

DUTCH EAST INDIA COMPANY'S INVESTOR BEHAVIOR
AFTER THE FIRST FINANCIAL BUBBLE 1720

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Master Thesis –Department of Finance

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Date of completion: 20 August 2013

ACKNOWLEDGEMENT

First and foremost, I would like to dedicate my sincere gratitude to my inspiring supervisor Rik Frehen for his invaluable expertise and constant support so I can successfully complete the paper.

I would also love to express my admiration and appreciation to all the lecturers at Department of Finance – Tilburg University for giving me a fruitful year of knowledge enlightenment and self-development.

Last but not least, I want to dedicate my dearest gratefulness to my family and friends at Tilburg University and back home in Vietnam for their unconditional love and encouragement so I can fulfill the journey with this master program.

ABSTRACT

The paper seeks answer to the phenomenon that no firms in the Amsterdam stock exchange issued new shares during more than 10 years after the bubble 1720 by exploring trading data from the Dutch East India Company (VOC). The company's unique trading record of individual investors has been collected by hand and documented for the first time. Results indicated that there was a significant break in trading volume of VOC after the year 1720 and liquidity for the stock remained at a critically low level for nearly a decade afterwards, implying investors' significantly lower demand and willingness to trade. Yet whether it was due to changes in fundamental value remained inconclusive. Further step into behavioral bias with a regression designed to test for traces of loss aversion among recorded accounts generally revealed that for every drop in returns, investors tended to increase their stock holding. Restricting the sample to only traders with loss further confirmed this negative negative correspondence and unfolded an interesting implication that investors with larger larger loss was less prone to such bias.

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1. INTRODUCTION

Since financial markets have been integrated intensively across the world, stock market bubbles have drawn much attention from economics scholars and recently become an essential field of study after the global impact of the asset bubble 2008. Among various debates comes the concept of “irrational exuberance” (Shiller, 2000) that describes the mechanism allowing a bubble to inflate when investors’ confidence and expectations were held up by past price increases to go enormously higher than its intrinsic value, evident for less than rational aspect of investor’s decision. Indeed, findings in behavioural finance have broken the absolute assumptions of traders’ utility maximization and perfect rationality in traditional financial economics, constructing a more realistic and humane view towards the market.

Behavioural aspects indeed do play a role in examining such mispricing events, including both its origin and consequential effects. Specifically, changes in risk taking ability and biases such as loss aversion are also interesting areas of inquiry for a bubble aftermath. However, both empirical and theoretical work on the first bubbles has been modest since data documentation remains a huge challenge. Particularly, data of English Stock Exchange and its listed companies since the first days of trading have been well-preserved and recorded scientifically, allowing more readily accessible for researchers. On the other hand, data of Dutch asset trading before the early eighteenth century were recorded in a less uniformed and structured manner (Homer, 1963) and hence create difficulty to collect and analyze. Despite such obstacle, I believe that learning about the first historical asset bubbles are, being independent of time and space, equally valuable for its implication with regards to both investors and analysts and hence worth researching.

The event of interest in this paper is the world’s first financial bubble, which was recorded in the year 1720 when the collapse of South Sea Company affected a major part of Europe. Because London was the primary determinant of prices in Amsterdam (Dempster et al. 2000), investors of companies in Dutch stock exchange could hardly be excluded from the madness created by South Sea Company in England and many stocks increased several folds. VOC was one of the few companies listed on Amsterdam exchange at the moment and was the dominant player in the Netherlands’ trade with far-

away lands after the “tulip mania” turned it into the most valuable company in world history. Most importantly, they are the only one having data record including both before and after 1720 survived until today, offering a precious opportunity for economic study.

Before the bubble burst, it could be noticed that there existed an “IPO wave” in the Netherlands (Frehen et al. 2012). Starting from July 1720 when almost all stocks in both London and Amsterdam reached their peak price level until October of the same year, more than twenty new firms were capitalized in the Netherlands and the only two firms that existed prior to 1720 also issued new shares. However, when investigating stock prices of the biggest companies that were listed in Amsterdam Stock Exchange during 1720s in the economic historian Dr. J. G. Van Dillen’s “Effective quotes on the Amsterdam Stock Exchange 1723-1794”, it is remarkably noted that there was no initial public offering or new listing of existing companies on the market from 1723 to 1733. During the whole 71 years of record, this market witnessed only one new company to enlist, which was Societeit van Berbice on 30 December 1735, and one existing company, English Assurance, to issue one new batch of annuities. The striking phenomenon is illustrated below, implying a serious lack of demand for stock and possibly an indication of a change in aversion towards financial assets as an impact from the bubble from both investor and issuer aspects.

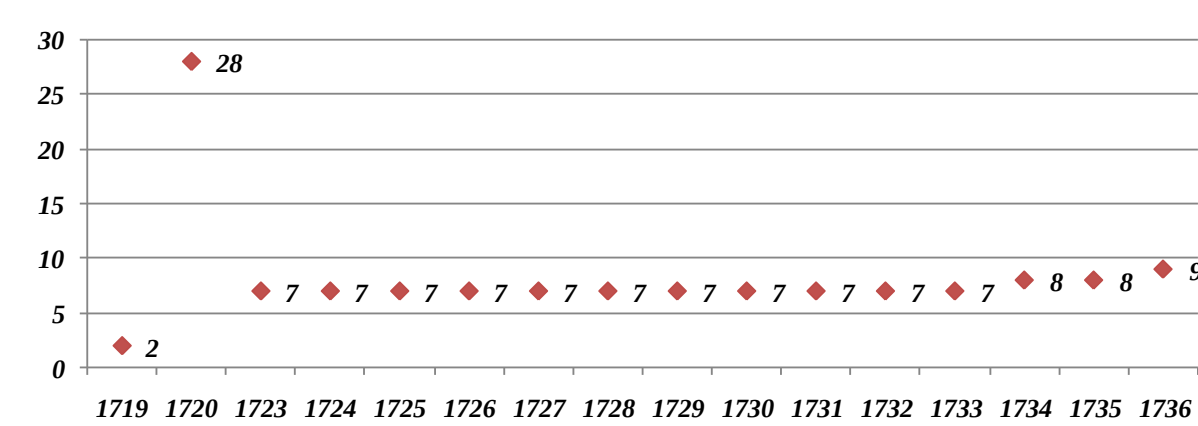


Table 01 – Securities issuance in Amsterdam Stock Exchange 1719 – 1736

Therefore, the paper seeks to find an explanation for the above-mentioned phenomenon: critical change in investor behaviour, presented in stock demand after a bubble burst. Did the investors of the first financial bubble have abnormal change their trading activities, which represented a change in their risk taking ability as a result of that major event? Or

was it a more dramatic hypothesis of aversion to equity? Did they also suffer from the behavioural “loss aversion” incident? The historical data of Dutch East India Company (VOC) in the Netherlands in the late seventeenth and early eighteenth century period makes it possible to study those inquiries. Furthermore, as the company’s stock valuation was usually regarded as contradictory to the highly speculative characteristic of the Amsterdam stock exchange (De Vries & Van der Woude, 1997), it is interesting to learn how “seem to be rational” investors behaved after a bubble.

Liquidity is the indicator for investor’s attitude towards an asset and would be the target parameter of this paper. The key feature of the paper, hand-collected original data about the trading details of individual investors of the VOC from 1704 to 1729 recorded in the company’s grand ledger in the National Library in The Hague, allows me to examine the trading behaviour of its investors. They are then used to calculate the volume of trading on a monthly basis to explore whether a significant structural break in volume existed after the bubble by regressing it against a dummy variable.

After a financial shock investors would usually be expected to trade less actively. However, if the investors are rational and market is efficient, the volume is forecast to not go down significantly as the price drop already adjusted the stock back to its fundamental value. Additionally, lower stock price should have encouraged new investors to enter the market and keep the volume level relatively stable. In contrast, if the volume persisted to dry up after a bubble, change in risk aversion or even an aversion to equity – a phenomenon when investors have dramatically negative view of equity and attempt to stay away from it - may explain such unusual trading behaviour.

Basing on VOC’s dividend data in “The first stock exchange” Petram (2011) and stock price record in Van Dillen’s lasting accomplishment “Effective quotes of Amsterdam Stock Exchange”, dividend yield for the periods before 1700 and after 1723 are calculated and compared with each other. Yields after the bubble are also compared with Dutch bond rate at the corresponding time taken from Homer’s “A history of interest rates”. Since the number of observations is limited, a non-parametric empirical test of difference is used to confirm the pattern presented in raw data.

Furthermore, trading volume can also be a valuable parameter to investigate the extent of loss aversion. Returns are calculated basing on price data in the year of the bubble 1720,

taken from Frehen et al. (2012). Changes in the holding of each investor are estimated and then regressed on the returns to reveal how losses affected their trading activity. Several controlling variables deriving from the trading record such as the length of their history trading with VOC, their frequency of trading, and the amount of shares they were holding are included in the regression with an expectation to unfold other interesting behavioural biases.

