

UNIVERSITY OF WAIKATO

Hamilton New Zealand

**Exuberance in Historical Stock Prices
during the Mississippi
and South Seas Bubble Episodes**

Yang Hu and Les Oxley

Department of Economics

Working Paper in Economics 17/08

April 2017

Corresponding Author

Les Oxley
Economics Department
Waikato Management School
University of Waikato
Private Bag 3105
Hamilton
NEW ZEALAND, 3216

Phone: +64 (0)7 838 4076

Email: les.oxley@waikato.ac.nz

Yang Hu
Economics Department
Waikato Management School
University of Waikato
Private Bag 3105
Hamilton
NEW ZEALAND, 3216

Email: kobeyang2006@gmail.com

Abstract

The Mississippi Bubble and the South Sea Bubble are the two most famous and earliest episodes in the history of speculation, which can be dated back to the eighteenth century. Unlike most studies focus on some recent financial bubble footprints, we pay special attention to the most remarkable events in 1720. We empirically test for evidence of exuberance in historical stock prices of the Mississippi Company and the South Sea Company during the well-documented Mississippi Bubble and South Sea Bubble episodes, respectively. The right-tailed unit root test of Phillips, Shi and Yu (2015, PSY) is utilised in this paper. In addition, contagion in these historical markets is also considered.

Keywords

exuberance
generalized sup ADF test
South Sea Bubble
Mississippi Bubble

JEL Classifications

C12; N2

Acknowledgements

We would like to thank Peter Phillips for his detailed and insightful comments on this and other papers where we have utilised his PSY test. In particular, his explanations regarding the 'with and without intercept' cases and support for our preference for and presentation of the without intercept results. We also acknowledge helpful comments received from presentation of earlier versions of this paper at the 2017 New Zealand Econometric Study Group (NZESG), Dunedin, New Zealand.

1. Introduction

Financial history reports the presence of bubbles in a range of commodity markets, for example, Tulipmania during 1634-1637, the Stock Market Crash of 1929, Japan's Lost Decade in the 1980s and the 1990s NASDAQ bubble. Ahamed (2009) and Brunnermeier & Schnabel (2016) provide a review of different financial bubbles/crises since the 17th century. Among many historical bubble episodes, the Tulipmania, the Mississippi Bubble and the South Sea Bubble are the three most famous and earliest example of financial bubbles. In particular, the Mississippi Bubble, the South Sea Bubble and similar bubbles in Holland and Germany between 1719 and 1720 are parts of the first international stock market speculative boom and bust in capitalist Europe (Neal, 1990). The main aim of this study is to investigate explosive behaviour in Mississippi and South Sea share prices during the well-documented Mississippi Bubble and South Sea Bubble episodes using the recent right-tailed unit root test of Phillips, Shi & Yu (2015, PSY). In this paper, we use 'exuberance' to describe explosive behaviour in stock prices. We also consider whether the British stock markets in 1720 are exuberant by investigating South Sea episode spillovers to other British share prices in 1720.

A simple definition of a bubble is a deviation of the market price from the asset's fundamental value, see Stiglitz (1990). The PSY approach is often applied to a price-fundamental ratio to assess the explosive behaviour. As we assess evidence of explosive behaviour in a price series without its fundamental, we conclude a finding of explosive behaviour in a price series as 'exuberance'. The 'exuberance' is part of the most famous quotes given by the Federal Reserve Board chairman, Alan Greenspan. Irrational exuberance is a phrase introduced by Alan Greenspan during a speech in 1996 to describe the significant surge in the stock market of the 1990s. This phrase is also used by Robert Shiller as the title of his book. Irrational exuberance is used for describing over-confident stock investors that bid stock prices up to unusually high and unsustainable levels. Shiller (2005) interprets irrational exuberance as the psychological basis of a speculative bubble. According to Shiller (2005), the famous Greenspan's speech in 1996 was given at the beginning of the most speculative growth in the US stock market history. The Dow Jones Industrial Average was 3600 at the beginning of 1994. It reached 10000 in March 1999 and peaked at 11722 in early 2000. Many people are puzzled over the most remarkable rise in the stock market. The irrational exuberance phrase becomes popular and has been referred to many times nowadays. We, therefore, use 'exuberance' to describe the speculation in the stock market.

