second factor. We omit days for which no return is observed and treat returns over non-trading days as multiple day returns. The analysis is conducted using the 'factanal' function in the R statistical language.

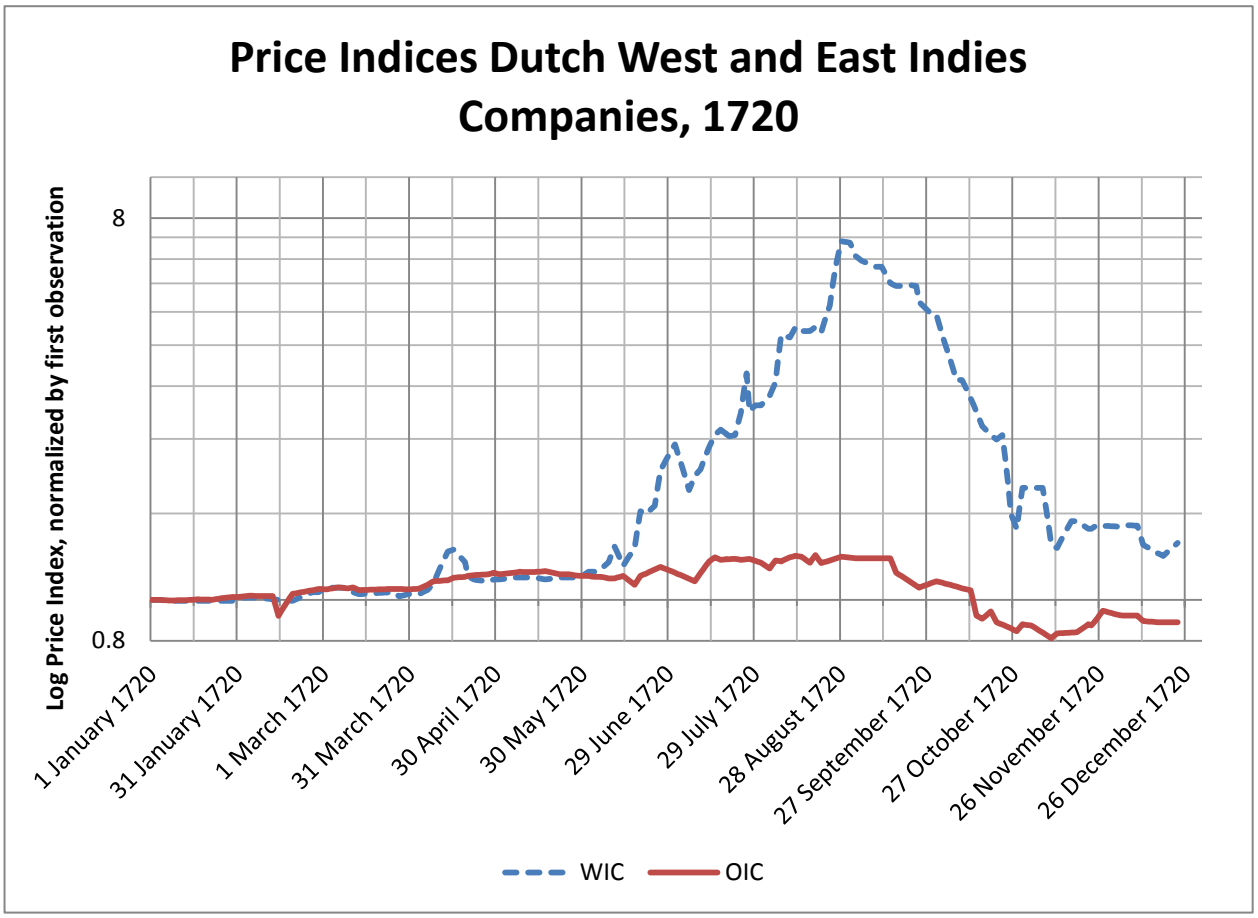

Figure 3: Price Indices Dutch West and East Indies Company, 1720. Daily price indices on a Julian calendar for Dutch East Indies Company and West Indies Company from 1 January 1720 to 31 December 1720. Prices are divided by the 1 January 1720 value and interpolated between trading days. Price indices are plotted on a logarithmic axis.

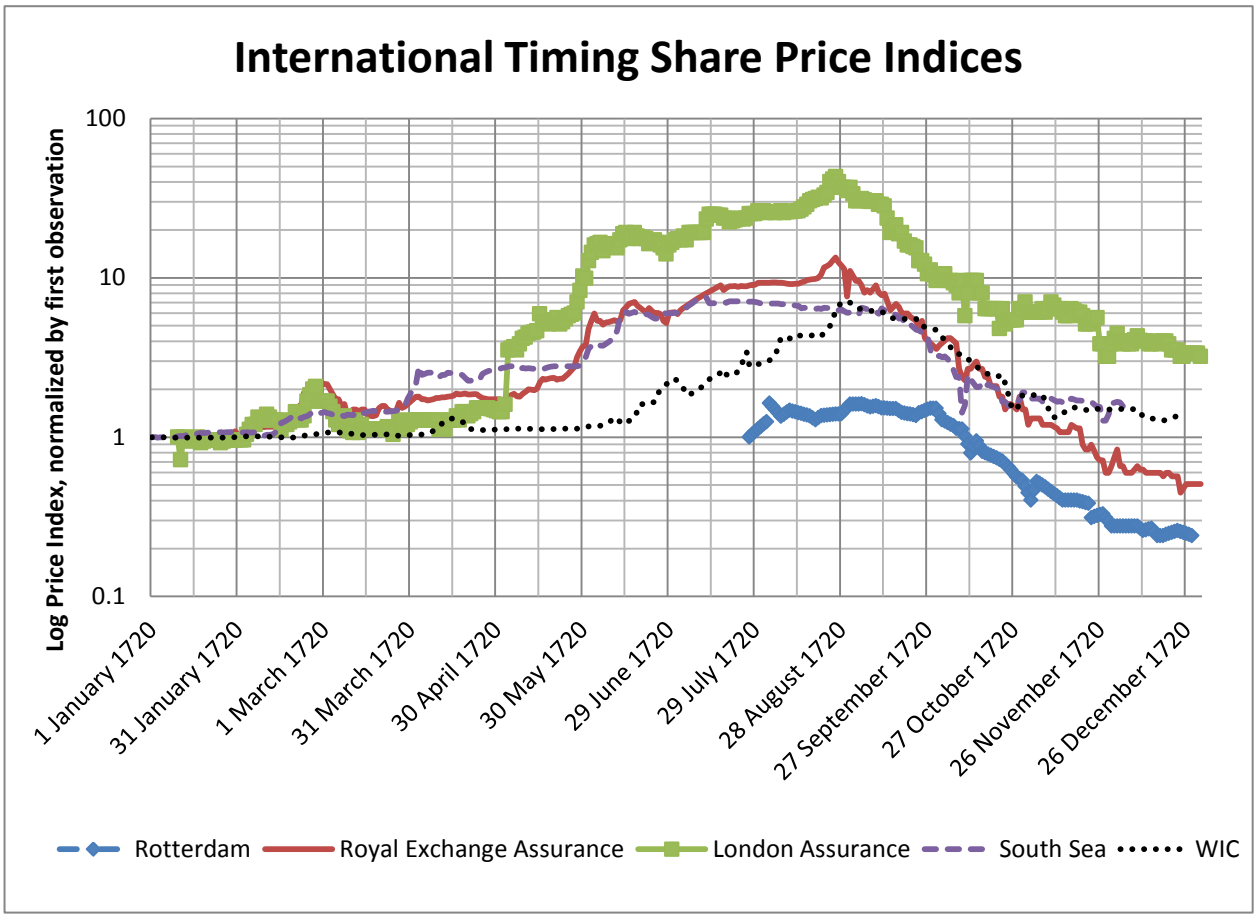

Figure 4: International Timing Share Price Indices. Daily price indices for Stad Rotterdam, Royal Exchange Assurance, London Assurance, South Sea Company and Dutch West Indies Company from 1 January 1720 to 31 December 1720. Prices are converted to Gregorian calendar and divided by the 1 January 1720 value for all shares, except Stad Rotterdam which is divided by its first observation (27 July 1720 [G]). All prices are interpolated between trading days and plotted on a logarithmic axis.

Table 2: Maximum Percentage Price Increase of British Firms over Issue Price by Industry, 1720

Industry	Total	Total (less large firms)	Number
Insurance	2117%	1717%	9
Commodity	1208%	1208%	12
Manufacture	1166%	1166%	6
Atlantic	895%	948%	4
Marine	875%	875%	6
Service/Utility	567%	567%	3
Pacific	349%	349%	1
Bank/Finance	335%	333%	3
Property	300%	300%	1
Total	**868%**	**829%**	**45**

Table 2: Maximum Percentage Price Increase of British Firms over Issue Price by Industry during the year 1720. Each share price increase is measured against par value. 'Industry' is the industry for which maximum price increases are measured, 'Total' reports maximum percentage price increase in the year 1720 for each industry relative to par value. 'Total (less large firms)' reports maximum percentage price increase per industry after removing the Royal Exchange Assurance, London Assurance, York Buildings Company, Million Bank, South Sea Company and Royal African Company. 'Number' displays the number of firms in each industry, without exclusion of the largest six companies. Data source: The Bubbler's Mirror, 1721.

Table 3: Levene Volatility Tests Old and New Economy

Panel I	**Std New**	**Std Old**	**F-Stat**	**p-value**
British New Economy	0.057	0.012	78.370	0.00
Dutch New Economy	0.095	0.011	18.674	0.00
Panel II				
British New World	0.057	0.012	12.268	0.00
Dutch New World	0.035	0.011	18.674	0.00
Panel III				
British Insurance	0.069	0.024	80.292	0.00
Dutch Insurance	0.058	0.013	54.232	0.00

Table 3: Tests of the difference in volatility for value-weighted indices of new economy and old economy shares. Share prices are value-weighted by nominal capital after prices are interpolated between trading days. In all panels, 'British Old Economy' is composed of Bank of England, Old East India Company and Million Bank and 'Dutch Old Economy' consists of the Dutch East India Company. Panel I and II have a sample period of 1 January 1715 [J] – 1 January 1721 [J] for British firms and 29 June 1720 [G] – 1 January 1721 [G] for Dutch firms. Panel III has a sample period of 1 January 1720 [J] – 1 January 1721 [J] for British firms and 27 July 1720 [G] – 1 January 1721 [G] for Dutch firms. In Panel I, 'British New Economy' consists of the York Building Society, Royal African Company, New African Company, South Sea Company, Royal Exchange Assurance and London Assurance and 'Dutch New Economy' includes all Dutch firms except Dutch East India Company. In Panel II, 'British New World' contains the Royal African Company, New African Company and South Sea Company and 'Dutch New World' is composed of Dutch West Indies Company. In Panel III, 'British Insurance' contains York Building Society, Royal Exchange Assurance and London Assurance and 'Dutch Insurance' is composed of all firms which indicate insurance as a line of business. 'Std New' reports the standard deviation of daily returns for the new economy index and 'Std Old' shows the standard deviation of daily returns for the old economy index in the panel-specific sample period. 'F-stat' reports the F-Statistic of a Levene test for equality of volatilities for new economy and old economy indices and 'p-value' is the corresponding p-value of the Levene test.