Result of the tests clarifies the significant drop in demand for stocks after the bubble and supports the hypothesis of a change in investors' risk taking ability after the bubble. A significant break in volume pattern during various periods before 1720 and afterwards is revealed. There are also fewer investors at the end of the ledger compared to its beginning account list and the majority of investors surviving the bubble sold all their shares by the end of the ledger, supporting my argument of lower willingness to hold VOC stock after 1720. However, dividend yield level was significantly lower post 1720 than that in the seventeenth century, indicating a possible deviation from fundamental value that chased investors away. That such yields were not significantly lower than the contemporary bond rate does not reject stock's attractiveness compared to other assets and hence shows little evidence for the argument that investors were averse to equity trading in general and hence further analysis in conjunction with other investing instruments is needed to draw a fine conclusion.

At a further step into behavioural perspectives, decrease in VOC investors' returns in the bubble is associated to an increase their holding as of the end of both 1720 and a year later. Although it is only statistically insignificant at 80% level for change in holding in 1720, such results still serve as evidence for the "loss aversion" theory when traders tend to hold on to their losses and to realize their gains (Odean, 1999). Interestingly, when the sample is limited to only investors who experienced a loss in the bubble, result confirms significantly such correspondence between the two main variables. It also reveals that investors with larger loss was more willing to liquidate their stock holding by the end of 1720 while investors with loss smaller than 5% tended to be more aggressive and accumulated more shares for every drop in returns, opening up fascinating idea for further researches with more data.

This paper with its focus on behavioural aspect of the first asset bubble hopes to contribute to the vast body of historical and financial knowledge with insightful

information and implications. First, unique data of one of the first listed company in the world are retrieved, hand-documented in digital form and analyzed under behavioural theme. Further researches, particularly in historical economics, with regards to such subject will find it beneficial from the work. Second, investor's unusual trading behaviour is crucial in estimating their aversion level, which will be input for various financial formulas in managing an asset portfolio. Therefore, the paper's findings will provide another evidence to foster a more flexible adjustment to investor's risk aversion when applying standard financial measures in portfolio management. Last, results obtained the paper are expected to make a meaningful contribution to the field of behavioural finance with its evidence for the existence of interesting trading bias after a bubble since the beginning era of financial trading. Such behavioural bias is indeed an important aspect to consider in investment consultancy.

The thesis would be comprised of seven parts. This current section gives an introductory overview of this paper. The next part describes in details how the topic has been academically investigated over the years and key indications to develop hypothesis for the paper. Methodology and data collection process will be further discussed in the third and fourth section. Afterwards, results of the empirical methods and well as discussion of the findings will be delivered next. The last two parts of the paper are about its implications for future researches as well as limitations and a brief conclusion.

2. LITERATURE REVIEW AND HYPOTHETICAL DEVELOPMENT

This part of the paper will be dedicated to give a background description of Amsterdam Stock Exchange and Dutch East India Company (the VOC) in South Sea Bubble period, to provide a summary of related literature and to describe in details how my flow of hypotheses has been developed.

2.1. Amsterdam Stock Exchange & VOC in the South Sea Bubble 1720

After the Dutch's nearly monopoly position in international trade over the entire seventeenth century faded as other countries developed their own shipping infrastructure and vehicles, Amsterdam turned gradually from trade to finance. Homer (1963, page 173-175) described the Amsterdam Stock Exchange in the eighteenth century as a developed world financial market with "many techniques of modern stock exchange trading" and active speculation.

Its efficiency during the eighteenth century has also been studied by a number of scholars and results generally indicated that this market was efficient in weak form. Both Dempster et al. (2000) and Koudijs (2012) found evidences to support the efficiency of Amsterdam stock market by comparing the difference in pairs of prices of companies that cross-listed in both London and Amsterdam stock exchange. Investors in both exchanges responded to such price differentials and information about assets translated quickly and accurately to price. Similar conclusion about the efficiency of Amsterdam Exchange in 1700s is made by Neal (1987). However, when applying ARMA (autoregressive moving average) model to both market with a hypothesis that the smaller number of parameters presents a more efficient market (in weak form), the result was only robustly ARMA (0,0) in London (Neal, 1987), indicating a less efficient market in Amsterdam stock exchange compared to London. Indeed, arguing for the efficiency of such distant period

Moreover, this market was closely integrated with the London Stock Exchange during the eighteenth century (Neal, 1987) and information dominantly flew from London to Amsterdam (Koudijs, 2009). Evidently, correlation coefficients of specific stocks quoted in both Amsterdam and in London were ranged from 0.986 to 0.995 (Neal, 1987). Therefore, even though originating and occurring in London, the South Sea Bubble had vast impact on Amsterdam stock market. Usually regarded by early economic historian as

evidence of the first irrational and speculative activity in financial market, this major stock crash was originated from companies' successive issuance of shares to fund its British government debt acquisitions (Garber, 1990). Such shares were then marketed at successively higher price as quoted by one of the famous investor – Isaac Newton – as immeasurable “madness of men” for the speculative audience's belief in the false claim of promising profit in dividends of such political deals, which never realized.

VOC was in fact not as strongly affected as other companies at the time of this bubble. While another major trading company named Dutch West India had their stock bubbled in the same scale with the South Sea Company in England at around 7 folds the price level at beginning of year, VOC did not even double. However, it “did fall below its price at the beginning of the year by end of 1720” (Frehen et al., 2012). Their price data of VOC during 1720 is replicated in the following figure.

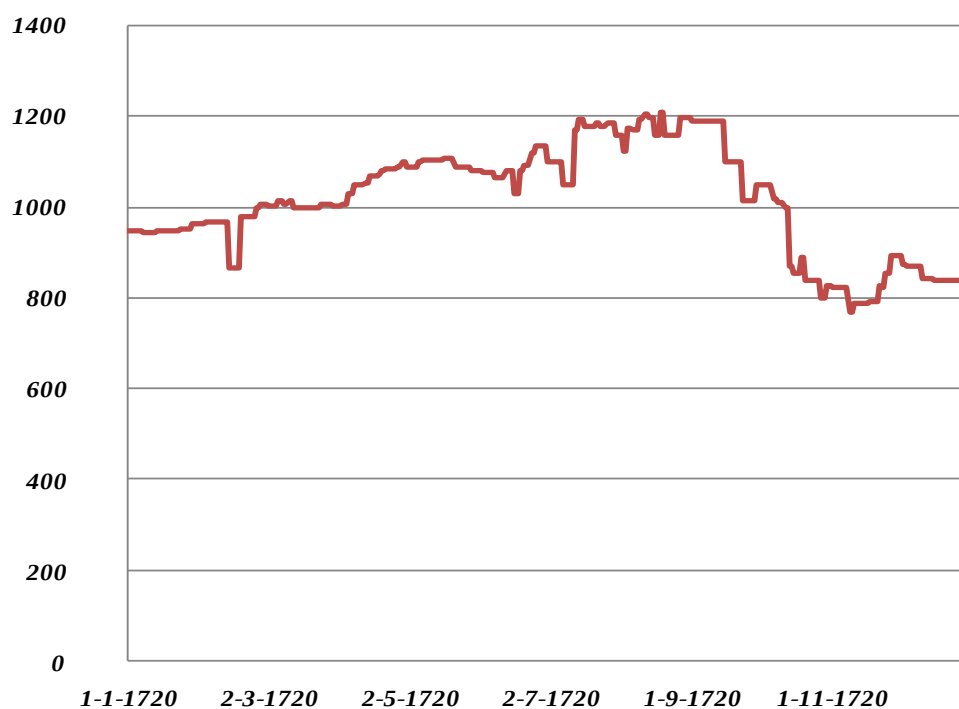


Figure 01 – VOC stock price in 1720

But VOC was one of the three biggest creditors of the British governmental debt in 1720 (Garber, 1990), hence unavoidably affected by the burst of South Sea Bubble in England. Furthermore, during such period the company was in its “Expansion Age” with stable dividend stream accounted for three quarters of the yearly profit. The outlook for long-

term stream of future dividends dominated the determination of its share price in particular and “Amsterdam stock market seems to have acted rationally in valuing VOC shares” (De Vries & Van der Woude, 1997). Therefore, I would expect its investors to be relatively more rational compared to the rest of the market known for speculation. If results obtained from the trading pattern reveals a negative effect of the bubble on VOC investor’s aversion level, the impact of such bubble should be present and likely to be more dramatic to stock holders in general. Indeed, it is an interesting target to investigate investor’s behaviours during such period of history.

2.2.Review of related literature

The rationality of investors is the base for the development of my hypothesis. The concept has been argued for ages between traditional economics and the new class of behavioural financial scholars. Rational investors are asserted to make optimal investing decisions according to their expected utility towards an asset and make unbiased forecast about the future. The utility function followed a theory of utility, which was first initiated by the economist Daniel Bernoulli. It shows human preference in engaging in any action presented as a function of expected payout, probabilities of occurrence and the risk attitude of individuals. It is the last quantity - aversion level - that sets people facing the same expected benefit apart, since their perception of risk preference differs and hence determines different total expected utility.