Both the speculation of the Mississippi and South Sea Bubbles behave in a similar way. In particular, the speculation of these historical events involved a company that expanded its balance sheet through corporate takeovers or acquisition of government debt, financed by successive issues of shares

(Garber, 1990). The motivation of both the Mississippi and the South Sea schemes is to refinance
35 the national debts accumulated during the War of the Spanish Succession (see Hamilton (1947) and
Dickson (1967)).

The following historical background of the Mississippi Bubble episode is obtained from Murphy
(1997) and Garber (1990). Mississippi bubble is an economic bubble that resulted from John Law's
'system'. Law developed and adopted a 'system' to take over the French national debt accumulated
40 by the wars of Louis XIV using equity. Law initially submitted a proposal for establishing a public
bank but it was rejected. Despite the slowdown in the French economy and a shortage of money, Law
was permitted to establish a private note-issuing bank-the Banque Generale in June 1716. Law then
started the Company of the West (Company d'Occident) and acquired the monopoly on trade with
French colonies in Louisiana. French Louisiana in 1717 included the current states of Arkansas, Illinois,
45 Iowa, Louisiana, Minnesota, Mississippi, Missouri and Wisconsin. According to (Murphy, 1997, p.167),
there are two objectives for establishing the Company d'Occident-one is debt management and the
other is colonial trade. The Company d'Occident gained tobacco monopoly and right to trade with
Africa by acquiring the Senegalese Company in September 1718 and November 1718, respectively.

In January 1719, Law's Banque Generale was renamed as the Banque Royal and was taken over
50 by the Crown. However, Law remained in control of the Banque Royal. Law went on a series of
acquisitions. For example, Law acquired the East India Company and the China Company in May
1719 as these two companies were in trouble. The Company of African was also taken over in June
1719. Law then renamed his entire business (the Company d'Occident with other acquired companies)
as the Compagnie des Indes, which was more commonly known as the Mississippi Company. Through
55 the acquisition, the Company effectively dominated all French trade outside Europe. The Company
purchased the right to mint new coinage in July 1719. The Company bought the right to collect all
French indirect and direct taxes in August 1719 and October 1719. Law was able to refund most of
the French debt through his company. Several share issues during 1719 were carried out to acquire
the debt.

60 Law was appointed as France's Controller General in January 1720, who controlled all government
finance and expenditure and the money creation of the Banque Royale. He then proposed to prohibit
to use specie in payments. Banque Royale's notes were made legal tender in February 1720. On 5
March 1720, the share price was fixed at 9000 livres and shares can be converted to banknotes or vice
verse at this fixed price. Law was monetizing the shares of the Mississippi Company. However, Law
65 realised that he had fixed the prices too high and he proposed a deflation in the price of shares and
banknotes on 21 May 1720. The reductions would reduce the price from 9000 livres to 5000 livres in

several steps between May 1720 and December 1720. The share price dropped significantly after the price deflation plan.

Similar to the Mississippi episode, the South Sea Bubble involved a company (the South Sea Company) that acquired some outstanding British government debt in 1720. However, the South Sea Company was not involved in takeovers of commercial companies. According to Garber (1990), the British debt in 1720 worth approximately 50 million and 18.3 million of the debt was held by three largest companies: Bank of England (3.4 million), East India Company (3.2 million) and South Sea Company (11.7 million). These three companies involved in the government debt financing. The following background of the South Sea Bubble is obtained from Scott (1912) and Garber (1990).

The South Sea Company was firstly founded in 1711. In 1720, the South Sea Company had monopoly rights on British trade with the Spanish colonies of South America. The most important event during early 1720 was that Parliament passed the South Sea Bill on 21 of March. The South Sea Company won the competitive bidding against the Bank of England to obtain the privilege of converting the government debt. The South Sea Company needed to pay the government 7.5 million pounds (including approximately 1.3 million bribes to members of Parliament) to acquire the 31 million of privately held government debt. In order to finance the debt acquisition, the South Sea Company was allowed to expand its shares. The higher price of South Sea Company stock, the more attractive for debt holders to exchange existing government debt for South Sea Company stock (Carlos & Neal, 2006). Hence, there is an incentive for the Company to concentrate on the market value of the stock. Instead of issuing all the stock at once, the Company offered four subscriptions for cash between April and August in 1720. For each subscription, the share price was issued at higher and higher prices. In addition, the company offered two bond subscriptions. The Company accumulated 80% of the irredeemables and 85% of the redeemables in public hands after the debt conversions (Garber, 1990).