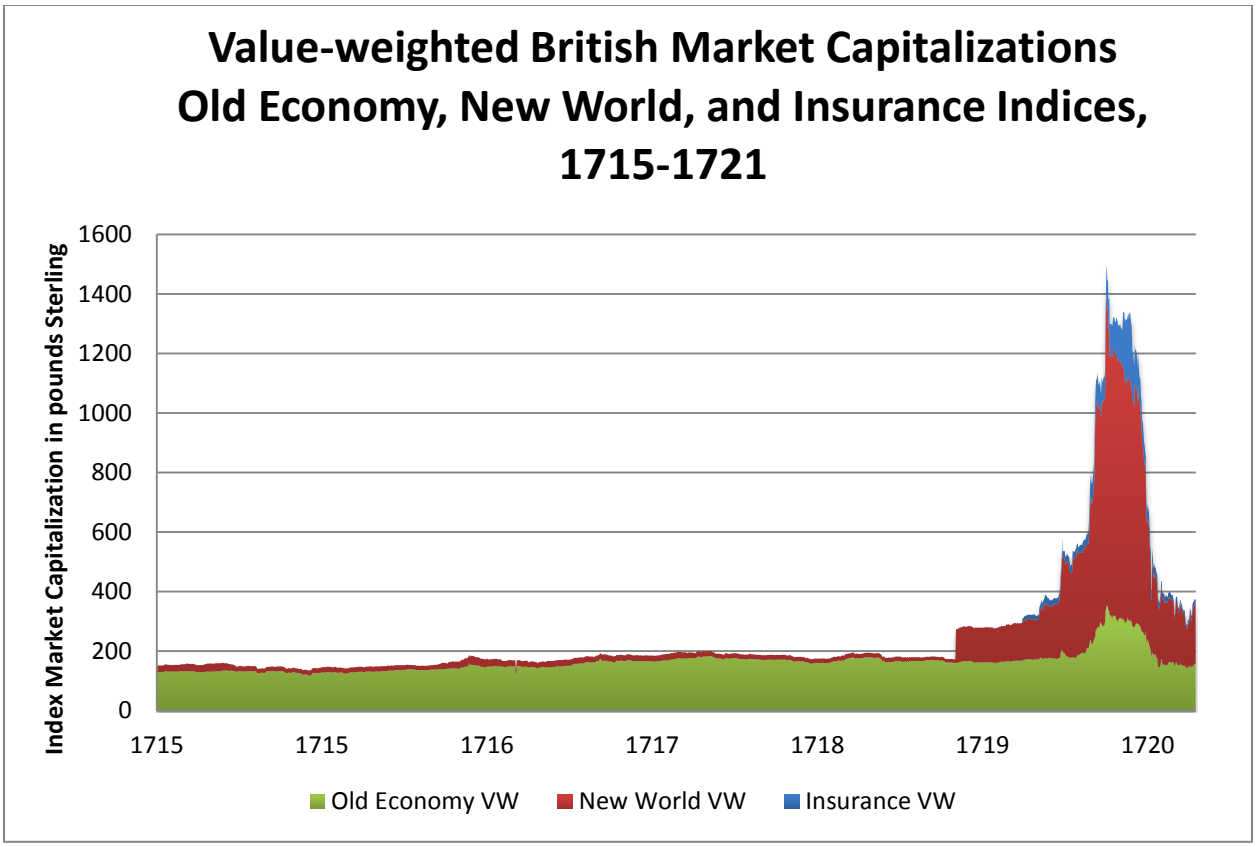

Figure 5: Value-weighted British Market Capitalizations Old Economy, New World, and Insurance Indices, 1715-1721. This figure displays the time series of British, value-weighted market capitalizations in pounds Sterling of an insurance index, new world index and old economy index (in descending order) for the period January 1, 1715 [J] to December 31, 1720 [J]. The insurance index consists of York Building Society, Royal Exchange Assurance, and London Assurance. The new world index is composed of The Royal African Company, New African Company and South Sea Company. The old economy index is composed of Bank of England, Old East India Company and Million Bank.

Table 4: Beta Structural Break Tests on Value-Weighted Indices of Old and New Economy Stock Indexes

	pre-break β	post-break β	F-Stat Chow	p-val Chow	Wald	p-val Wald
British Market: Daily data from January 1, 1715 [J] to January 1, 1721 [J]						
British New Econ	0.65	1.15	380.43	0.00	487.91	0.00
British Old Econ	0.58	0.27	327.55	0.00	132.14	0.00
British New World	0.65	1.16	393.69	0.00	500.13	0.00
British Insurance	0.22	0.27	47.37	0.00	0.38	0.01
Dutch Market: Thrice-weekly data from July 27, 1720 [G] to January 1, 1721 [G]						
Dutch New Econ	2.12	1.51	18.12	0.00	6.82	0.00
Dutch Old Econ	0.64	0.82	20.78	0.00	3.52	0.00
Dutch New World	2.78	2.00	7.91	0.00	6.27	0.01
Dutch Insurance	0.13	0.98	21.19	0.00	4.81	0.00

Table 4: Beta Structural Break Tests on Value-Weighted Indices of Old and New Economy Stock Indexes

'British New Econ' consists of the York Building Society, Royal African Company, New African Company, South Sea Company, Royal Exchange Assurance and London Assurance, 'British Old Econ' is composed of Bank of England, Old East India Company and Million Bank and 'British New World' contains the Royal African Company, New African Company and South Sea Company. 'British New Econ', 'British Old Econ' and 'British New World' have sample period of January 1, 1715 [J] – January 1, 1721 [J]. 'British Insurance' contains York Building Society, Royal Exchange Assurance and London Assurance and has a sample period of January 1, 1720 [J] – January 1, 1721 [J].

'Dutch New Econ' includes all Dutch firms except Dutch East India Company, 'Dutch Old Econ' consists of Dutch East India Company and 'Dutch Insurance' is composed of all firms which indicate insurance as a line of business. 'Dutch New Econ', 'Dutch Old Econ' and 'Dutch New World' have a sample period of July 27, 1720 [G] – January 1, 1721 [G] and 'Dutch Insurance' has a sample period of July 27, 1720 [G] – January 1, 1721 [G]. Prices are interpolated over non-trading days.

'pre-break β' is the market beta estimate before the break date and 'post-break β' the market beta estimate of the sub-sample after the break date. The column labeled 'F-Stat Chow' reports the F-statistic of a Chow test on market betas. The value-weighted index is regressed on a constant and a value-weighted market index of all firms in a country for two sample periods. British samples are split in two around 27 August 1720 [G] and Dutch samples are split in two around 1 October 1720 [G]. 'p-val Chow' reports the p-value belonging to the F-Statistic of the Chow test. 'Wald' reports the statistic of a Wald test of equality of market beta before and after the break date and 'p-val Wald' its corresponding p-value.

Table 5: Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds						
Panel I	**Directors**	**Arbs**	**British**	**Selling Out**	**Regents**	**Infrequent**
Holdings 29 June, 1720	255.40	405.00	247.00	598.60	387.40	370.60
Holdings 31 December, 1720	264.00	635.00	292.00	0.00	397.00	313.00
Average Holdings	287.16	659.49	318.92	211.17	390.38	278.01
Minimum Holdings	245.40	405.00	238.00	0.00	342.00	225.00
Average # Shares Sold	38.16	41.74	22.73	5.58	10.81	1.47
Average # Shares Bought	58.03	54.04	28.92	7.22	19.07	2.78
Panel II						
HM Statistic Past Return	0.55	4.72	1.30	0.45	1.68	0.02
HM p-value Past Return	0.46	0.03	0.25	0.50	0.19	0.90
HM Statistic Future Return	7.68	1.93	5.59	0.01	2.90	2.05
HM p-value Future Return	0.01	0.16	0.02	0.91	0.09	0.15
Panel III						
αBuy	-0.11	-0.09	-0.11	-0.09	-0.08	-0.09
t-stat	-5.77	-4.16	-5.49	-3.79	-3.55	-3.96
β_{Buy}	0.08	0.00	0.11	-0.03	-0.05	-0.02
t-stat	1.49	-0.08	1.58	-0.69	-1.42	-0.56
αSell	-0.08	-0.09	-0.07	-0.09	-0.10	-0.09
t-stat	-3.39	-3.94	-3.00	-4.87	-4.97	-3.96
β_{Sell}	-0.09	-0.03	-0.09	-0.01	0.02	-0.02
t-stat	-2.51	-0.68	-2.55	-0.28	0.31	-0.56
Panel IV						
Proceeds IPO price missing	-36.31	-24.26	-12.20	-5.76	-12.13	-2.87
Proceeds IPO price = 250	7.67	6.53	2.79	-0.80	2.59	0.51
IRR in % IPO price =250	0.07	-0.60	-0.39	7.48	0.66	4.79

Table 5: Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds. All traders in Stad Rotterdam shares in 1720 are grouped based on their characteristics. 'Directors' contains all 12 directors of the Stad Rotterdam Company in the year 1720. 'Arbs' is

composed of arbitrageurs, i.e. traders who are ranked among the top 10% in terms of number of transactions. 'British' are traders with an Anglo-Dutch background. Background information is retrieved from Scottish church registers (http://www.scotsintchurch.com/sicarchives/INDEX.htm), Klein (1984), Morison (1801) and Bourn (1764). 'Selling Out' refers to all traders who hold no shares at the year-end. 'Regents' consists of all Rotterdam regents as listed in Slechte (1972). 'Infrequent' is composed of all traders who conduct less than the median number of 9 trades. Rows labeled 'Holdings 29 June 1720' and 'Holdings 31 December 1720' show the holdings for each group on 29 June and 31 December, 1720. 'Average Holdings' refers to the time series average holdings and 'Minimum Holdings' to the minimum holdings for each group in the year 1720. 'Average # Shares Sold' is the average number of shares sold per group member in the year 1720 and 'Average # Shares Bought' the average number of shares bought per group member in 1720.