Since it is very challenging to estimate aversion level for individual ones, it usually assumed to be constant for all investors along with the premise that they are rational in financial models for practical purposes. A number of economists have attempted to find a way to derive such quantity using sophisticated mathematical formulas, for example Pratt and Arrow (1965), Menezes and Hanson (1970). However, this paper is not focusing on the mathematical aspect to measure accurately that quantity since the nature of risk aversion belongs to human psychological factors, which desires more of a behavioural approach.

Malmendier and Nagel (2011) studied how the investing experience affects an investor’s risk taking ability using four indicators: willingness to participate in stock market, willingness to take risks, allocation of wealth to stocks and anticipation of future stock returns. The result is that who experienced high equity returns report higher risk

tolerance, are more likely to take part in stock market, and have higher proportion of their liquid assets in stock because individuals learn from their own lifetime experiences rather than available historical data as in standard rational models. In light of their work, I hope to find evidence for a change in VOC investors' aversion level presented in their willingness to trade and hold the stock by investigating the company's trading data.

Besides changes in aversion after an adverse financial experience, investors' aversion have also been proved to be exposed to systematic bias that is far from optimal decision making. One major subject is the disposition effect, which is derived to serve investment context from the prospect theory of Kahneman & Tversky (1979). It is proved empirically that traders are prone to more frequently realize their gains than their losses and hence have a tendency to hold on to loss position (Barber & Odean, 1999). This effect is greatest among individual investors and does not seem to be motivated by trading cost or rebalancing purposes (Odean, 1998a). Odean (1998b) also showed that investors exhibit greater overconfidence through greater trading. However, such biases are mainly tested using modern trading data and I am curious to examine whether those systematic bias existed in the first financial bubble 1720.

For every bubble that has been studied, it can be noticed that there often are two contradictory schools of thoughts. Whenever there is one paper researching the over- or under-reaction of investors in a bubble, another work done on explaining the plausible reasons for such an event will follow. The 1720 Bubble is not an exemption. Contrary to conventional belief in the first example for "madness of man", there has been another school of thoughts that defended for a rational drive behind this enormous rise in price.

For one, Garber (1990) refused the recognition of South Sea Bubble as an asset bubble as he considered expectation of prospective dividends paid out of such ventures as a plausible explanation for investor's decision rather than their foolish irrationality. Similar thought is shared by Frehen et al. (2012) as they argued that price surge was due to at least three critical innovations including debt-equity swap mechanism, maritime insurance and shifts in global trade. However, such previous work mainly found possible reasons for an increase in price of stocks in the year 1720, the extent to which investors really traded basing on a rational drive has not been convincingly concluded yet.

Therefore, it is appealing to examine the extent to which the 1720 bubble affected contemporary investors. Do VOC investors who were known to rationally trade on such stock have lower risk taking ability and alter their aversion level after the event? Because they did not actually lose as much as other company's investors, if they did go through such change in risk attitude, it could also be aversion towards equity in general instead of just a specific stock.

2.3. Hypothesis

My hypotheses are constructed basing on the above-mentioned literature review. The line of reasoning is quite intuitive and simple.

First, as it was observed that there were no new shares to be issued during the entire period from 1723 to 1733, the demand for stocks at the time could be significantly low. The reason is investors changed their risk attitude due to effect of the bubble. Using trading volume as a measurement for willingness to participate in stock market and willingness to hold the shares, I hypothesize that the South Sea Bubble in 1720 had a negative influence on the VOC's investor risk taking ability and therefore, liquidity for VOC stock should dry up and experience a break before and after 1720.

Hypothesis 1: There is significantly less liquidity after the bubble 1720.

Second, the significant break which is initially hypothesized in trading volume could be due to deviation in fundamental factors which can be presented in dividend yields pattern. Therefore, the following hypothesis is designed to test if such possibility could be ruled out. Its result is also expected to strengthen the belief of a change in investor's aversion that leads to lower demand because if dividend yields were not significantly different between before and after the bubble period, there is no fundamental change in VOC stock and hence the break in trading volume can only be explained by a change in investors' aversion.

Hypothesis 2: Dividend yields after the bubble 1720 was different from its value prior to 1720.

To gather additional support for the aversion to hold VOC stock hypothesis, and furthermore the aversion to hold equity in general, other assets such as bond should be

taken into consideration. If the company was indeed not a good investment at the contemporary period compared to other assets, lower liquidity in stock market was also understandable to some extent. After 1720, investors can also find bonds more profitable and rushed out of equity. Thus such situation could weaken my initial hypothesis that investors avoid holding bonds for their mental change in aversion rather than change in fundamental factors such as there is a better investment option. Thus if dividend yields after the year 1720 did not differ significantly from bond yields, investors would be indifferent towards both assets and hence there should be no rational preference to any asset.

Hypothesis 3: Dividend yields after the bubble 1720 was lower than bond yield level of the same period.

More importantly, the behavioural influence of the bubble on trading pattern could be examined more comprehensively in conjunction with the gain or loss that investors experienced during such major event. Rational investors are expected to trade positively in accordance with their gain or loss, meaning investors who bared a loss in the bubble were expected to liquidate part of their holding of VOC after the bubble and vice versa. However, it can be inferred from the loss aversion theory that investors would otherwise tend to hold on to losing stocks and sell when they saw gains since realizing loss is more painful than realizing gains. Hence it is interesting to test this last hypothesis also to see if such bias also existed in the first bubble 1720 since it could be the case that investors were loss averse and increased their holding for every drop in returns with an anticipation of a price reversion.

Hypothesis 4: Investors holding position after the bubble is negatively correlated with their returns in the bubble.

3. EMPIRICAL METHODOLOGY

3.1. Time interval

The main event of study is the South Sea Bubble in 1720 and hence that entire year will be left out completely in measuring the changes in liquidity. The volume data collected covers a wide range of time-series observations, however, only a portion of them is selected in specified time intervals to focus on the main study.

The first hypothesis that there is a break in trading volume after 1720 is studied mainly by dividing data into two intervals: 1715 to 1719 and 1721 to 1725, each has in total 60 months. This 5-year interval represents the appropriate time frame before and after the bubble, during which the liquidity should not have been affected by such an event and hence should have remained stable if there is no abnormal change in investor's risk attitude. Additionally, it is short enough so as not to be distorted by any other major changes in macro environment. Availability of data also supports this window selection. Besides, several other windows are selected to confirm the break and test for variable stability: 1704-1729, 1711-1729 and 1711-1719.

The second hypothesis that there is no significant difference in fundamental value of the firm, presenting by dividend yields, two time intervals are determined: the prior to Bubble period is the last 3 decades of 1600s and the post-bubble period is 10 years starting from 1723. This "relatively distant" time selection is unfortunately due to unavailability of the data collected. However, for the latter period, it is reasonable to study from 1723 onwards so the market would be more likely to recover back from the chaos caused by such a huge event. In addition, this interval is also used to estimate the difference between profits of holding stock and holding bond after the bubble was over.

To study the last hypothesis that investors with larger loss would have higher incentive to buy VOC stocks, special interval is determined. After examining carefully the price pattern of the bubble 1720, I came to realize that stock price started falling since 1 September but only fall sharply from 15 September onwards so between day 1 and day 15, investors would have still accumulated more shares without noticing the first indication of a bubble burst. Therefore, it is plausible to estimate the change in individual portfolio from 15 September onwards.

3.2. Analysis of trading volume

First, to test whether a structural break in trading volume, initially I plan to use Chow test to test if there is a break in the coefficient of volume in a regression with price or dividend yields. However, both price and dividend data are limited and cause a trouble in creating a time-series regression with trading volume. The only source of price after 1720 quoted it twice a year and dividend data was on a yearly basis, meaning that there are only around 10 to 20 observations in total and hence using the initial approach is infeasible and the result would be unreliable.

The structural break in volume is changed to a simple test of difference. With 120 observations, the monthly trading volume is then regressed on a dummy variable with one (1) representing period after 1720 and zero (0) denoting the time before 1720 using the following regression line:

$$Volume_t = \beta_0 + \beta_1 * Dummy_t + \varepsilon_t$$

If the coefficient of the dummy variable differs significantly from zero, there is a structural break in volume. This method is similar to conducting a t-test of significant difference between the two mean values of these periods. The coefficient of the dummy variable represents the difference in mean values.

However, as this test works under an assumption that the observations are normally distributed, even though number of observations is relatively high to allow such assumption, another non-parametric test is employed to ensure the obtained result is consistent even if the assumption is loosened. The specific test to be used here is two-sample Wilcoxon rank-sum (Mann-Whitney) test for one group before 1720 and the other after 1720.

Furthermore, since liquidity could be unstable quantity and hence would yield less reliable results for the tests, I conduct similar tests between various time intervals to see if there is also a break in volume. The first test is between 1704-1720 and 1720-1729 to confirm the break due to the bubble. Second, if between 1710 and 1719 there is also a structural break, liquidity is unstable and interpretation of the results of the tests from such data should be handled with caution.

In addition, the indexes of the ledgers show the number of traders at the beginning of the ledger in 1704 and the number of investors who still held VOC shares at the end of July 1729. By counting and comparing the number of traders in this two indexed, I wish to find lower number of traders at the end of the period as evidence to support my argument that traders expressed much less interest in holding VOC shares after the bubble.