Following the speculation of the South Sea Company, some other joint-stock companies had been created. These newly created companies are known as “bubbles companies”. These newly created companies looked very attractive to investors and speculators, which carved up some potential South Sea profits. As a result, Parliament passed the Bubble Act in 1720 to stop companies without Royal charter to exist, which was promoted by the South Sea Company. When the Bubble Act was enforced on August 1720, downward pressure was placed on all shares including the South Sea Company. The share price collapsed in September 1720. The market value of all the South Sea shares on 31 August was 164 million pounds. However, 103 million of these shares were lost in September.

The three monied companies - the South Sea Company, the Bank of England, and the East India Company played a major role in the South Sea Bubble as they engaged in the debt-for-equity swap.

100 The Bank of England is founded in 1694. The Bank was the first permanent stock and the longest-lived
 security in London Stock Exchange (Neal, 1990). According to Carlos et al. (2006), Bank of England
 shares were one of few publicly available securities, and shares are reorganised as a stable asset as
 they are the least speculative during 1720. The original East India Company was founded in 1600
 with a royal charter, and it became a permanent joint-stock 1657. The new East India Company was
 105 established in 1698. The old and new companies were emerged by 1709. We consider those British
 companies that do not involve debt-equity swap as well (e.g., London Assurance, Million Bank, Royal
 African Company and Royal Exchange Assurance). The Million Bank is founded in 1695 which held
 a large number of securities. A review of the Million Bank is provided by Scott (1911). The share
 price of Million Bank is higher than that of the Bank of England in most cases. Hence, the share price
 110 of Million Bank looks more promising and attractive compared with that of the Bank of England.
 The Royal African Company received a Royal charter in 1672 and then became the second largest of
 the joint-stock companies after the East India Company (Carlos et al., 2002). The company has the
 monopoly of English trade in Africa and engages in the slave trade, but it does not involve in the
 financing of national debt. In 1720, the company issued stock that rose quickly in value. One of the
 115 innovations in 1720 is the establishment of marine insurance companies-Royal Exchange Assurance and
 London Assurance. The early growth of British insurance industry is completed by the establishment
 of two insurance companies in 1720 along with their powers to include fire and life insurance in 1721
 (Supple, 1970). Both insurance companies founded in 1720 are a major innovation in sharing-risk for
 foreign trade. The creation of the Royal Exchange Assurance is important not only in the development
 120 of insurance in the British history but also the share market in Britain. Such a company is needed
 to provide a better and secure service for the marine trade. The growth of the London insurance
 market is associated with the marked expansion of English foreign trade during the second half of the
 seventeenth century; and forms part of that remarkable period of financial activity culminating in the
 South Sea Bubble (John, 1958). Marine insurance played a vital role in facilitating the expansion of
 125 trade during the eighteenth and nineteenth centuries (Kingston, 2007).

Many studies in the literature attempt to explain how bubble-like behaviour in stock prices is linked
 with technological innovation. According to the Economist, “every previous technological revolution
 has created a speculative bubble, and there is no reason why IT should be different”(21 September
 2000). Recent studies focus on examining how technological innovation changes could affect stock prices
 130 and potentially lead to stock price bubbles. Especially, the arrival of new technology is contributed to
 the most famous 1920s and 1990s stock market run-ups in the US (see, Hall (2001), Shiller (2005)).
 Hobijn & Jovanovic (1999) and Hobijn & Jovanovic (2001) argue that major technological revolutions
 often lead to a fall in stock prices as the incumbent firms cannot adopt the new technology and new