Panel II reports tests of relations between returns and trading decisions. 'HM statistic Past Return' and 'HM p-value Past Return' display the test statistic and p-value of a Henriksson-Merton test on past returns. It tests the relation between positive (negative) past ten-day returns and net buying (selling) decisions by groups of traders. 'HM statistic Future Return' and 'HM p-value Future Return' display the test statistic and p-value of a Henriksson-Merton test on future returns. It tests the relation between net buying (selling) decisions by groups of traders and future ten-day returns. The Henriksson-Merton statistic is corrected for serial correlation in returns and investment decisions using the Tavaré and Altham (1983) procedure.

Panel III displays regressions of future returns on trading decisions. In the first sub-panel, future 10-day returns are regressed on a constant 'α_{Buy}' and a dummy indicating a positive net share purchase 'β_{Buy}' by the specific group. In the second sub-panel future 10-day returns are regressed on a constant 'α_{Sell}' and a dummy indicating a negative net share purchase 'β_{Sell}' by the specific group. Corresponding t-statistics are reported below the parameter estimates.

Panel IV displays the average investment proceeds per group member in thousands, assuming different IPO share prices. Results in the row labeled 'Proceeds IPO price missing' treat the IPO price as missing. The row 'Proceeds IPO price = 250' of Panel IV, assumes that shares in the initial allotment were sold for 250 guilders and prices are interpolated between the IPO price and the first observation (27 July [G]). The row labeled 'IRR in %, IPO price = 250' shows internal rates of return for each group assuming an IPO price of 250.

Table 6: Cluster-Based Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds										
Panel I	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
Holdings 29 June, 1720	66.00	40.00	65.00	22.00	154.00	20.00	6.00	123.00	454.40	60.00
Holdings 31 Dec, 1720	114.00	77.00	97.00	102.00	181.00	44.00	0.00	118.00	319.00	95.00
Average Holdings	125.34	73.68	108.11	69.18	192.91	60.75	4.27	161.19	310.55	96.09
Minimum Holdings	66.00	40.00	65.00	22.00	154.00	20.00	0.00	113.00	239.00	51.00
Average # Shares Sold	86.60	89.00	35.56	60.33	32.21	46.67	61.00	28.56	19.60	134.00
Average # Shares Bought	109.40	166.00	44.33	94.33	40.47	61.33	61.00	38.00	27.69	229.00
Panel II										
HM statistic Past Return	0.57	2.54	6.13	10.92	2.38	2.71	1.39	8.16	0.00	3.27
HM p-value Past Return	0.45	0.11	0.01	0.00	0.12	0.10	0.24	0.00	0.97	0.07
HM statistic Future Return	0.04	1.17	3.81	6.67	0.09	6.23	0.47	0.23	0.00	7.08
HM p-value Future Return	0.84	0.28	0.05	0.01	0.76	0.01	0.50	0.63	0.95	0.01
Panel III										
α_{Buy}	-0.10	-0.10	-0.10	-0.11	-0.09	-0.11	-0.10	-0.10	-0.09	-0.11
t-stat	-4.79	-5.01	-5.07	-5.64	-3.94	-5.87	-4.39	-4.56	-3.85	-5.55
β_{Buy}	0.01	0.08	0.05	0.07	-0.04	0.13	0.00	0.02	-0.05	0.10
t-stat	0.20	1.13	0.78	1.10	-0.74	1.62	0.00	0.39	-1.08	1.86
α_{Sell}	-0.10	-0.09	-0.08	-0.09	-0.11	-0.09	-0.10	-0.09	-0.10	-0.09
t-stat	-4.59	-4.09	-3.62	-4.05	-5.04	-3.87	-4.41	-4.13	-4.43	-3.81
β_{Sell}	0.01	-0.05	-0.06	-0.07	0.05	-0.03	0.01	-0.05	0.01	-0.09
t-stat	0.26	-0.81	-1.40	-1.30	1.07	-0.76	0.16	-0.74	0.13	-1.76
Panel IV										
Proceeds IPO price missing	-63.57	-118.83	-22.28	-27.45	-22.27	-33.03	-5.60	-16.42	-16.46	-103.88
Proceeds IPO price = 250	12.09	41.98	5.47	21.12	4.44	8.23	-1.50	2.72	2.45	49.13
IRR in %, IPO price = 250	-0.57	-0.45	-0.56	-0.92	-0.08	-0.44	0.39	-0.52	5.97	-0.79

Table 6: Cluster-Based Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds. Share Positions, Predictability Tests and Investment Proceeds. Traders in Stad Rotterdam shares with at least 10 trades in 1720 are clustered into 10 groups based on the direction and size of their trades. Rows labeled 'Holdings 29 June 1720' and 'Holdings 31 December 1720' show the holdings for each cluster on 29 June and 31 December, 1720. 'Average Holdings' refers to the time series average holdings and 'Minimum Holdings' to the

minimum holdings for each cluster in the year 1720. 'Average # Shares Sold' is the average number of shares sold per cluster member in the year 1720 and 'Average # Shares Bought' the average number of shares bought per cluster member in 1720.

Panel II reports tests of relations between returns and trading decisions. 'HM statistic Past Return' and 'HM p-value Past Return' display the test statistic and p-value of a Henriksson-Merton test on past returns. It tests the relation between positive (negative) past ten-day returns and net buying (selling) decisions by clusters of traders. 'HM statistic Future Return' and 'HM p-value Future Return' display the test statistic and p-value of a Henriksson-Merton test on future returns. It tests the relation between net buying (selling) decisions by clusters of traders and future ten-day returns. The Henriksson-Merton statistic is corrected for serial correlation in returns and investment decisions using the Tavaré and Altham (1983) procedure.

Panel III displays regressions of returns on trading decisions. In the first sub-panel, future 10-day returns are regressed on a constant 'α_{Buy}' and a dummy indicating a positive net share purchase 'β_{Buy}' by the specific cluster. In the second sub-panel future 10-day returns are regressed on a constant 'α_{Sell}' and a dummy indicating a negative net share purchase 'β_{Sell}' by the specific cluster. Corresponding t-statistics are reported below the parameter estimates.

Panel IV displays the average investment proceeds per cluster member in thousands, assuming different IPO share prices. Results in the row labeled 'Proceeds IPO price missing' treat the IPO price as missing. The row 'Proceeds IPO price = 250' of Panel IV, assumes that shares in the initial allotment were sold for 250 guilders and prices are interpolated between the IPO price and the first observation (27 July [G]). The row labeled 'IRR in %, IPO price = 250' shows internal rates of return for each cluster assuming an IPO price of 250.

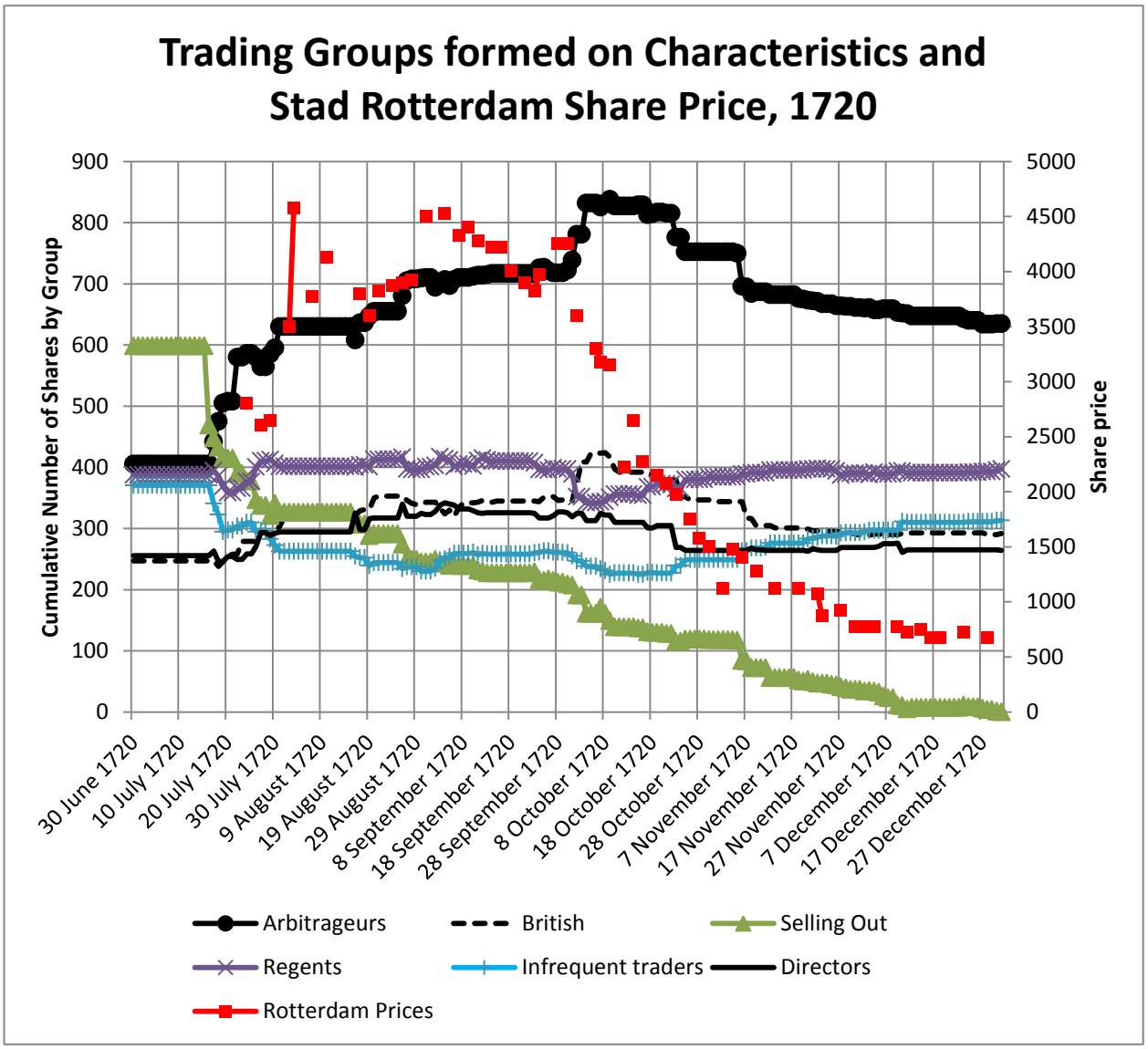

Figure 6: Trading Groups formed on Characteristics and Stad Rotterdam Share Price, 1720. This figure plots the time series of Stad Rotterdam share price on the right axis and the number of shares held by characteristic-sorted trading groups on the left axis, for the period June 30, 1720 to December 31, 1720. A trader is defined an 'Arbitrageur' if he is ranked among the top 10% of traders in terms of number of transactions. 'British' is the group of share holders with an Anglo-Dutch background. We retrieve background information from Klein (1984), Morison (1801), Bourn (1764) and Scottish church registers (http://www.scotsintchurch.com/sicarchives/INDEX.htm). 'Selling Out' contains all traders who hold no shares at the year-end. 'Regents' are share holders who are listed as regent in Slechte (1972). The group 'Infrequent traders' are all traders who conduct less than the median number of 9 trades. The group 'Directors' contains all directors of the Stad Rotterdam Company in the year 1720 and 'Rotterdam prices' is the price of the Stad Rotterdam share, plotted on the right axis.