With the record of individual transactions on hand, the holding of each investor is estimated and change in their holding is also calculated as described in the previous section. I would like to test whether loss and gain during the bubble time can affect investor's trading decision by regressing the change in their portfolio on the returns they earned through 1720. However, the raw set of change in holding witnesses extreme outliers and highly skewed to the right, its top 10% is then trimmed down prior to running the regression to obtain a more reliable result.

In order to make best use of the available data, a number of other controlling variables are determined and added to the regression to increase its accuracy and to explore further meaningful implications. The model for the regression is as below:

$$\% \text{ Holding change}_i = \beta_0 + \beta_1 * \text{Return}_i + \beta_2 * \text{Record}_i + \beta_3 * \text{Frequency}_i + \beta_4 * \text{Holding}_i$$

Detailed explanation of each variable is presented in the Data section following this part of the paper. To obtain more insights into the theory of loss aversion, the above regression is also replicated only with only those who experienced a loss in the bubble with an expectation that the impact will be stronger for those with more loss. In specific, larger loss will induce investors to hold on to the investment rather than selling it out. Hence, loss investors are separated into two groups with dummy variable of 0 equal to investors with returns higher than -0.05 and investors who lost more than 5% will have dummy value of 1. The regression is transformed into the following specification:

$$\% \text{ Holding change}_i = \beta_0 + \beta_1 * \text{Return}_i + \beta_2 * \text{Record}_i + \beta_3 * \text{Frequency}_i + \beta_4 * \text{Holding}_i + \beta_5 * \text{Return}_i * \text{Loss Dummy}$$

The effect of returns on tendency to hold stocks of investors with larger loss will be displayed by the sum of β_1 and β_5 , holding other variables constant.

3.3. Analysis of dividend yields

To investigate whether fundamental value of VOC after the bubble was different from its values before the bubble, the average dividend yield ratio in the 17th century is tested against its value from 1723 to 1729. However, the number of observation is again a big hindrance to this simple test. The non-parametric two-sample Wilcoxon rank-sum (Mann-Whitney) test is used for another time with 18 observations prior to 1720 and 11 observations after 1720. However, the period selected to represent fundamental value before 1720 is relatively distant to the main event and possibly conveys different characteristic that does not have any relationship with the main event of study. Thus, another rank-sum test using closer window of the last 2 decades as described in time interval selection is conducted. Last, to compare the string of dividend yields after the bubble with contemporary interest rate as a proxy for alternative asset choice, another non-parametric test called Wilcoxon signed-rank test is used since there was in total 11 observations.

All empirical tests presented in this paper are conducted using STATA statistical software.

4. DATA COLLECTION AND ANALYSIS

4.1. Stock price

To investigate how investors' valuation of the stocks changes after a bubble, it is desirable to compare changes made before and after the shock event but I was unsuccessful to retrieve eighteenth century data prior to the bubble and it is still a mystery whether such data actually exists. Data in seventeenth century is, nevertheless, quite well-documented in Petram (2011). Regarding stock price in the 1700s, Frehen et al. (2012) was successful in retrieving a price list of various companies listed for the entire year of 1720 including the VOC, which is precious for the analysis of how the bubble occurred. Afterwards there seemed to be no sources of information other than the famous work by Van Dillen (1931). He recorded stock price of VOC and six other companies listed on Amsterdam Stock Exchange twice every month from 1723 – 1794 in his book “Quotes impact on the Amsterdam Stock Exchange during 1723 – 1794”. According to Neal (1993), this source of data “represents a major and lasting accomplishment” of Dutch stock prices in the eighteenth century. Stock prices documented in this book have also been used as primary input for a number of academic papers such as Dempster, Wells & Wills (2000) and Koudijs (2009). Prices of VOC were stated as percentage of the nominal value of a share instead of its actual price in Dutch currency at the moment – guilders – like nowadays stock market. It means that there is no fixed denomination for one share and its market value is actually measured as a percentage of its price at the initial public offering in 1602 (Petram, 2011).

4.2. Volume

Pictures of accounts on the grand ledgers of VOC preserved in the National Archief (Library) of the Netherlands in Den Haag were collected and digitally documented by hand, which comprises of more than 400 individual investors' accounts in almost 550 pages written in Dutch using Gothic style. However, the study is limited to contain only sixty five most *active investors* taken from VOC's ledgers from the year 1704 to 1729. The reason is that there were a plenty of long-term investors who followed buy-and-hold strategy throughout the entire period or seldom engaged in any deal, thus only the ones who frequently entered a trade are meaningful in measuring the liquidity of the market.

The selection rule is to choose traders who entered at least twenty four transactions either as a seller or as a buyer of VOC stock throughout the period from the beginning until page 426. A number of investors were so active that their account was actually split into several small periods that run to almost page 500 of the book. Hence, it is a reliable source of data since it covers almost all active trades during the entire period.

Variable	Observations	Mean	Median	Standard Deviation	Min	Max
<i>Traders</i>	65	33	33	19	1	65
<i>Trades</i>	4,717	73	55	53	24	327
<i>Buys</i>	2,363	3,445	3,000	3,163	33	78,000
<i>Sells</i>	2,354	3,812	3,000	4,873	-	86,406
<i>Volume</i>	298	48,585	43,299	35,012	-	186,000

Table 02 – Summary of trader’s accounts taken from VOC grand ledger

The table above presents a summary of the selected accounts from 1704 to 1729. In total, 4,171 observations are collected by hand and filtered to form 298 monthly trading volumes with an average amount of liquidity of more than 48,500 guilders each month. In general, an average successful buy order was lower than an average sell order by roughly 10%. Among the 65 selected traders, the average number of trades that each individual had for the period is 73 transactions.

This ledger is, according to Petram (2011), “the only source that can be used to estimate the level of market activity”. In the ledger, each trader had his or her own account since the beginning of the period and it was updated frequently to add new transactions. Each account had two sides, which are debit and credit, with detailed information of transaction dates, the buyer or seller of the deal and the nominal amount of the shares traded. Unlike price and dividends, the unit of each transaction recorded was in guilders, Dutch currency in the eighteenth century, and was the nominal value of the shares traded. Interestingly, the VOC never issued stock certificates so the only evidence of an investor’s share ownership was the balance on the account under his name in the ledger of the VOC (Petram, 2011). Therefore, the data collected in this paper served perfectly as the volume record of VOC stock and probably the only source for it.

However, in this specific case, if volume is calculated as total number of successful trades, it will be a problem of double-counting since accounts are filtered beforehand to satisfy “active trader” criteria and therefore there is possibility that active accounts trade with each other, requiring manual refining process to eliminate double transactions. Fortunately, the link to the counter party in any transaction was given as a page number where the counter-party account of such a transaction locates. The number of shares traded is then filtered again and counted to obtain monthly volume, ready to be used as input for regression.

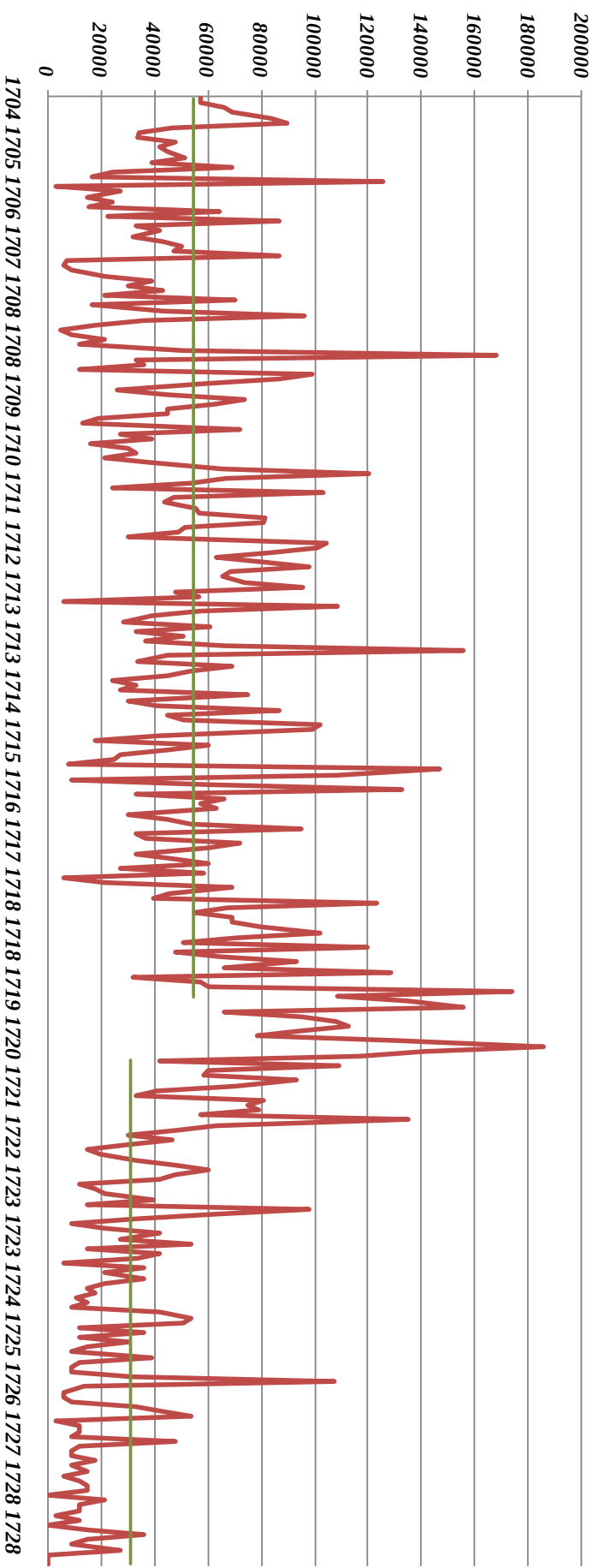


Figure 02 - Trading volume of VOC full sample (from October 1704 to July 1729)

It is noticeable that the volume increased significantly during the bubble and as suggested by the average lines, liquidity level for VOC stock was noticeably lower after the bubble. Especially starting from the end of 1721, its general level decreased strongly and remained low during the entirely later period. However, whether this change in volume is significantly different between pre and post bubble periods required empirical test to confirm.