firms enter the market with a time lag. A similar conclusion is drawn by Laitner & Stolyarov (2003),
 135 who argues that new technology causes the stock price to drop by obsoleting old capitals. Shiller
 (2005) looks at the S&P 500 price-earnings ratio during the period 1871-2005 that involves a lot of
 technological innovations in the American history. The ratio shows several historical peaks which are
 likely caused by the invention of new technology. For example, the peak in 1901 is likely driven by
 the first transatlantic radio transmission and prospects for high-tech. The recent boom in 2000 (as
 140 known as the dot-com bubble) is driven by telecommunication industry and is another example for
 innovation-driven bubbles. The peak in the 1920s can also be explained by innovation changes as well.
 According to DeMarzo et al. (2007), the bubble of the 1920s is mainly driven by some new technology
 stocks (e.g., the automobile, aircraft, motion picture, and radio industries)¹. DeMarzo et al. (2007)
 use their model to explain that overinvestment increases the risk of the technology which could lead
 145 to bubbles as investors frequently ignore the potential risks of the new technology by over-investing.
 They observe that bubble-like behaviour in stock prices are always associated with innovative firms
 adopting a new technology. For instance, both the Mississippi Company and the South Sea Company
 are examples of firms adopting a technological innovation as both companies were granted the monopoly
 power of foreign trading. The British railway mania in the 1840s is another great example. Therefore
 150 stock price bubbles can be driven by major technological innovations, and these examples support the
 hypothesis of innovation-driven bubbles. Wang (2007) provides a new explanation for the dot-com
 bubble as equilibrium industry dynamics driven by new and existing technologies. New firms will
 enter the market by adopting the new technology and some incumbent firms succeed in adopting the
 new technology innovation because of existing technology and assets. However, some new firms will
 155 be forced out as more incumbent firms get used to adopting the innovation. Nicholas (2008) argues
 that the development of technological innovation during the 1920s is a key driver of the US stock
 market run-up. Pástor & Veronesi (2009) summary that technological innovations are often associated
 with bubble-like behaviour in stock prices of those innovative firms. Stock prices for those innovative
 firms tend to rise initially due to high prospects, but prices fall due to the risks associated with new
 160 technology changes. They explain that both high uncertainty and quick adoption during the revolution
 promote bubbles. A recent paper by Fostel & Geanakoplos (2012) shows that the financial innovation
 results in the mortgage boom and bust and the crisis of 2007-2009.

The above studies seem to suggest that technological innovation plays a major role in promoting
 bubbles. The natural question is to consider whether technological innovations cause the Mississippi
 165 Bubble and South Sea Bubble. According to Frehen et al. (2013), there are four important innova-

¹The US 1920s stock market is overvalued by 30 percent (De Long & Shleifer, 1991).

tions in 1720, three of which are financial innovations and the rest is a shift in global trade. A major innovation in 1720 is government finance as both the Mississippi Company and the South Sea Company adopt a new financial innovation approach of exchanging equity shares for national debt. The second innovation is a shift in global trade as both companies are granted monopoly power of foreign trade. Maritime insurance provided by Royal Exchange Assurance and London Assurance Company for sharing-risk is the third technological innovation. The four innovation involves the British corporations to seek opportunities beyond their charter. These four innovations suggested by Frehen et al. (2013) help us to understand the causes of the first international stock market bubble, which is one of the most extraordinary historical events.

Several studies have tested the Mississippi Bubble or the South Sea Bubble as these episodes have generated considerable interest in the literature. Neal (1990) carries out the statistical analysis using the method of Blanchard & Watson (1982) and concludes that the Mississippi share price contains a rational bubble from mid-July 1719 to the end of November 1719 and the South Sea share price contains a rational bubble between 23 February 1720 and 15 June 1720 only. Carlos et al. (2002) examine the Royal African Company share prices during the South Sea episode and find no significant evidence to support the existence of a bubble. They call into question the arguments by Chancellor (1999) that the South Sea Bubble was the result of mania and speculative excesses. However, Garber (2001) claims that he provides market fundamental explanations for the three most famous bubbles: the Tulipmania, the Mississippi Bubble and the South Sea Bubble, which seems to provide no evidence of bubbles for these historical episodes. Velde (2009) concludes that the Mississippi Company is overvalued. The famous South Sea Bubble has attracted a lot of academic attentions, especially why the bubble grows significantly. Dale (2004) argues that apparent mispricing of subscription receipts prove investor irrationality. Temin & Voth (2004) examined an investor in the South Sea Bubble - the Hoare's Bank, a fledgeling West End London bank. They argue that the bank was aware that South Sea shares were overvalued but still invested in South Sea shares. The bank invested rationally and found it was profitable to "ride" the bubble before the bubble burst in 1720.