Appendix A: The interpretation of price quotes

One of the problems in the analysis of the price data from Holland in 1720 is the question of how the price quotations should be interpreted. Share or subscription prices were not quoted in currency, but in a percentage in excess of some value. Scholars to date have disagreed on the interpretation of this value. We address this basic question through examination of the language used in the price lists in 1720, and by matching share loan transactions in the books of one company to the documented market quotations. The benefit of matching price quotes to company transactions in their shares is that the books were kept in units of currency.

Price quotes in the Leydse Courant typically were given in sentences such as: ”Rotterdam: Today the shares of our company were traded for prices ranging from 52 to 56 percent *avans*”. Intervals like this are not uncommon due to the high daily volatility; especially in the rise of the bubble the morning prices differed substantially from evening quotes. A key question posed by these quotes is of course, what is meant by “*avans*”? What amount is the quotation in excess of? This question is more challenging than it appears. Shares were issued through subscriptions that required capital calls. Thus, the relevant multiplicand might be interpreted as the capital paid in to the company up to that date [the paid in capital] or it might be interpreted as the face value of the share after all the shareholder installments are paid -- something we now often refer to as the par value or nominal share value.

It is therefore not surprising that previous authors have debated the interpretation of these quotes. For example:

van Rijn (1899) presumed that the *avans* referred to the nominal (or fully paid in) value of the share, and that additional paid-in capital represented a fraction that incremented the quoted price.[1]

[1] ”The furnishment up till 80% of the shares of the first subscription is also foolish and absurd, since the amount furnished in these shares exceeds the market value of the original shares, i.e. 15% has been paid

There is logical because newspaper percentages could not practically be based on the amounts paid-in. The paid-in capital increased over time and the exact amount paid-in was therefore uncertain until the books were closed and the paid-in amounts computed. If newspaper percentages were based on the amount paid-in, the newspaper percentages would have to drop after the payment of an installment; if the market share price does not change and more capital is paid-in, the percentage decreases by construction. Also, share holders often had two or three weeks to pay their next contribution. If the quoted share price were a percentage of the amount paid in, during the weeks of the payments newspapers would have to differentiate between shares for which the payment had been made and shares on which the payment was still required. Obviously, no such difference is documented in the newspapers.

Smith (1919) concurs with this interpretation: ”The share price was recorded in percentages “avans”, i.e. it indicated the percentages to be paid in excess of par value, calculated based on the amount which, with respect to the nominal amount traded by the company as installment was demanded.”[2] Likewise, Slechte (1982): “In the first two months the prices fluctuated between 100 and 80%, but dropped in September and October to 60%. The Rotterdam shares … were therefore on average priced at 4000 guilders in this period.”[3]

Despite their general agreement, none of the earlier authors offered empirical evidence supporting their interpretations. Thus, we sought to reject or verify their calculations of

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in on the subscription shares, to demand an additional 65% would be highly unfair ... The shares of the first subscription have already been traded at 38%, together with the paid-in amount of 15% this makes 53 percent, if an additional 65% were to be paid in then these shares would be worth 118%, this would be unreasonable …If … on the old shares 75% had been paid in, these would now be worth 3750 guilders, so a share of 1000 guilders would be worth 750 guilders.”

[2] Original Dutch text:”De koers werd genoteerd in procenten “avans”, dus men gaf aan hoeveel procenten boven pari betaald moest worden, te berekenen over de geldsom, die, met betrekking tot het verhandelde nominaal bedrag, door de compagnie als storting was geëischt.”

[3] This quote is in line with our interpretation as the nominal value of a share of the Rotterdam company was 5,000 guilders. The quotes are hardly affected by paid in capital since typically very little was paid in.

monetary share prices by matching transactions in the Leydse Courant with company records.

After the burst of the bubble at the end of September 1720, the directors of Stad Rotterdam made non-recourse loans to directors using their shares as collateral. If share prices fell during the maturity of the loan, the company incurred the loss. This arrangement could be interpreted as beneficial to shareholders because it was a means to reduce the "float" of shares by keeping directors from dumping into a falling market. It could also be interpreted as pure self-dealing by directors. In either case, these transactions allow us to link the market quotes to currency-valued transactions.

On pages 37 and 142 of the general ledger of Stad Rotterdam, some of these share loans are recorded in prices that match quotations reported in the Leydse Courant for the same day.[4] Since the ledger accounts are recorded in guilders, we can ascertain that the newspaper prices are reported in percentages of the nominal share value (5,000 guilders for the Rotterdam company). The losses incurred in these loan transactions also appear on the profit and loss account of the Rotterdam company (page 9 of the general ledger account).

A simple example of our interpretation is useful. Suppose that Rotterdam shares [with 5,000 guilders nominal value] are trading for 2,500 guilders on a certain date and that up until that date 1% had been paid in. Then the Leydse Courant quote of 49% a*vans* would imply the following: 'Rotterdam is trading today at 50% (2,500/5,000 * 100%) or 49% of the par value of the share above the paid-in capital ((2,500-1%*5,000)/5,000)*100%= 49%'.

This convention was convenient during weeks of installment payments. It allowed investors to distinguish between shares on which the installment has been paid and shares on which the installment still needed to be paid.

[4] Gemeentearchief Rotterdam, archive no. 199 inventory no. 451, pages 37 and 142.

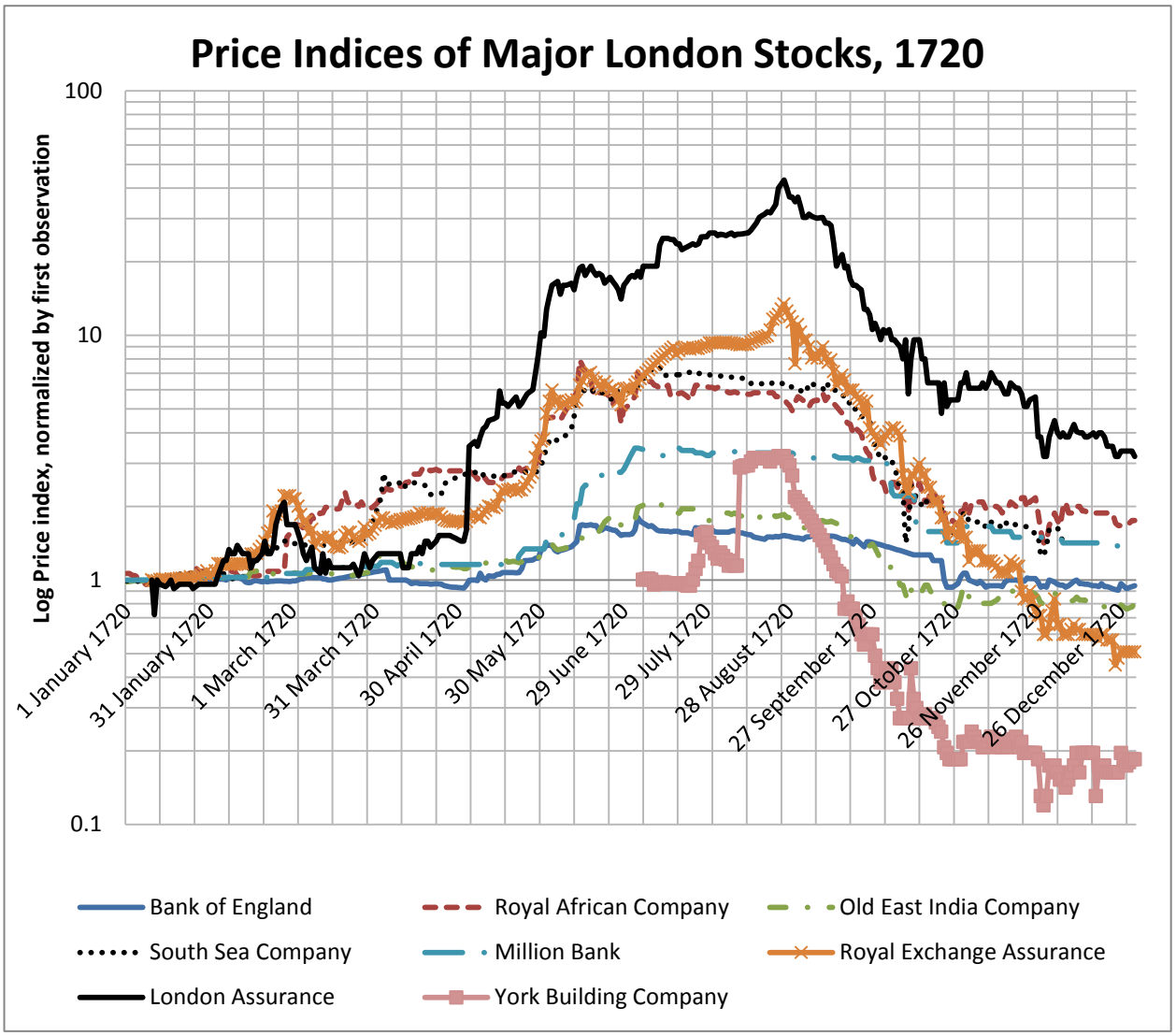

Figure 1: Price Indices of Major London Stocks, 1720. Daily price indices on a Julian calendar for the major stocks trading on the London market, from January 1, 1720 to December 31, 1720. Major stocks are Bank of England, Royal African Company, Old East India Company, South Sea Company, Million Bank, Royal Exchange Assurance, London Assurance and York Building Company. Prices are divided by the January 1st value for all series except the York Building Company, where prices are divided by the first available data point (June 28, 1720 [J]). Price indices are plotted on a logarithmic axis. Prices are interpolated between trading days.