4.3. Dividends and dividend yield

Dividend data are taken from Klerk de Reus, *Geschiedlicher Überblick*, Appendix VI (Petram, 2011). It can be seen from the data that the dividend stream was volatile over the last 30 years of 1600s, but remained fairly stable at 25% prior to 1712 before rising sharply to 40% until the bubble 1720 caused a strong decline. Mixed pattern is observed in dividends after 1722. In contrast, VOC stock price hardly fluctuated during the last 30 years of seventeenth century but was shifted up to a higher level after the bubble.

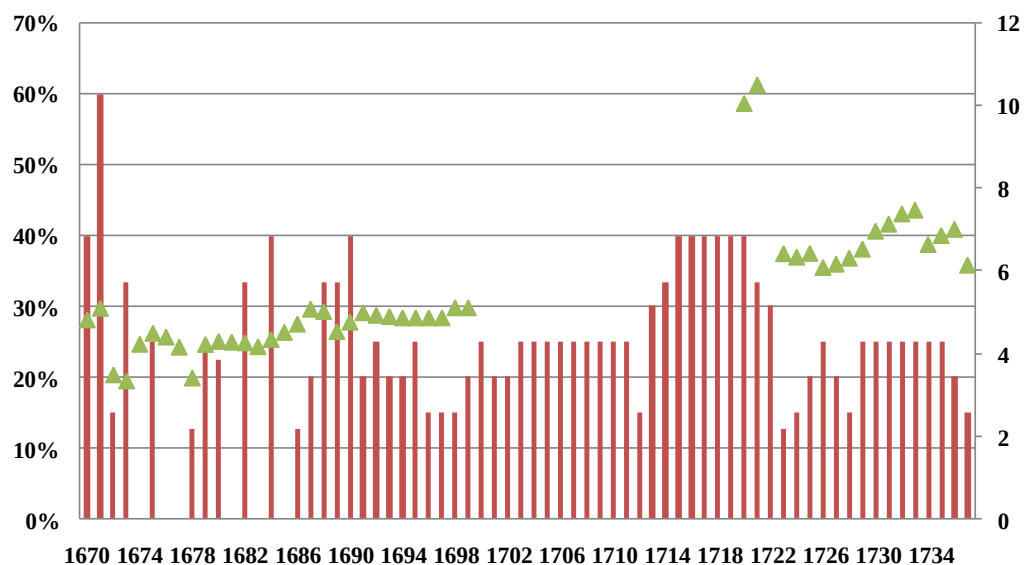


Figure 03 – VOC dividend and stock price pattern from 1670 to 1736

Similar to stock price, all dividends were recorded as percentage of the nominal value of shares, allowing dividend yield calculation to be unit-free. This quantity is then used as nominator to result in dividend yield. Unlike total returns that take into account the potential changes in value of a stock, dividend yield, according to definition given by Scott (1988), measures the current return of a common stock and is calculated as annual dividend divided by current stock price. It is an important indicator of the current income

investors are entitled to from the ownership of a company's stock. In this paper, since dividends were paid on a yearly basis, dividend yields will be derived from a yearly average stock price. Time-series dividend yields are illustrated in figure 4.

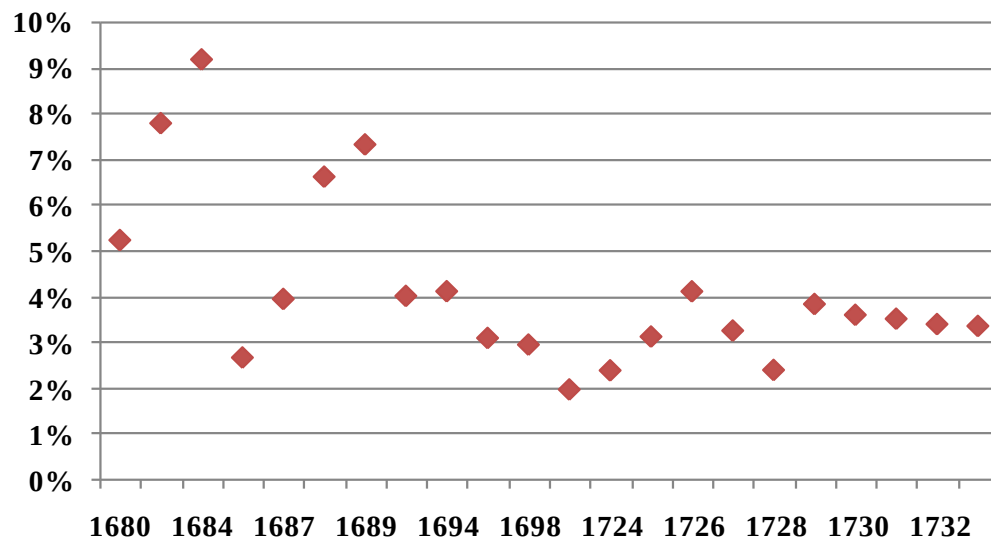


Figure 04 – Dividend yields of VOC from 1680 to 1733

From this raw data, it is clear that the general dividend yield level in the seventeenth century was much higher than that in the following century. This can be explained by a price shift after the bubble 1720 since dividends remained relatively stable as presented on the graph above. Missing columns due to lack of full set of dividend information in several years and price data from 1699 to 1722 are omitted for better observation of the difference. Overall, despite lack of data, it can be noticed that the last decade of 1600s witnessed a relatively similar level in dividend yield compared to the post 1720 period.

4.4. Bond yield

Bond yield remains one of the most challenging issues. Although by eighteenth century, Amsterdam Exchange developed into a world market dealing in a variety of complex financial instruments including stocks, bonds, margin, short sales, and future contracts; “A history of interest rate” (Homer, 1963) quoted that “the basic data are probably available but have not been published as a satisfactory continuous series of rates of interest”. Unfortunately, the general level is no doubt often very low but the precise string of yields has not been documented yet.

It is stated in the book (page 173 – 178) that at the beginning of the eighteen century, commercial loans were negotiated on the Amsterdam Exchange at as low as 1¼ to 2% and longer period witnessed a slightly higher rate of 2 to 3%. Therefore, in this paper, I would like to assume that the interest rate during 1710 to 1730 were approximately 3% to be conservative. As all interest rates on a variety of Dutch bonds were maintained stable and significantly lower than all other countries throughout the entire eighteenth century (Homer, 1963) while Amsterdam remained the most active financial market in Europe, it is plausible to argue that such obligations were traded at yields close to its nominal interest rate. It is not clear in the plot below that expected earnings from VOC's dividend were higher than holding its bond during most time of this period and requires an empirical test of difference to confirm.

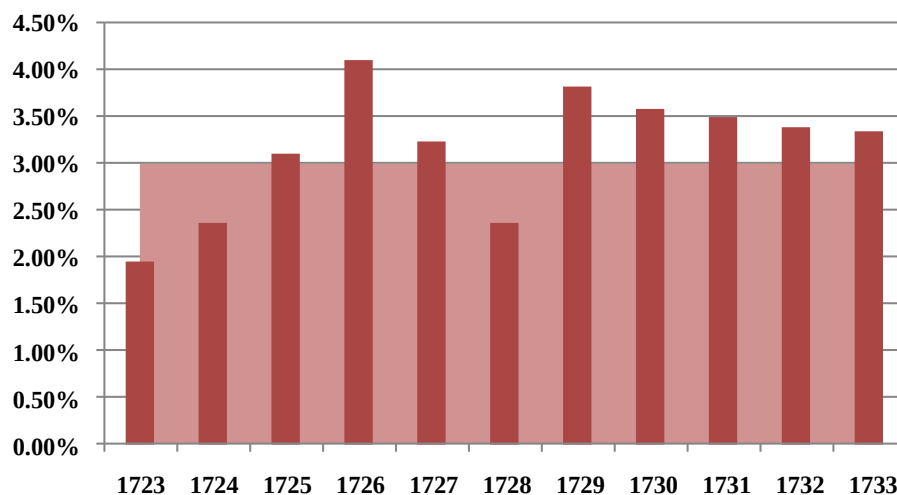


Figure 05 – Dividend yield versus interest rate of VOC from 1723 to 1733.