Most existing studies focus on examining some recent financial bubble episodes using a relatively short price series. Only do few studies investigate the presence of bubbles/exuberance using a historically long series. For example, Phillips, Shi & Yu (2015) provide evidence of bubbles in the US S&P stock market using a 150-year data. A recent study by Hu & Oxley (2016) presents some results using long run house price data (at least 190 years data) for Amsterdam, Norway and Paris. Instead, in this paper, we attempt to examine the evidence of exuberance during one of the earliest bubbles in financial history. Our study contributes to the literature in several ways. First, we empirically investigate evidence of exuberance in Mississippi and South Sea share prices during the eighteenth

200 century. This is perhaps the earliest empirical study that we can formally test for explosive behaviour
in historical stock prices.² Second, we also look for empirical evidence in other six British share prices
during the South Sea Bubble episode (e.g., Bank of England, London Assurance, Million Bank, East
India Company, Royal African Company and Royal Exchange Assurance). In particular, we explore
evidence of exuberance in a different perspective by focusing on four companies that do not involve
205 the government debt for equity swap (e.g., London Assurance, Million Bank, Royal African Company
and Royal Exchange Assurance). These four companies are more representative of the general ground
market. It is of great interest to look for speculative behaviour in British share market, and we essen-
tially investigate whether the famous South Sea episode spillovers into other British company share
prices in 1720. Unlike the Mississippi Company, even if the South Sea episode is purely related to the
210 South Sea Company, there is a broad-based rise for other shares in the British market.

This paper is organized as follows. Section 2 describes the data and Section 3 gives a brief descrip-
tion of the PSY of Phillips, Shi & Yu (2015). Section 4 presents the empirical results and Section 5
concludes.

2. Data

215 The daily share price indices used in this paper are obtained from Frehen et al. (2013)³ and are
shown in Figure 1 between 1719 and 1720 on a Julian calendar. The daily share price for the Mississippi
Company between 2 July 1719 and 14 November 1720 (N=385) is displayed in Figure 1a, where N is
number of observation. The Mississippi share price rose from 2000 livres in July 1719 to more than
10000 livres at the end of 1719. However, the Mississippi price declined to less than 4000 livres in
220 November 1720. The daily share price for the South Sea Company between 10 August 1719 and 23
November 1720 (N=393) is shown in Figure 1b. The South Sea share price was about 130 pounds at
the start of 1720, and it reached the peak in June/ July at almost 1000 pounds. When the bubble
collapsed in October, the price dropped to 200 pounds. Many investors and potential investors are
convinced by the fact that the price would keep rising at that time (Hoppit, 2002). Figure 1c shows
225 the time series plot of the share price per pound for Bank of England (N=393), London Assurance
(N=307), Million Bank (N=348), East India Company (N=417), Royal African Company (N=418) and
Royal Exchange Assurance (N=294). All share prices are transformed into logarithm before analysis.
Figure 1b and Figure 1c show that the British share prices in 1720 are characterised by a spectacular
rise and fall in value, occasioned by the South Sea Bubble.

²Garber (2001) provides some tulip price data but it is too short to apply the PSY.

³Several sources are used for constructing the share price index including the *Leydse Courant*, Neal (1990), Murphy (1997), Velde (2003), see Frehen et al. (2013) for details.