Table 1: Factor and Principal Component Analysis of London Stock Market Returns

	Weights for Factors		Weights for Components	
	Factor 1	**Factor 2**	**Pr. Com. 1**	**Pr. Com. 2**
Bank of England	0.5896	0.2766	0.1615	-0.5449
Royal Afr. Company	0.5264	0.3417	0.1603	-0.2707
East India Company	0.6398	0.2458	0.1611	-0.3945
South Sea Company	0.7622	0.1803	0.1701	-1.2122
Million Bank	0.4705	0.0443	0.1143	-2.2624
Royal Exchange Assurance	0.1576	0.7402	0.1240	2.7167
London Assurance	0.1633	0.5116	0.1087	2.9679
Variance Explained	26.97%	15.68%	42.16%	15.86%
Cumulative Explained	26.97%	42.65%	42.16%	58.02%

Table 1: Factor and Principal Component Analysis of London Stock Market Returns. This table displays results of a factor analysis on the return series and principal components analysis on the correlation matrix of the returns series of 7 British stocks listed in column 1 over the period January 10, 1720 [G] to December 31, 1720 [G]. We apply the 'varimax' rotation algorithm in the factor analysis and reject the Null of a chi squared test for the number of factors being equal to 1 with a p-value of 8.36E-11. 'Factor 1' and 'Factor 2' are the two factors from the factor analysis. 'Pr. Com. 1' and 'Pr. Comp. 2' are the weights on every single stock, scaled to sum to 1. We report two principal components for the correlation matrix of stock returns of all companies listed in column 1 for the period the period January 10, 1720 [G] to December 31, 1720 [G]. We do not report more than two principal components since the explanatory power of the third component is less than 14%, the percentage expected if all components have equal explanatory power. In the lines labeled 'Variance Explained' and 'Cumulative Explained' we display the variance and cumulative variance explained by the (set of) column factors and principal components.

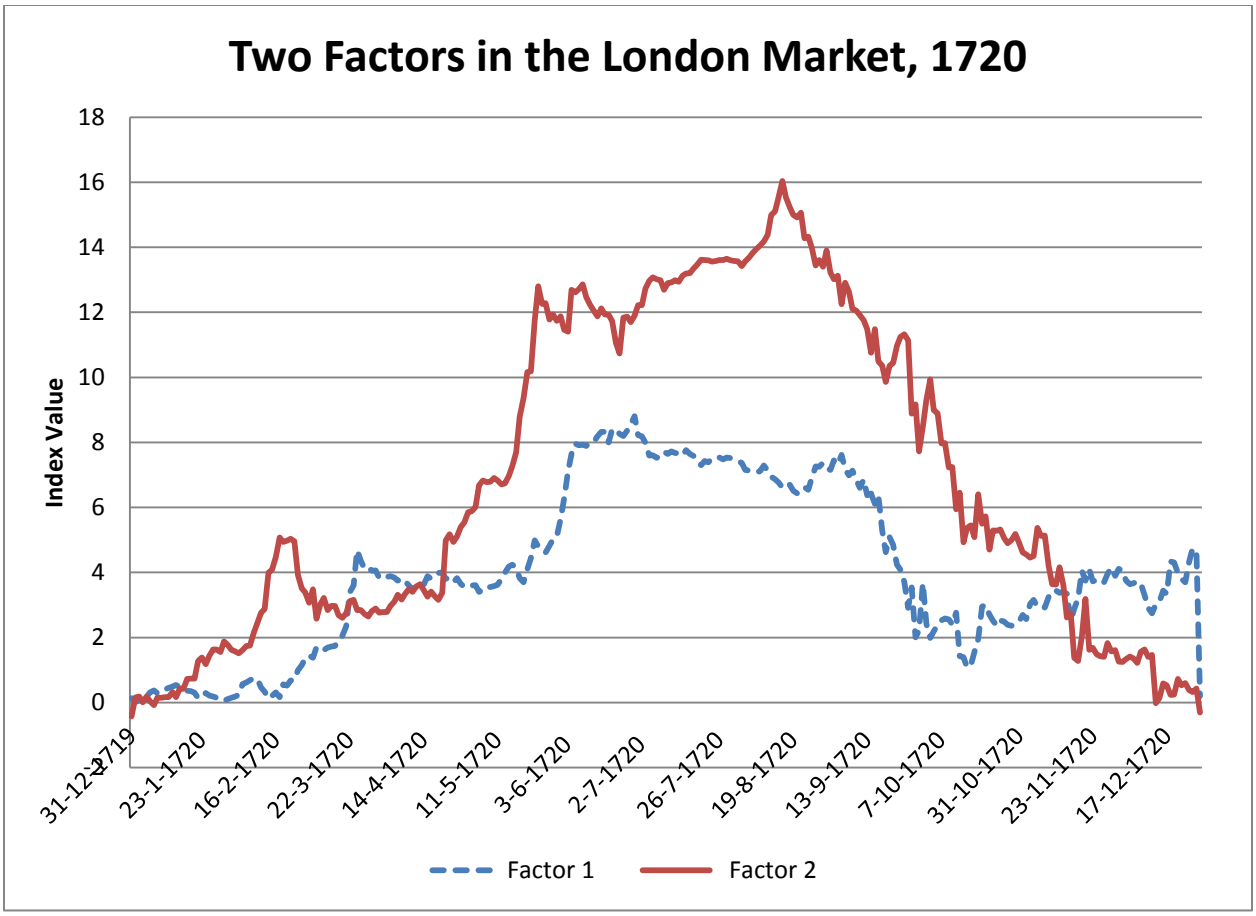

Figure 2: Two factors in London Market, 1720. This figure shows the time series of the index value of two indices comprising the scaled rotations of a factor analysis on 7 stocks in the London market over the period January 10, 1720 [G] to December 31, 1720 [G]. We perform a factor analysis on the daily return series for the Bank of England, Royal African Company, East India Company, South Sea Company, Million Bank, Royal Exchange Assurance and London Assurance using the 'varimax' rotation algorithm. 'Factor 1' displays the time series for the first factor and 'Factor 2' for the second factor. We omit days for which no return is observed and treat returns over non-trading days as multiple day returns. The analysis is conducted using the 'factanal' function in the R statistical language.

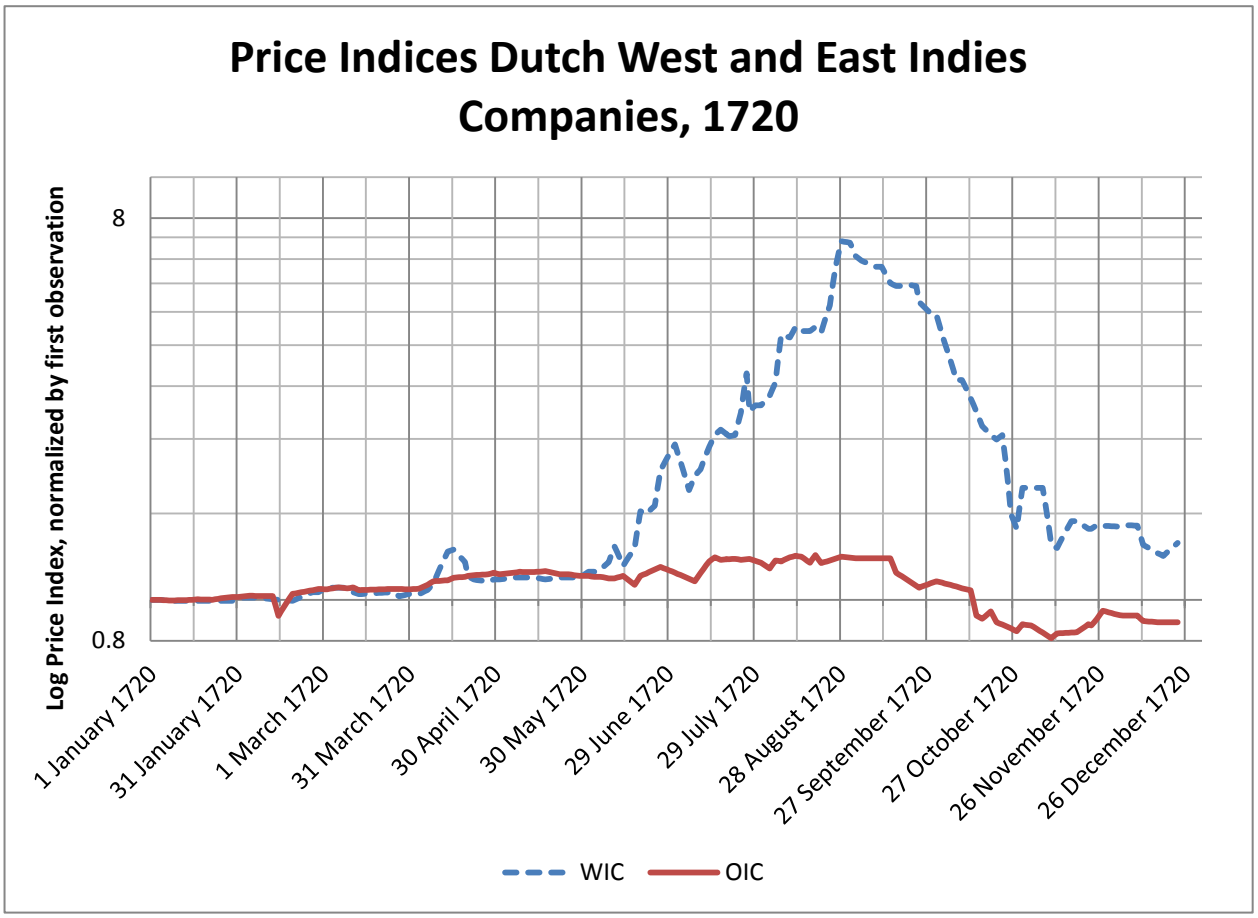

Figure 3: Price Indices Dutch West and East Indies Company, 1720. Daily price indices on a Julian calendar for Dutch East Indies Company and West Indies Company from 1 January 1720 to 31 December 1720. Prices are divided by the 1 January 1720 value and interpolated between trading days. Price indices are plotted on a logarithmic axis.