4.5. Change in holding

To further examine the change in trading behavior of investors, change in specific holding of each investor is also taken into consideration. With record of individual transactions on hand, I reconstruct the portfolio for each investor and estimate their holding at different point in time. It is remarked that among the 65 accounts recorded, only 40 accounts existed throughout the bubble time. Among them, four investors temporarily stopped trading during the whole 1720 so even though it is possible to calculate their unrealized return basing on their holding, the shock event is by no means strongly affected the trader's risk attitude and hence will not be taken into account in my study. The change in

holding to reflect the impact of the bubble is estimated between 15 September 1720 – the peak of the bubble and the end of 1720. It is also calculated between the holdings at that peak and the end of 1721.

4.6. Stock returns

From the recorded individual accounts, specific holding position at any point in time is calculated for each trader. Together with the price list obtained from Frehen et al. (2012), returns on VOC stocks of each trader during the whole 1720 are calculated. This return is in fact total return which comprises of both realized and paper gains/losses during 1720. The holding of each account at the beginning of the period is priced at the price level of 1 January 1720 and the end balance of 1720 is at the price level of 31 December 1720. Although it is desirable to calculate realized returns and even gains and losses separately to compare with total returns in order to investigate the loss aversion theory, the limited availability of data does not allow dividing further the small sample yet obtaining reliable results from the test using such data.

Noticeably from the graph summarizing the returns in relation to percentage change in holding by the end of 1720 below, while more than 75% of the trader (27 out of 36) experienced negative total returns; some still managed to earn a profit during the bubble time. Extreme values of percentage change in holding (respectively 29,000%, 12,000%, and 2900% are completely removed for their heavy distortion of the correlation of the variables. Such extreme values result from the fact that these investors managed to sell all their holding of VOC shares by September 1720 and started to accumulate largely its stock afterwards, particularly by the end of 1720 and 1721. As can be seen from table 3, the value range for change in holding is observed from -100% to 100% as of the end of 1720 and from -100% to 200% as of the end of 1721, hence removing the mentioned outliers is a necessary and correct move, corresponding to the bottom 90% of the whole sample.

Statistics	Mean	Standard deviation	Median	Min	Max
% Change in holding 1720	-5%	46%	0%	-100%	100%
% Change in holding 1721	-2%	82%	-20%	-100%	200%
Returns	-4%	6%	-4%	-13%	11%

Table 03 – Summary statistics of main variables

When returns are simply plotted against the change in holding, without the extreme effect of outliers, the linear relationship between the two variables seems to be negative but not so obvious. Empirical methods would be useful to determine whether they are significantly related to each other, especially after being controlled for other variables.

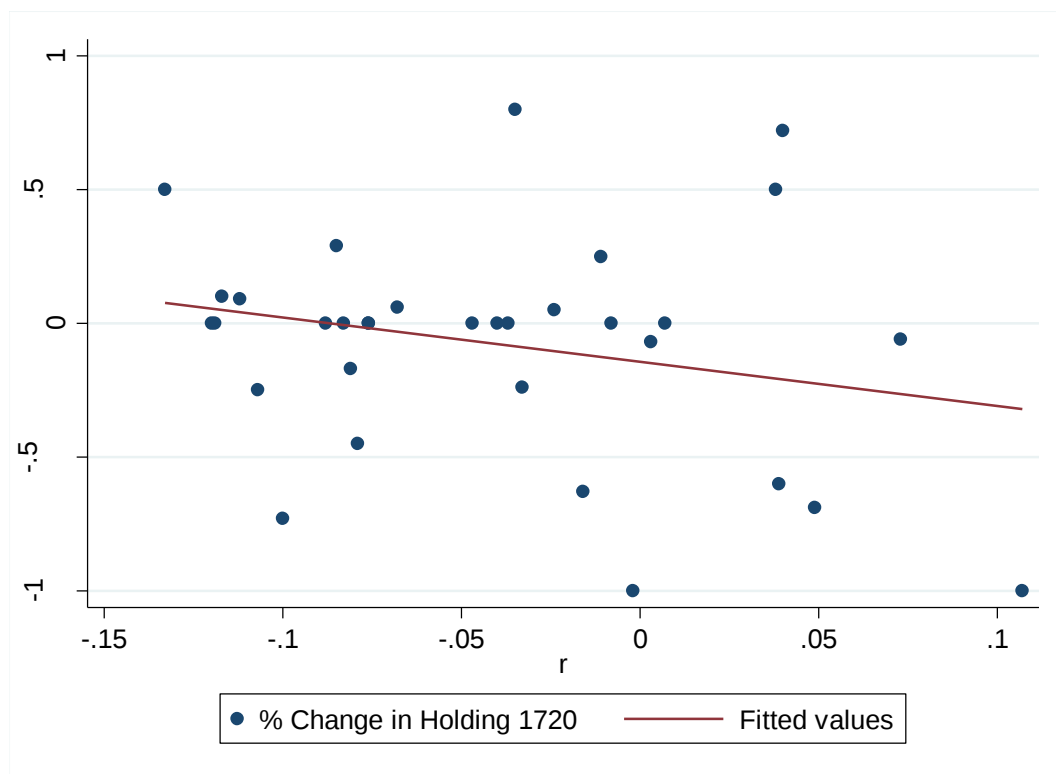


Figure 06 – VOC stock unrealized returns of individual investors during the bubble

4.7. Controlling variables

The available data are explored to the maximum to obtain meaningful controlling variables for the regression between returns and change in holding, whose summary statistics are provided in the below table:

<i>Statistics</i>	<i>Mean</i>	<i>Standard deviation</i>	<i>Median</i>	<i>Min</i>	<i>Max</i>
Number of years transacted	16.5	4.8	17	8	25
Yearly trading frequency	5.6	3.4	4.5	1.3	14.9
Holding at peak of bubble	25,808	19,370	18,050	3,000	87,000

Table 04 – Summary statistics of controlling variables

Basing on transaction history of each investor, the number of years they transacted was calculated. It is expected to play a role in determining the trading behaviour of an investor after a major event. Traders who had longer history with VOC would be likely to know more about the company and would have little change in holding position of the stock after the bubble.

The second variable, trading frequency is an important factor of interest. In accordance with the theory of “overconfidence”, excessive trading would be present in traders who are too confident or optimistic of the stock they are holding (Barber & Odean, 1999). This paper is not capable of examining whether investors were trading in excess of what should be considered necessary level. However, the regression can show whether investors were overconfident, indicated by that in case of loss they would be expected to not liquidate their stocks.

The last variable to control for is the number of shares each trader was holding at the peak of the bubble. Such factor is expected to make an impact on trader’s mentality and behaviour. Higher holding at the peak of the bubble would make larger unrealized loss in guilden value compared to the others, and hence is expected to put higher pressure on liquidating the holding instead of accumulating more afterwards. Before running the regression, this quantity is scaled down by dividing by 100,000.

5. RESULTS

The result of the first regression on time dummy variable indicates that there is a significant break in trading volume for VOC stocks in the year 1720 (see Table 5). The break in 1720 is significant for both the whole sample from 1704 to 1729 and smaller intervals from 1711 to 1729 and from 1715 to 1725. The coefficients for dummy variable representing the latter period are all negative and statistically significant. For example, between two periods 1715-1719 and 1721-1725, trading volume after the bubble is lower by 23,177 guilders, equivalent to 47% of an average trading day of the entire record or to equal to 45% of an average trading day during that particular period of research.

In addition, the non-parametric two-sample Wilcoxon rank-sum yields the same statistical significant conclusion with the regression at p-value of 0%. Higher value in total rank sum of the former period indicates higher level of volume compared to the latter one. Additional tests using data from 1711 to 1729 also disclose the same result of a significant break in liquidity after the year 1720.

Volume break					
Regression	Observations	Dummy coefficient	Std. Err.	Test statistic	P-value
1704-1729	286	-23,317	3,706	-6.29	0.000
1711-1729	206	-31740	4,145	-7.66	0.000
1715-1725	120	-23,177	5,738	-4.04	0.000
1711-1719	108	1,407	6,296	0.22	0.824
Wilcoxon	Rank-sum		Test	P-value	
rank-sum	d=0	d=1	statistic		
1704-1729	30,733	10,308	6.663	0.000	
1711-1729	13,818	7,503	7.384	0.000	
1715-1725	4,391	2,869	3.995	0.000	
1711-1719	2,889	2,997	0.003	0.998	

Table 05 – Structural break in trading volume after the bubble 1720

The main variable of interest, i.e. the trading volume, is also a relatively stable variable, illustrated by no statistically significant change in the trading pattern over the previous period from 1711 to 1719 as I tested for a break in 1715. Hence, the structural break in

liquidity is confirmed, exhibiting the dramatically lower willingness to hold stock after the bubble, which led to the fact of “no securities issue” during such period.