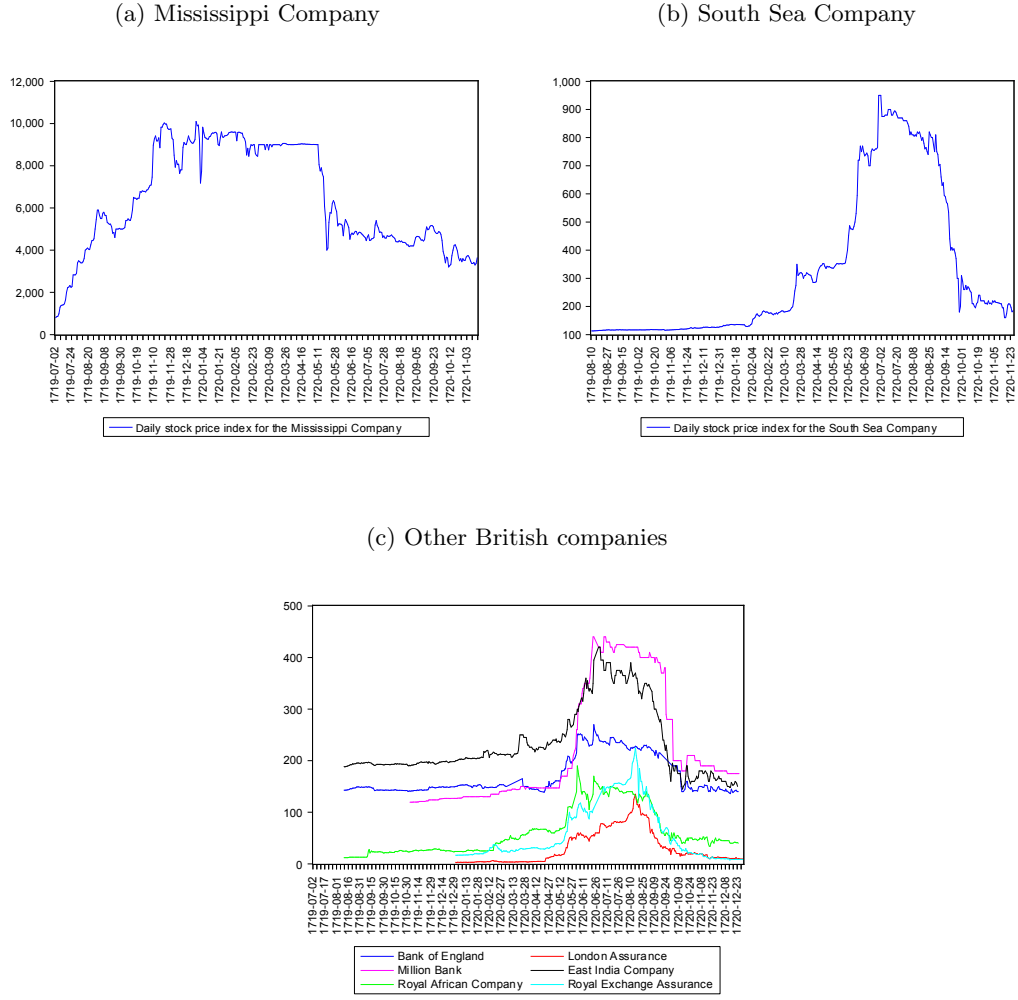


Figure 1: The time series plot of the daily stock price index (Julian dates) for the Mississippi Company, South Sea Company, Bank of England, London Assurance, Million Bank, East India Company, Royal African Company and Royal Exchange Assurance.

230 3. Method

We apply the right-tailed unit root test of Phillips, Shi & Yu (2015) to examine evidence of explosive behaviour in historical stock prices. The martingale null with an asymptotically drift is specified as:

$$H_0 : y_t = dT^{-\eta} + y_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim \text{NID}(0, \sigma^2), \quad (1)$$

where d is a constant, T is the sample size and η is a localizing coefficient. The alternative hypothesis is a mildly explosive process:

$$H_1 : y_t = \delta_T y_{t-1} + \varepsilon_t, \quad (2)$$

where $\delta_t = 1 + cT^{-\theta}$ with $c > 0$ and $\theta \in (0, 1)$.

The following regression model is estimated:

$$\Delta y_t = \alpha + \beta y_{t-1} + \sum_{i=1}^K \gamma_i \Delta y_{t-i} + \varepsilon_t, \quad (3)$$

where α is an intercept.