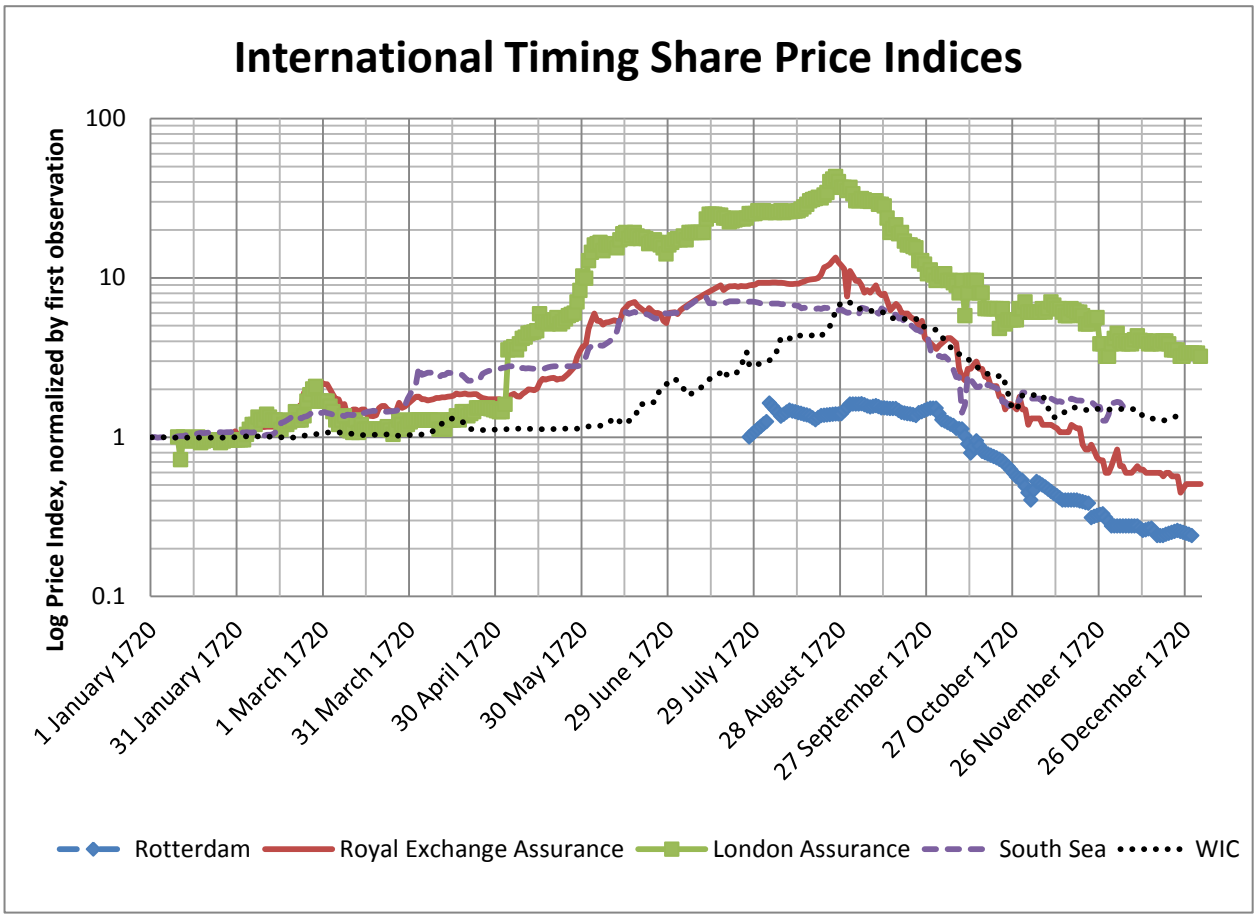

Figure 4: International Timing Share Price Indices. Daily price indices for Stad Rotterdam, Royal Exchange Assurance, London Assurance, South Sea Company and Dutch West Indies Company from 1 January 1720 to 31 December 1720. Prices are converted to Gregorian calendar and divided by the 1 January 1720 value for all shares, except Stad Rotterdam which is divided by its first observation (27 July 1720 [G]). All prices are interpolated between trading days and plotted on a logarithmic axis.

Table 2: Maximum Percentage Price Increase of British Firms over Issue Price by Industry, 1720

Industry	Total	Total (less large firms)	Number
Insurance	2117%	1717%	9
Commodity	1208%	1208%	12
Manufacture	1166%	1166%	6
Atlantic	895%	948%	4
Marine	875%	875%	6
Service/Utility	567%	567%	3
Pacific	349%	349%	1
Bank/Finance	335%	333%	3
Property	300%	300%	1
Total	**868%**	**829%**	**45**

Table 2: Maximum Percentage Price Increase of British Firms over Issue Price by Industry during the year 1720. Each share price increase is measured against par value. 'Industry' is the industry for which maximum price increases are measured, 'Total' reports maximum percentage price increase in the year 1720 for each industry relative to par value. 'Total (less large firms)' reports maximum percentage price increase per industry after removing the Royal Exchange Assurance, London Assurance, York Buildings Company, Million Bank, South Sea Company and Royal African Company. 'Number' displays the number of firms in each industry, without exclusion of the largest six companies. Data source: The Bubbler's Mirror, 1721.

Table 3: Levene Volatility Tests Old and New Economy

Panel I	**Std New**	**Std Old**	**F-Stat**	**p-value**
British New Economy	0.057	0.012	78.370	0.00
Dutch New Economy	0.095	0.011	18.674	0.00
Panel II				
British New World	0.057	0.012	12.268	0.00
Dutch New World	0.035	0.011	18.674	0.00
Panel III				
British Insurance	0.069	0.024	80.292	0.00
Dutch Insurance	0.058	0.013	54.232	0.00

Table 3: Tests of the difference in volatility for value-weighted indices of new economy and old economy shares. Share prices are value-weighted by nominal capital after prices are interpolated between trading days. In all panels, 'British Old Economy' is composed of Bank of England, Old East India Company and Million Bank and 'Dutch Old Economy' consists of the Dutch East India Company. Panel I and II have a sample period of 1 January 1715 [J] – 1 January 1721 [J] for British firms and 29 June 1720 [G] – 1 January 1721 [G] for Dutch firms. Panel III has a sample period of 1 January 1720 [J] – 1 January 1721 [J] for British firms and 27 July 1720 [G] – 1 January 1721 [G] for Dutch firms. In Panel I, 'British New Economy' consists of the York Building Society, Royal African Company, New African Company, South Sea Company, Royal Exchange Assurance and London Assurance and 'Dutch New Economy' includes all Dutch firms except Dutch East India Company. In Panel II, 'British New World' contains the Royal African Company, New African Company and South Sea Company and 'Dutch New World' is composed of Dutch West Indies Company. In Panel III, 'British Insurance' contains York Building Society, Royal Exchange Assurance and London Assurance and 'Dutch Insurance' is composed of all firms which indicate insurance as a line of business. 'Std New' reports the standard deviation of daily returns for the new economy index and 'Std Old' shows the standard deviation of daily returns for the old economy index in the panel-specific sample period. 'F-stat' reports the F-Statistic of a Levene test for equality of volatilities for new economy and old economy indices and 'p-value' is the corresponding p-value of the Levene test.

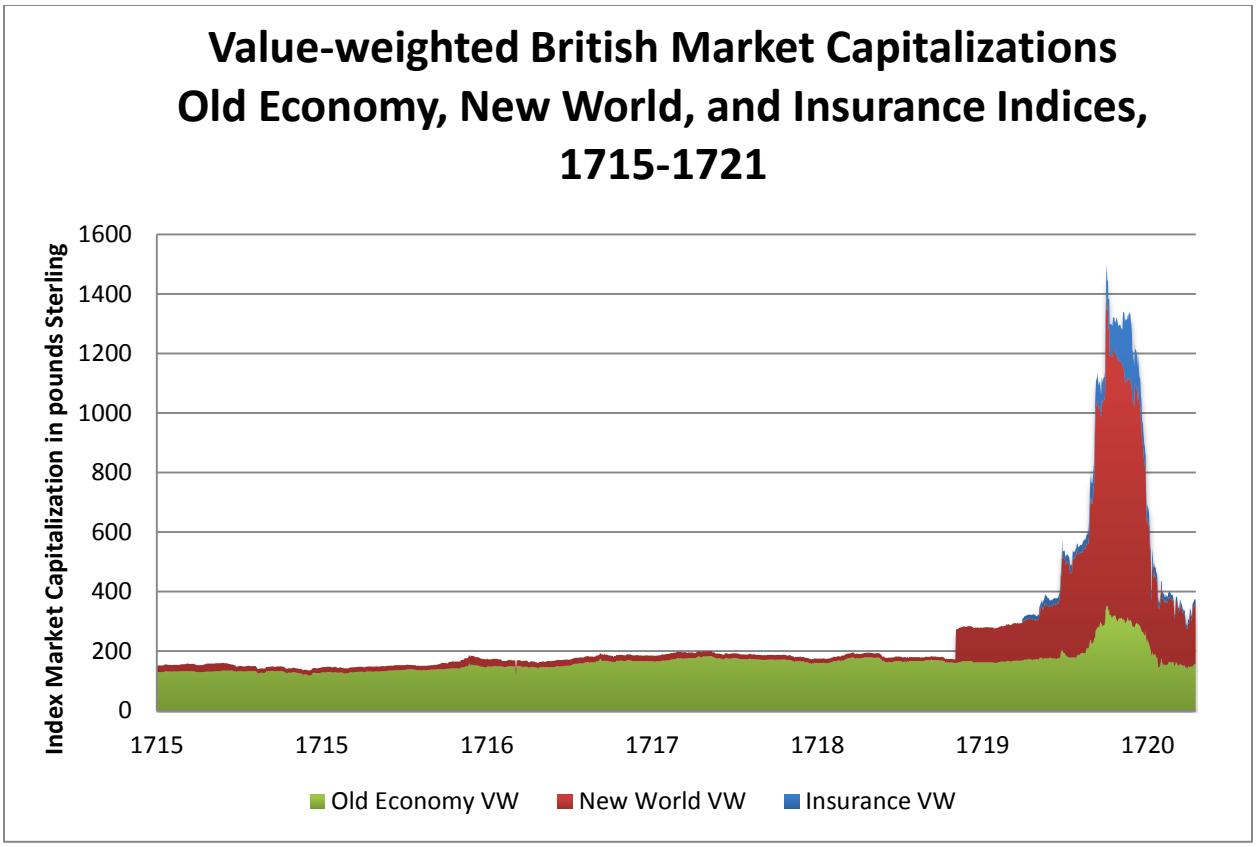

Figure 5: Value-weighted British Market Capitalizations Old Economy, New World, and Insurance Indices, 1715-1721. This figure displays the time series of British, value-weighted market capitalizations in pounds Sterling of an insurance index, new world index and old economy index (in descending order) for the period January 1, 1715 [J] to December 31, 1720 [J]. The insurance index consists of York Building Society, Royal Exchange Assurance, and London Assurance. The new world index is composed of The Royal African Company, New African Company and South Sea Company. The old economy index is composed of Bank of England, Old East India Company and Million Bank.

Table 4: Beta Structural Break Tests on Value-Weighted Indices of Old and New Economy Stock Indexes

	pre-break β	post-break β	F-Stat Chow	p-val Chow	Wald	p-val Wald
British Market: Daily data from January 1, 1715 [J] to January 1, 1721 [J]						
British New Econ	0.65	1.15	380.43	0.00	487.91	0.00
British Old Econ	0.58	0.27	327.55	0.00	132.14	0.00
British New World	0.65	1.16	393.69	0.00	500.13	0.00
British Insurance	0.22	0.27	47.37	0.00	0.38	0.01
Dutch Market: Thrice-weekly data from July 27, 1720 [G] to January 1, 1721 [G]						
Dutch New Econ	2.12	1.51	18.12	0.00	6.82	0.00
Dutch Old Econ	0.64	0.82	20.78	0.00	3.52	0.00
Dutch New World	2.78	2.00	7.91	0.00	6.27	0.01
Dutch Insurance	0.13	0.98	21.19	0.00	4.81	0.00

Table 4: Beta Structural Break Tests on Value-Weighted Indices of Old and New Economy Stock Indexes

'British New Econ' consists of the York Building Society, Royal African Company, New African Company, South Sea Company, Royal Exchange Assurance and London Assurance, 'British Old Econ' is composed of Bank of England, Old East India Company and Million Bank and 'British New World' contains the Royal African Company, New African Company and South Sea Company. 'British New Econ', 'British Old Econ' and 'British New World' have sample period of January 1, 1715 [J] – January 1, 1721 [J]. 'British Insurance' contains York Building Society, Royal Exchange Assurance and London Assurance and has a sample period of January 1, 1720 [J] – January 1, 1721 [J].