Another important test to gather additional support for such hypothesis is to analyze dividend yields to find evidence that VOC was not an undesirable asset in fundamental terms. Result of the two-sample Wilcoxon rank-sum test implies that the dividend yield level in seventeenth century was significantly higher than that observed after the bubble 1720 (see Table 6). However, when the time frame is moved up to only two last decades of 1600s instead of the last 30 years of the seventeenth century, the coefficient still confirms a significant decrease in yields but turns less statistically significant with a p-value of 0.02. The change in results can be explained by differences in macroeconomic factors between more distant periods. Furthermore, as can be seen in the graph depicting both stock price and dividend pattern over the entire sample period, there is a significant surge in stock price in the eighteenth century while dividend level remained quite stable, leading to an increase in dividend yields compared to the previous decade. Although its results infer that the attractiveness of VOC stock decreased after the bubble, opening up another explanation for exhausting trading activity, the test is conducted with severe lack of data so interpreting such results require caution and additional evidence.

Dividend yields	Obs.	Rank-sum		z-value	P-value
		Before 1720	After 1720		
1670-1733	29	341	94	3.2	0.00
1680-1733	22	163	90	2.4	0.02
Dividend yields - Bond rate		Positive	Negative		
Difference	11	4	3	0.3	0.70

Table 06 – Results for dividend yields analysis

The next hypothesis represents additional efforts to support the attractiveness of VOC stock as to prove if aversion to equity existed. It is also designed to explore whether other assets such as bond were more desirable than VOC stock and hence could explain why investors tended to sell out VOC stocks after the bubble. On contrary to the previous test of significant difference, result of the non-parametric Wilcoxon signed-rank test demonstrates that there was no significant difference in the dividend yield of VOC and bond rate after the bubble with a weak z-value of only 0.37 (see Table 6).

To confirm the attempt to avoid holding stock, there should be fewer investors remaining in the market after the bubble. First, after examining the Index pages of the grand ledger of VOC, I found that the number of traders at the beginning of the ledger in 1704 is indeed 11.5% more than the number of traders at the end of the year 1729; indicating shares were on hands of fewer investors. Second, among those remaining in the market after 1720, a further investigation of each trader's account could to some extent exhibit their willingness to hold VOC shares until the end date of the ledger. However, of all investors remaining in the market after the bubble, a balanced portion - 50% - of investors sold out all their shares by the end of 1729. Although it is interesting estimates, such change in stock holder records could be affected by events in between the two distant dates other than the bubble 1720.

Besides, an interesting finding that I encountered when studying the individual accounts is that 60% of the investors remaining after 1720 held a net sell position. Regardless of their beginning or ending balance, total number of shares for each buy or sell transaction is gathered and net holding position is calculated on a yearly basis. Net sellers are those who have more net sell positions in such a period than their own net buy position. The majority of these most active traders were net sellers so it is likely that they indeed lost interest in VOC stocks and the attempt to avoid holding equity should be present. However, interpreting this finding needs careful consideration since there is buy side for every sell position and there is possibility that the counter-position of these trades were not documented.

So it can be inferred from the analysis above that investors of VOC did experience a significant change in trading behaviour after the bubble 1720 and their lower willingness to trade was convincingly presented, which can be considered analogous to Malmendier and Nagel (2011) that those experiencing lower equity returns in a macroeconomic shock tend to have lower risk tolerance and have lower proportion of their assets in stock. Furthermore, since VOC stocks' intrinsic value was not consistently proved to deviate at least in statistical aspect, such liquidity pattern that persisted until 1729 and the striking "no IPO" phenomenon that I mentioned in the first sections of the paper could be more convincingly explained by the behavioural aspect of the market, i.e. a change in investors' risk aversion towards equity after the bubble burst.

Historical information about the Dutch market and the VOC during such period of interest also supports this key hypothesis of the paper. The stock market at that time was strongly influenced by not only economic elements but also political factors. No war or major political events occurred after the bubble 1720 up until the 1730s, hence there should be no significant change in market liquidity. Furthermore, VOC was in its “Expansion Age” with a reported annual profit of 2 million guilders per year from 1680 to 1730, of which three-quarter was distributed as dividends, implying a promising economic outlook at least from the standpoint of 1720 investors. So a change in investors’ risk taking ability as an impact of the bubble seemed to be most plausible reason and the existence of a change in aversion has also been supported to some extent.

However, the direct link between the bubble and change in investors’ aversion has not been proved clearly in the paper and needs further analysis. Additionally, willingness to trade may also be subject to unknown factors other than the reasons mentioned. To conclude whether investors were averse to hold specifically equity in general needs further investigation of other assets with more available data instead of other company. Study of the other company that existed both before and after the bubble – the Dutch West India Company may result in more extreme results in investors’ behaviours since its stock price increased more than 8 folds at the bubble peak. And the results would also be likely less reliable since the company was much smaller in scale and was more of speculative stock than of fundamental values like the dividend payer VOC.

Another important aspect of the paper is to study whether loss aversion existed among the investors of the first bubble. Five specifications of one main model are conducted. The coefficients as well as their p-values (in brackets) are reported in Table 7. The result of this empirical regression is expected to give further insights to the several behavioural aspects of investors after a bubble. In general, it is revealed that there is a negative relationship between the change in stock holding position after the bubble and the returns each investor experienced during the bubble. It is especially clear between returns of 1720 and changes in stock holding by the end of 1720. Unfortunately, the coefficients of this main variable are statistically insignificant in almost all specifications at the confidence level of 90%.

Specifically, in the first regression, returns are solely regressed against percentage change in holding by the end of the bubble year before three other regressors are added

(specification 1 and 2). The coefficient for returns remained negative in both of the tests and its significance level even increase with controlling factors included. At 80% to 85% confidence level, it can be interpreted that for every gain in returns, investors would liquidate 1.65% of their holding and 1% drop in return would lead them to increase their position by 1.65%, holding everything else constant.

Despite the statistical insignificance and modest economic magnitude, it is very interesting result since the signs reflect the tendency to hold on to loss as suggested by loss aversion theory (Barber & Odean, 1999). Another possible explanation is the psychology to accumulate more shares when stock prices plummeted in hope of future price recovery to make up for the loss. The results turn much less significant when the percentage change in holding by the end of 1721 replaces the dependent variable, which indicates faded effect of the bubble as the time passed by (specification 3 and 4).

% Change in holding					
Independent	1720		1721		Loss 1720
	(1)	(2)	(3)	(4)	(5)
Returns	- 1.65 (0.20)	-2.34 (0.16)	0.52 (0.89)	-0.47 (0.87)	-14.76 (0.05)
Record		0.01 (0.99)		0.02 (0.87)	-0.02 (0.15)
Frequency		0.02 (0.53)		0.03 (0.59)	-0.08 (0.03)
Holding at peak		-0.38 (0.45)		-0.93 (0.29)	-0.38 (0.37)
Returns*Dummy					13.31 (0.02)
R-square	0.05	0.07	0.02	0.05	0.42
Adj. R-square	0.02	-0.05	-0.03	-0.09	0.28
Observations	34	34	33	33	26

Table 07 – Summary of regressions result

It is noticeable that the power of the test as indicated in R-square statistics improves after controlling variables are added while due to the scarcity of observations and the insignificance of regressors, its adjusted value tends to yield negative result, particularly with more variables. However, when the sample is restricted to only traders who lost in the bubble with a dummy variable to separate larger loss and smaller loss, these two

measurements improved dramatically as can be seen in specification 5 to 42% and 28% respectively.

In a more comprehensive analysis of the effects of loss, investors who experienced gains in the bubble are removed. As a result, both statistical significance level and economic magnitude of almost all variables improves strongly. The sign of the main variable remains the same, indicating the same tendency to hold on to loss in accordance with results of previous regressions is further confirmed in this specification at confidence level of 5%. More importantly, its magnitude reveals a fascinating story. For 1% decrease in returns, investors who experienced less than 5% loss would tend to accumulate 14% more of VOC shares by the end of 1720. But investors with larger loss seemed to be less aggressive towards this bias. They tended to increase their position at bubble peak by 13% less than investors with smaller loss and this difference in holding tendency is significant. This result is in contrast with my initial anticipation and reveals another interesting point for further researches that the bias is more present among investors with less loss.

It is unexpected that all controlling factors have relatively modest economic influence on the change in holding and are statistically insignificant when full sample is used. Trading history with VOC, represented by the number of years on record, does not have any correspondence to change in holding and the holding position at bubble peak provides modest impact, as indicated by their very low significance level. Meanwhile, in a more positive note, trading frequency seems to play a role in determining the stock holding tendency of VOC investors with its lowest p-value. It can be interpreted that among losing investors, the more frequently he or she transacts, the more likely he or she would liquidate instead of accumulating VOC shares after the bubble burst. For example, specification 5 suggests that one more trade per year would motivate the investor who witnessed a loss in the bubble to sell out 1% of the VOC stock that they own. This result is contradictory to my expectation that they would be prone to overconfident, exhibiting by higher trading frequency leading to accumulation of shares despite their loss in the bubble.

In summary, the results of the regressions conducted in the paper provide relatively consistent evidence for the existence of behavioural bias of investors. Loss aversion generally seems to be present at the bubble 1720 among VOC investors and it is

particularly statistically significant within a restricted sample of lost investors. Furthermore, result indicates that this bias is smaller for investors with larger loss in the bubble. However, other factors including trading history with the company, trading frequency and the amount of shares they own have fairly negligible impact on the trader's decision of liquidating or accumulating more shares after the bubble.