The generalized sup ADF (GSADF) test relies on repeated estimation of the ADF test rescissions of Equation (3) on subsamples of the data in a recursive fashion. The window size r_w expands from r_0 to 1, where r_0 is the minimum window size. The ending point r_2 varies from r_0 to 1 and the starting point r_1 varies from 0 to $r_2 - r_0$. The GSADF statistic is the largest ADF statistic over range of r_1 and r_2 and is defined as:

$$GSADF(r_0) = \sup_{\substack{r_2 \in [r_0, 1] \\ r_1 \in [0, r_2 - r_0]}} ADF_{r_1}^{r_2}$$

The backward SADF (BSADF) statistic is defined as the sup value of the ADF statistic sequence:

$$BSADF_{r_2}(r_0) = \sup_{r_1 \in [0, r_2 - r_0]} ADF_{r_1}^{r_2}$$

The BSADF statistic and its corresponding critical value are used for dating the origination and termination dates of a bubble. The minimum window size r_0 is equal to $0.01 + 1.8/\sqrt{T}$. A fixed lag order of 0 is also selected. The finite sample critical values are obtained from Monte Carlo simulations with 2,000 replications.

The PSY approach is often applied to a price-fundamental ratio to assess explosive behaviour where the rejection of the null hypothesis of a unit root implies explosive behavior for y_t . If the time series y_t involves an economic fundamental, we conclude that a finding of explosive behavior denotes the presence of a *bubble*. Alternatively, if the time series y_t doesn't involve an economic fundamental, we may only conclude that a finding of explosive behavior is evidence of *exuberance*, and such an episode is described as an *exuberant episode*, see Hu & Oxley (2016).

Most studies have followed Phillips et al.'s (2014) suggestion to include an intercept in the regression model for right-tailed unit root tests. Hu & Oxley (2016), however, show how many empirical papers which follow this suggestion have reported rejections of the null suggesting periods of rapid increase in for example, prices associated with a growing 'bubble' or an 'exuberant episode', when in fact the data identifies a 'collapse' or a 'collapse and recovery' phase and not a bubble or an exuberant episode, see Figure 2. Visual inspection can usually resolve these cases, although it also seems that false (positive)

bubbles also seem to be reported when an intercept is included. Chong & Hurn (2016) also show
 250 that the regression model specification without an intercept is preferred. Here we use two different
 specifications for the regression model, one with an intercept and one without, to explore evidence of
 explosive behaviour and compare the results obtained from both formulations.

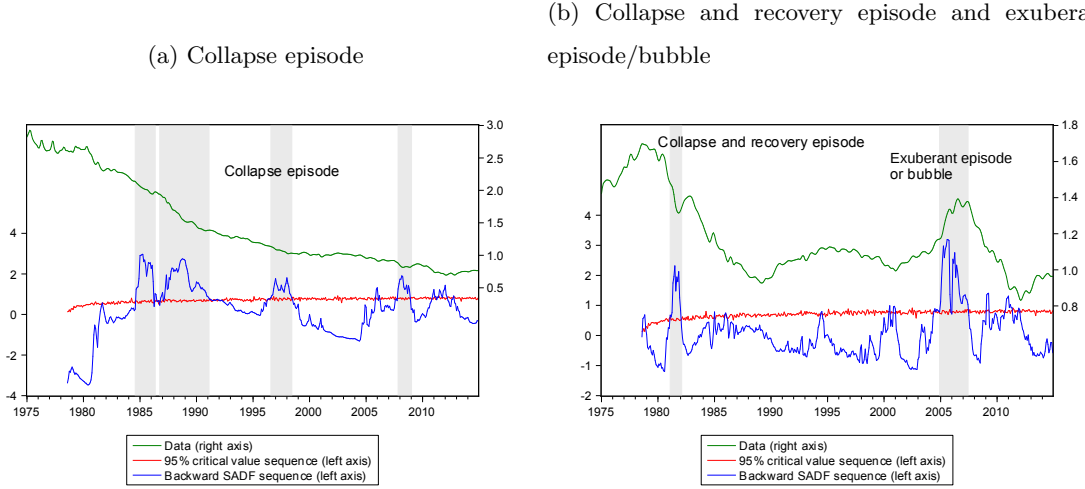


Figure 2: Examples of collapse episode, collapse and recovery episode and exuberant episode/bubble.