'Dutch New Econ' includes all Dutch firms except Dutch East India Company, 'Dutch Old Econ' consists of Dutch East India Company and 'Dutch Insurance' is composed of all firms which indicate insurance as a line of business. 'Dutch New Econ', 'Dutch Old Econ' and 'Dutch New World' have a sample period of July 27, 1720 [G] – January 1, 1721 [G] and 'Dutch Insurance' has a sample period of July 27, 1720 [G] – January 1, 1721 [G]. Prices are interpolated over non-trading days.

'pre-break β' is the market beta estimate before the break date and 'post-break β' the market beta estimate of the sub-sample after the break date. The column labeled 'F-Stat Chow' reports the F-statistic of a Chow test on market betas. The value-weighted index is regressed on a constant and a value-weighted market index of all firms in a country for two sample periods. British samples are split in two around 27 August 1720 [G] and Dutch samples are split in two around 1 October 1720 [G]. 'p-val Chow' reports the p-value belonging to the F-Statistic of the Chow test. 'Wald' reports the statistic of a Wald test of equality of market beta before and after the break date and 'p-val Wald' its corresponding p-value.

Table 5: Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds						
Panel I	**Directors**	**Arbs**	**British**	**Selling Out**	**Regents**	**Infrequent**
Holdings 29 June, 1720	255.40	405.00	247.00	598.60	387.40	370.60
Holdings 31 December, 1720	264.00	635.00	292.00	0.00	397.00	313.00
Average Holdings	287.16	659.49	318.92	211.17	390.38	278.01
Minimum Holdings	245.40	405.00	238.00	0.00	342.00	225.00
Average # Shares Sold	38.16	41.74	22.73	5.58	10.81	1.47
Average # Shares Bought	58.03	54.04	28.92	7.22	19.07	2.78
Panel II						
HM Statistic Past Return	0.55	4.72	1.30	0.45	1.68	0.02
HM p-value Past Return	0.46	0.03	0.25	0.50	0.19	0.90
HM Statistic Future Return	7.68	1.93	5.59	0.01	2.90	2.05
HM p-value Future Return	0.01	0.16	0.02	0.91	0.09	0.15
Panel III						
αBuy	-0.11	-0.09	-0.11	-0.09	-0.08	-0.09
t-stat	-5.77	-4.16	-5.49	-3.79	-3.55	-3.96
β_{Buy}	0.08	0.00	0.11	-0.03	-0.05	-0.02
t-stat	1.49	-0.08	1.58	-0.69	-1.42	-0.56
αSell	-0.08	-0.09	-0.07	-0.09	-0.10	-0.09
t-stat	-3.39	-3.94	-3.00	-4.87	-4.97	-3.96
β_{Sell}	-0.09	-0.03	-0.09	-0.01	0.02	-0.02
t-stat	-2.51	-0.68	-2.55	-0.28	0.31	-0.56
Panel IV						
Proceeds IPO price missing	-36.31	-24.26	-12.20	-5.76	-12.13	-2.87
Proceeds IPO price = 250	7.67	6.53	2.79	-0.80	2.59	0.51
IRR in % IPO price =250	0.07	-0.60	-0.39	7.48	0.66	4.79

Table 5: Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds. All traders in Stad Rotterdam shares in 1720 are grouped based on their characteristics. 'Directors' contains all 12 directors of the Stad Rotterdam Company in the year 1720. 'Arbs' is

composed of arbitrageurs, i.e. traders who are ranked among the top 10% in terms of number of transactions. 'British' are traders with an Anglo-Dutch background. Background information is retrieved from Scottish church registers (http://www.scotsintchurch.com/sicarchives/INDEX.htm), Klein (1984), Morison (1801) and Bourn (1764). 'Selling Out' refers to all traders who hold no shares at the year-end. 'Regents' consists of all Rotterdam regents as listed in Slechte (1972). 'Infrequent' is composed of all traders who conduct less than the median number of 9 trades. Rows labeled 'Holdings 29 June 1720' and 'Holdings 31 December 1720' show the holdings for each group on 29 June and 31 December, 1720. 'Average Holdings' refers to the time series average holdings and 'Minimum Holdings' to the minimum holdings for each group in the year 1720. 'Average # Shares Sold' is the average number of shares sold per group member in the year 1720 and 'Average # Shares Bought' the average number of shares bought per group member in 1720.

Panel II reports tests of relations between returns and trading decisions. 'HM statistic Past Return' and 'HM p-value Past Return' display the test statistic and p-value of a Henriksson-Merton test on past returns. It tests the relation between positive (negative) past ten-day returns and net buying (selling) decisions by groups of traders. 'HM statistic Future Return' and 'HM p-value Future Return' display the test statistic and p-value of a Henriksson-Merton test on future returns. It tests the relation between net buying (selling) decisions by groups of traders and future ten-day returns. The Henriksson-Merton statistic is corrected for serial correlation in returns and investment decisions using the Tavaré and Altham (1983) procedure.

Panel III displays regressions of future returns on trading decisions. In the first sub-panel, future 10-day returns are regressed on a constant 'α_{Buy}' and a dummy indicating a positive net share purchase 'β_{Buy}' by the specific group. In the second sub-panel future 10-day returns are regressed on a constant 'α_{Sell}' and a dummy indicating a negative net share purchase 'β_{Sell}' by the specific group. Corresponding t-statistics are reported below the parameter estimates.

Panel IV displays the average investment proceeds per group member in thousands, assuming different IPO share prices. Results in the row labeled 'Proceeds IPO price missing' treat the IPO price as missing. The row 'Proceeds IPO price = 250' of Panel IV, assumes that shares in the initial allotment were sold for 250 guilders and prices are interpolated between the IPO price and the first observation (27 July [G]). The row labeled 'IRR in %, IPO price = 250' shows internal rates of return for each group assuming an IPO price of 250.

Table 6: Cluster-Based Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds										
Panel I	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
Holdings 29 June, 1720	66.00	40.00	65.00	22.00	154.00	20.00	6.00	123.00	454.40	60.00
Holdings 31 Dec, 1720	114.00	77.00	97.00	102.00	181.00	44.00	0.00	118.00	319.00	95.00
Average Holdings	125.34	73.68	108.11	69.18	192.91	60.75	4.27	161.19	310.55	96.09
Minimum Holdings	66.00	40.00	65.00	22.00	154.00	20.00	0.00	113.00	239.00	51.00
Average # Shares Sold	86.60	89.00	35.56	60.33	32.21	46.67	61.00	28.56	19.60	134.00
Average # Shares Bought	109.40	166.00	44.33	94.33	40.47	61.33	61.00	38.00	27.69	229.00
Panel II										
HM statistic Past Return	0.57	2.54	6.13	10.92	2.38	2.71	1.39	8.16	0.00	3.27
HM p-value Past Return	0.45	0.11	0.01	0.00	0.12	0.10	0.24	0.00	0.97	0.07
HM statistic Future Return	0.04	1.17	3.81	6.67	0.09	6.23	0.47	0.23	0.00	7.08
HM p-value Future Return	0.84	0.28	0.05	0.01	0.76	0.01	0.50	0.63	0.95	0.01
Panel III										
α_{Buy}	-0.10	-0.10	-0.10	-0.11	-0.09	-0.11	-0.10	-0.10	-0.09	-0.11
t-stat	-4.79	-5.01	-5.07	-5.64	-3.94	-5.87	-4.39	-4.56	-3.85	-5.55
β_{Buy}	0.01	0.08	0.05	0.07	-0.04	0.13	0.00	0.02	-0.05	0.10
t-stat	0.20	1.13	0.78	1.10	-0.74	1.62	0.00	0.39	-1.08	1.86
α_{Sell}	-0.10	-0.09	-0.08	-0.09	-0.11	-0.09	-0.10	-0.09	-0.10	-0.09
t-stat	-4.59	-4.09	-3.62	-4.05	-5.04	-3.87	-4.41	-4.13	-4.43	-3.81
β_{Sell}	0.01	-0.05	-0.06	-0.07	0.05	-0.03	0.01	-0.05	0.01	-0.09
t-stat	0.26	-0.81	-1.40	-1.30	1.07	-0.76	0.16	-0.74	0.13	-1.76
Panel IV										
Proceeds IPO price missing	-63.57	-118.83	-22.28	-27.45	-22.27	-33.03	-5.60	-16.42	-16.46	-103.88
Proceeds IPO price = 250	12.09	41.98	5.47	21.12	4.44	8.23	-1.50	2.72	2.45	49.13
IRR in %, IPO price = 250	-0.57	-0.45	-0.56	-0.92	-0.08	-0.44	0.39	-0.52	5.97	-0.79

Table 6: Cluster-Based Stad Rotterdam Investor Groups. Share Positions, Predictability Tests and Investment Proceeds. Share Positions, Predictability Tests and Investment Proceeds. Traders in Stad Rotterdam shares with at least 10 trades in 1720 are clustered into 10 groups based on the direction and size of their trades. Rows labeled 'Holdings 29 June 1720' and 'Holdings 31 December 1720' show the holdings for each cluster on 29 June and 31 December, 1720. 'Average Holdings' refers to the time series average holdings and 'Minimum Holdings' to the

minimum holdings for each cluster in the year 1720. 'Average # Shares Sold' is the average number of shares sold per cluster member in the year 1720 and 'Average # Shares Bought' the average number of shares bought per cluster member in 1720.

Panel II reports tests of relations between returns and trading decisions. 'HM statistic Past Return' and 'HM p-value Past Return' display the test statistic and p-value of a Henriksson-Merton test on past returns. It tests the relation between positive (negative) past ten-day returns and net buying (selling) decisions by clusters of traders. 'HM statistic Future Return' and 'HM p-value Future Return' display the test statistic and p-value of a Henriksson-Merton test on future returns. It tests the relation between net buying (selling) decisions by clusters of traders and future ten-day returns. The Henriksson-Merton statistic is corrected for serial correlation in returns and investment decisions using the Tavaré and Altham (1983) procedure.