6. LIMITATIONS AND IMPLICATIONS FOR FURTHER RESEARCHES

The first important drawback of historical economic research lies in its lack of data. Lack of VOC stock prices for the years 1721 and 1722 as well as prices prior to 1720 hinders me from performing the expected event study to measure the direct changes in investing behaviour of investors before and after this bubble when the effects are strongest. Additionally, for this same reason, dividend yields of years closer to the main event could not be tested to obtain more accurate results although dividend information is available throughout the entire period.

Once the data of prices are solved, analysis of dividend yields should yield interesting result, using this same line of reasoning as mine or exploiting new ideas. A regression to examine the correlation between dividend yields and trading volume before and after the bubble could be implemented. Furthermore, structural break in volume could also be tested using Chow-test as an alternate to my simple empirical method of using dummy variable of time. Lack of price data prior to 1720 also leaves me no choice but calculating returns basing on price at the beginning of the year instead of average purchase price.

Second, one key hypothesis to rule out an alternate investment asset, i.e. bond, has been relatively poorly done due to severely lack of data. Concrete assumptions are made in the paper using existing evidence, however, it is undeniable that without real market yields for bond, using interest rate as a proxy for such a long period of 10 years was quite risky and likely to subject to bias.

Third, the main data of the paper, which is the trading volume drawing from individual accounts also faces limitations. The total number of traders' accounts selected is only roughly 15% of the total number of accounts presented in the ledger during the period. Although these accounts are highly representative for trading pattern of the majority of investors in general at that time because my solid decision rule allows them to be the most active traders in the market, they cannot fully represent the whole market.

In addition, sample selection bias seems to be the biggest shortcoming of this thesis. I fully acknowledge that the traders should have been selected on a random basis. However, randomizing the data to select traders sees huge obstacles. First of all, there are more than 400 investors during the period and the book has never been digitalized yet,

making it very time-consuming to enter them all and difficult to randomize the selection. Furthermore, as far as I am concerned, the majority of investors seldom traded during the period. Randomizing the investors will pose a threat that many of the randomly selected investors will actually have only several trades during the entire 20 years and will poorly represent the liquidity of the market, which is the utmost target of this paper.

Last, regarding empirical aspect, the tests conducted in this paper need further robust check. For example, the structural break in liquidity should have been tested with Newey-west statistic to avoid autocorrelation in the errors of such a simple regression with time dummy variable. Limited data also expose the empirical results to other statistical biases and reduce the power of the test. Loss aversion would have been yielded more solid results with more investors who gained in the bubble. More importantly, what factor actually caused the significantly lower level of trading volume remains questionable since I cannot provide more direct proof of the relation between the phenomenon and change in aversion level of investors.

Hence, the paper was just an initial step with limited scope to explore such a precious historical data. The availability of resource as well as my current documentation will be a good base for future studies, and researchers with larger time frame. A wider variety of empirical methods can also be used to better explore the data and research ideas once the problem of data insufficiency is solved. For example, it would be very interesting to see if investors who experienced larger loss would sell out shares in a quicker pace. Trading activeness after the bubble is also another interesting variable to observe. With a larger sample I would also love replicate Barber and Odean (1999) methodology to study whether loss aversion existed in this first asset bubble by contrasting the realized gains and losses with their unrealized values. Specifically, it is not only desirable to see whether investors were affected by the bubble but also whether such effect on those suffering loss was more severe than those who gained.

7. CONCLUSION

Using the remaining data record of VOC – one of the two companies that existed both before and after the year 1720, the paper discusses a change in the risk taking ability of investors surviving the first financial bubble measured by their trading volume. A significant structural break in liquidity prior to and after the bubble is revealed. Along with the phenomenon of no new stock issues during more than 10 years after 1720 that is observed in Van Dillen (1931), this result solidifies the hypothesis that there is critical change in investors trading behaviour and their demand for stocks diminished strongly after the bubble. Furthermore, detailed analysis of the available data also supports this main hypothesis since stocks were indeed on hands of fewer investors after the bubble. Other reasoning for lower trading volume is also tested yet partly ruled out. Generally speaking, VOC's investors indeed lost their interest in holding the company's stock for the negative impact of the bubble, but whether it is due to a change in their aversion level towards equity remains questionable.

In addition to exploring the change in risk taking ability, the paper seeks to engage in the trading bias of loss aversion. By regressing investors' individual returns over the bubble time against the change in their own net holding position of VOC stocks after the bubble, it is clear that there is a negative correspondence between investor's returns in the bubble and their change in stock holding. The link is confirmed with a smaller sample of only investors with loss when investors tended to accumulate more stocks for every drop in returns. More interestingly, this bias is significantly stronger with investors with smaller loss, contradictory to conventional expectation.

Despite a number of limitations in data and methodology, the study makes a contribution to future historical economic and behavioural finance researches since trading volume and individual trading accounts for VOC stocks, one of the most valuable companies in history as well as one of the first companies to issue shares in the world, are recorded for the first time. Furthermore, researching the first asset bubble under the aspect of behavioural finance, the paper's results support the view that aversion level of investors would change as a result of dramatic adverse experiences in their life, and more impressively, investors of VOC stock in the first financial bubble were also prone to the loss aversion bias.

REFERENCE

01. Barber, B., & Odean, T. (1999). The courage of misguided convictions: The trading behavior of individual investors. *Available at SSRN 219175*.
02. Barber, B. M., & Odean, T. (2000). Trading is hazardous to your wealth: The common stock investment performance of individual investors. *The Journal of Finance*, 55(2), 773-806.
03. Bondt, W. F., & Thaler, R. (1985). Does the stock market overreact?. *The Journal of Finance*, 40(3), 793-805.
04. Dale, R. S., Johnson, J. E., & Tang, L. (2005). Financial markets can go mad: evidence of irrational behavior during the South Sea Bubble. *The Economic History Review*, 58(2), 233-271.
05. Dechow, P. M., Hutton, A. P., Meulbroek, L., & Sloan, R. G. (2001). Short-sellers, fundamental analysis, and stock returns. *Journal of Financial Economics*, 61(1), 77-106.
06. Dempster, G., Wells, J. M., & Wills, D. T. (2000). A common-features analysis of Amsterdam and London financial markets during the eighteenth century. *Economic inquiry*, 38(1), 19-33.
07. De Vries, J., & Van der Woude, A. (1997). *The first modern economy: success, failure, and perseverance of the Dutch economy, 1500-1815*. Cambridge University Press.
08. Frehen, R. G., Goetzmann, W. N., & Geert Rouwenhorst, K. (2012). New evidence on the first financial bubble. *Journal of Financial Economics*.
09. Garber, P. M. (1990). Famous first bubbles. *The Journal of Economic Perspectives*, 4(2), 35-54.
10. Homer, S. (1963). *A history of interest rates*. Rutgers University Press.
11. Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.
12. Koudijs, P. (2009). The boats that did not sail: evidence on the sources of asset price volatility from an 18th century natural experiment. *Available at SSRN 1343659*.
13. Levy, H., & Markowitz, H. M. (1979). Approximating expected utility by a function of mean and variance. *The American Economic Review*, 69(3), 308-317.

14. Malmendier, U., & Nagel, S. (2011). Depression Babies: Do Macroeconomic Experiences Affect Risk Taking?. *The Quarterly Journal of Economics*, 126(1), 373-416.
15. Menezes, C. F., & Hanson, D. L. (1970). On the theory of risk aversion. *International Economic Review*, 11(3), 481-487.
16. Neal, L. (1993). *The rise of financial capitalism: International capital markets in the age of reason*. Cambridge University Press.
17. Neal, L. (1987). The integration and efficiency of the London and Amsterdam stock markets in the eighteenth century. *Journal of Economic History*, 47(1), 97-115.
18. Odean, T. (1998a). Are investors reluctant to realize their losses?. *The Journal of finance*, 53(5), 1775-1798.
19. Odean, T. (1998b). Do investors trade too much?. *Available at SSRN 94143*.
20. O'Hara, M. (2008). Bubbles: Some perspectives (and loose talk) from history. *Review of Financial Studies*, 21(1), 11-17.
21. Osborne, J. W., & Overbay, A. (2004). The power of outliers (and why researchers should always check for them). *Practical assessment, research & evaluation*, 9(6), 1-12.
22. Petram, L. O. (2011). The world's first stock exchange: how the Amsterdam market for Dutch East India Company shares became a modern securities market, 1602-1700. Dissertation.
23. Schiller, R. J. (2000). *The Irrational Exuberance*.
24. Shiller, R. J. (2003). From efficient markets theory to behavioral finance. *The Journal of Economic Perspectives*, 17(1), 83-104.
25. Scott, D. L. (1988). *Wall Street words*. Houghton Mifflin.
26. Stringham, E. (2003). The extralegal development of securities trading in seventeenth-century Amsterdam. *The Quarterly Review of Economics and Finance*, 43(2), 321-344.
27. Van Dillen, J. G. (1931). Effectenkoersen aan de Amsterdamsche beurs 1723-1794. *Economische Historische Jaarboek* 17.