Panel III displays regressions of returns on trading decisions. In the first sub-panel, future 10-day returns are regressed on a constant 'α_{Buy}' and a dummy indicating a positive net share purchase 'β_{Buy}' by the specific cluster. In the second sub-panel future 10-day returns are regressed on a constant 'α_{Sell}' and a dummy indicating a negative net share purchase 'β_{Sell}' by the specific cluster. Corresponding t-statistics are reported below the parameter estimates.

Panel IV displays the average investment proceeds per cluster member in thousands, assuming different IPO share prices. Results in the row labeled 'Proceeds IPO price missing' treat the IPO price as missing. The row 'Proceeds IPO price = 250' of Panel IV, assumes that shares in the initial allotment were sold for 250 guilders and prices are interpolated between the IPO price and the first observation (27 July [G]). The row labeled 'IRR in %, IPO price = 250' shows internal rates of return for each cluster assuming an IPO price of 250.

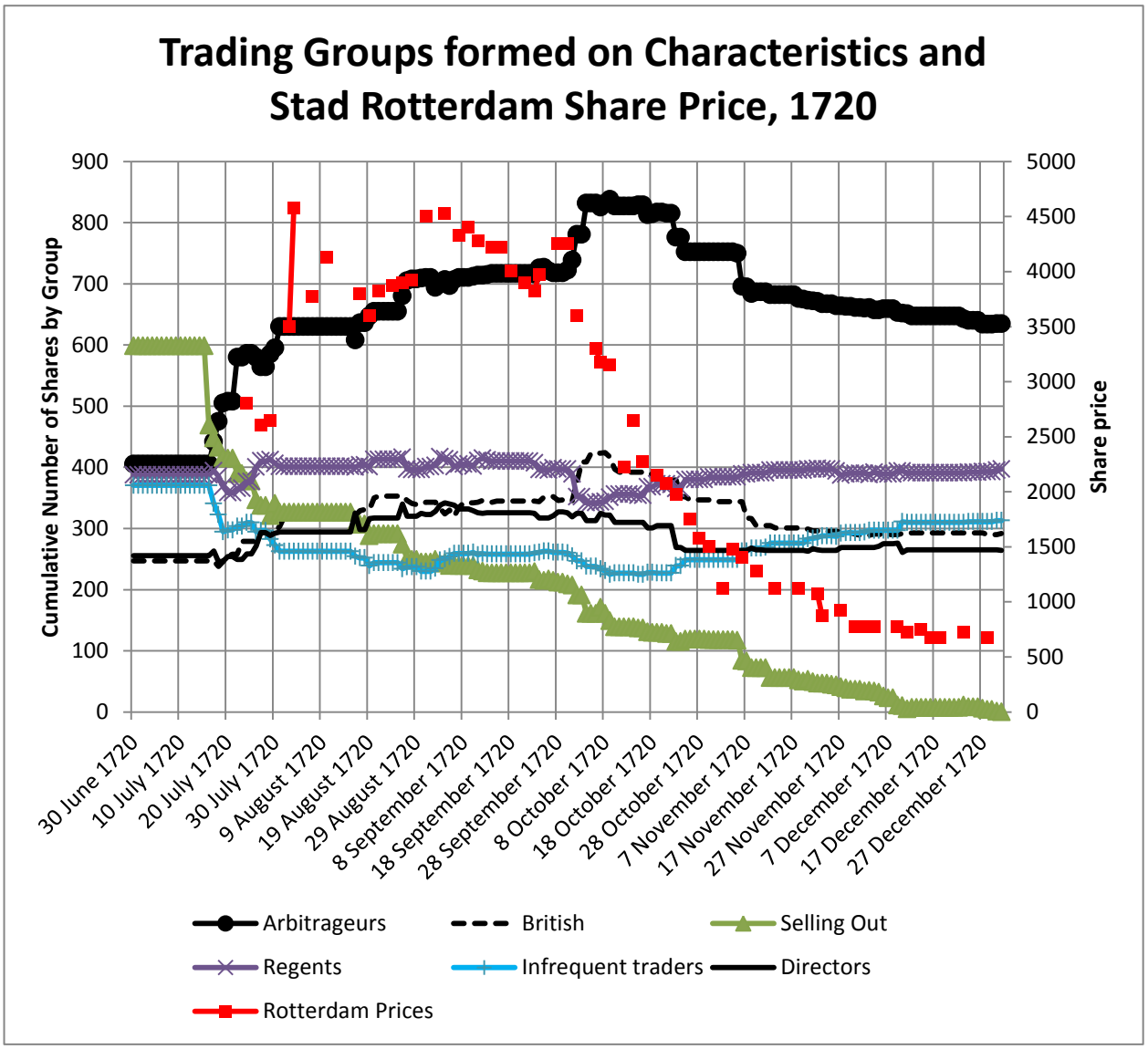

Figure 6: Trading Groups formed on Characteristics and Stad Rotterdam Share Price, 1720. This figure plots the time series of Stad Rotterdam share price on the right axis and the number of shares held by characteristic-sorted trading groups on the left axis, for the period June 30, 1720 to December 31, 1720. A trader is defined an 'Arbitrageur' if he is ranked among the top 10% of traders in terms of number of transactions. 'British' is the group of share holders with an Anglo-Dutch background. We retrieve background information from Klein (1984), Morison (1801), Bourn (1764) and Scottish church registers (http://www.scotsintchurch.com/sicarchives/INDEX.htm). 'Selling Out' contains all traders who hold no shares at the year-end. 'Regents' are share holders who are listed as regent in Slechte (1972). The group 'Infrequent traders' are all traders who conduct less than the median number of 9 trades. The group 'Directors' contains all directors of the Stad Rotterdam Company in the year 1720 and 'Rotterdam prices' is the price of the Stad Rotterdam share, plotted on the right axis.

Appendix A: The interpretation of price quotes

One of the problems in the analysis of the price data from Holland in 1720 is the question of how the price quotations should be interpreted. Share or subscription prices were not quoted in currency, but in a percentage in excess of some value. Scholars to date have disagreed on the interpretation of this value. We address this basic question through examination of the language used in the price lists in 1720, and by matching share loan transactions in the books of one company to the documented market quotations. The benefit of matching price quotes to company transactions in their shares is that the books were kept in units of currency.

Price quotes in the Leydse Courant typically were given in sentences such as: ”Rotterdam: Today the shares of our company were traded for prices ranging from 52 to 56 percent *avans*”. Intervals like this are not uncommon due to the high daily volatility; especially in the rise of the bubble the morning prices differed substantially from evening quotes. A key question posed by these quotes is of course, what is meant by “*avans*”? What amount is the quotation in excess of? This question is more challenging than it appears. Shares were issued through subscriptions that required capital calls. Thus, the relevant multiplicand might be interpreted as the capital paid in to the company up to that date [the paid in capital] or it might be interpreted as the face value of the share after all the shareholder installments are paid -- something we now often refer to as the par value or nominal share value.

It is therefore not surprising that previous authors have debated the interpretation of these quotes. For example:

van Rijn (1899) presumed that the *avans* referred to the nominal (or fully paid in) value of the share, and that additional paid-in capital represented a fraction that incremented the quoted price.[1]

[1] ”The furnishment up till 80% of the shares of the first subscription is also foolish and absurd, since the amount furnished in these shares exceeds the market value of the original shares, i.e. 15% has been paid

There is logical because newspaper percentages could not practically be based on the amounts paid-in. The paid-in capital increased over time and the exact amount paid-in was therefore uncertain until the books were closed and the paid-in amounts computed. If newspaper percentages were based on the amount paid-in, the newspaper percentages would have to drop after the payment of an installment; if the market share price does not change and more capital is paid-in, the percentage decreases by construction. Also, share holders often had two or three weeks to pay their next contribution. If the quoted share price were a percentage of the amount paid in, during the weeks of the payments newspapers would have to differentiate between shares for which the payment had been made and shares on which the payment was still required. Obviously, no such difference is documented in the newspapers.

Smith (1919) concurs with this interpretation: ”The share price was recorded in percentages “avans”, i.e. it indicated the percentages to be paid in excess of par value, calculated based on the amount which, with respect to the nominal amount traded by the company as installment was demanded.”[2] Likewise, Slechte (1982): “In the first two months the prices fluctuated between 100 and 80%, but dropped in September and October to 60%. The Rotterdam shares … were therefore on average priced at 4000 guilders in this period.”[3]

Despite their general agreement, none of the earlier authors offered empirical evidence supporting their interpretations. Thus, we sought to reject or verify their calculations of

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in on the subscription shares, to demand an additional 65% would be highly unfair ... The shares of the first subscription have already been traded at 38%, together with the paid-in amount of 15% this makes 53 percent, if an additional 65% were to be paid in then these shares would be worth 118%, this would be unreasonable …If … on the old shares 75% had been paid in, these would now be worth 3750 guilders, so a share of 1000 guilders would be worth 750 guilders.”

[2] Original Dutch text:”De koers werd genoteerd in procenten “avans”, dus men gaf aan hoeveel procenten boven pari betaald moest worden, te berekenen over de geldsom, die, met betrekking tot het verhandelde nominaal bedrag, door de compagnie als storting was geëischt.”

[3] This quote is in line with our interpretation as the nominal value of a share of the Rotterdam company was 5,000 guilders. The quotes are hardly affected by paid in capital since typically very little was paid in.

monetary share prices by matching transactions in the Leydse Courant with company records.

After the burst of the bubble at the end of September 1720, the directors of Stad Rotterdam made non-recourse loans to directors using their shares as collateral. If share prices fell during the maturity of the loan, the company incurred the loss. This arrangement could be interpreted as beneficial to shareholders because it was a means to reduce the "float" of shares by keeping directors from dumping into a falling market. It could also be interpreted as pure self-dealing by directors. In either case, these transactions allow us to link the market quotes to currency-valued transactions.

On pages 37 and 142 of the general ledger of Stad Rotterdam, some of these share loans are recorded in prices that match quotations reported in the Leydse Courant for the same day.[4] Since the ledger accounts are recorded in guilders, we can ascertain that the newspaper prices are reported in percentages of the nominal share value (5,000 guilders for the Rotterdam company). The losses incurred in these loan transactions also appear on the profit and loss account of the Rotterdam company (page 9 of the general ledger account).

A simple example of our interpretation is useful. Suppose that Rotterdam shares [with 5,000 guilders nominal value] are trading for 2,500 guilders on a certain date and that up until that date 1% had been paid in. Then the Leydse Courant quote of 49% a*vans* would imply the following: 'Rotterdam is trading today at 50% (2,500/5,000 * 100%) or 49% of the par value of the share above the paid-in capital ((2,500-1%*5,000)/5,000)*100%= 49%'.

This convention was convenient during weeks of installment payments. It allowed investors to distinguish between shares on which the installment has been paid and shares on which the installment still needed to be paid.

[4] Gemeentearchief Rotterdam, archive no. 199 inventory no. 451, pages 37 and 142.