4. Results

4.1. Mississippi share prices

We present the date-stamping outcomes for Mississippi share prices in Figure 3 under two model
 255 specifications. Under the assumption with an intercept, the GSADF test statistic suggests strong
 evidence of explosive behaviour at the 1% level, where the test statistic is much greater than the
 critical value ($10.5665 > 2.7015$). The corresponding date-stamping outcomes in Figure 3a seem to
 provide some evidence where the test statistic (blue line) exceeds the critical value sequences (red line)
 260 in May 1720. However, we could not interpret such results as evidence of explosive behaviour in share
 prices due to the fact that the explosive behaviour in share prices is caused by a ‘collapse and recovery
 episode’ in May 1720, which is clearly shown in Figure 3a.

It would be interesting to compare test results obtain from the regression specification without an
 intercept with those under the assumption with an intercept. As shown in Figure 3b, we obtain quite
 265 different results when the intercept term is excluded in the model specification. The null hypothesis
 of no explosive behaviour is strongly rejected at the 1% level as the test statistic is greater than the

critical value ($4.4062 > 4.1552$). We identify an exuberant episode between September 1719 and May 1720, which coincides with the traditional view of the Mississippi episode period. Hence this finding provides evidence of exuberance in share prices to support the well-known Mississippi episode during 1719-1720. Overall, our results provide evidence of an exuberant episode only under the assumption without an intercept. This result is still of great importance as this is the first empirical study to provide evidence of exuberance during the Mississippi episode by formally testing Mississippi stock prices using the PSY. However, it also acts as an additional warning about naive interpretation of the PSY test.

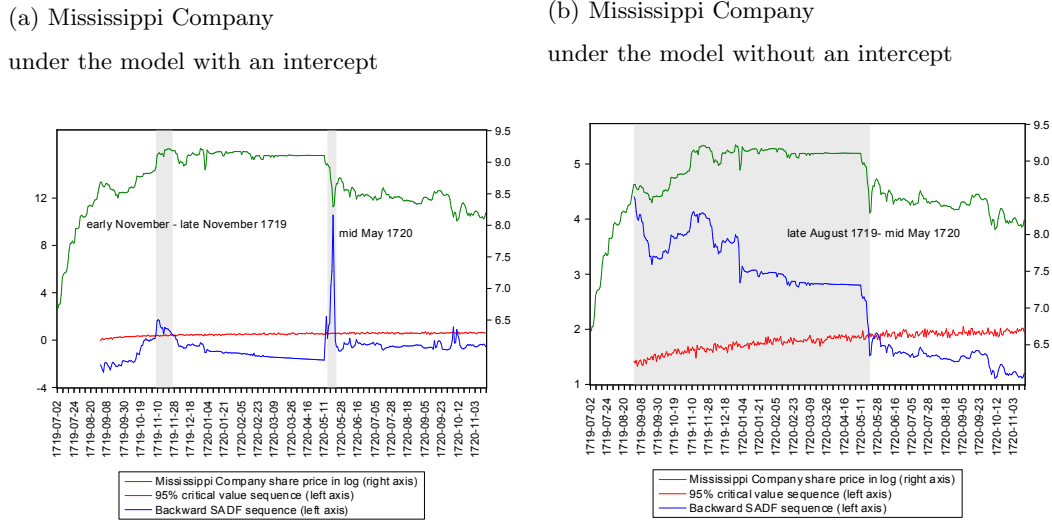


Figure 3: Date-stamping strategy of Mississippi share prices between July 1719 and November 1720 (Julian dates) based on different model formulations.

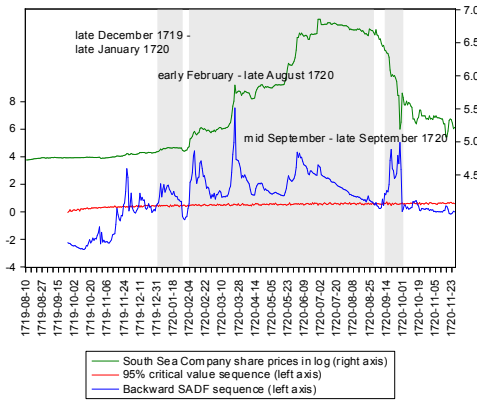
4.2. South Sea share prices

The date-stamping outcomes for South Sea share prices are presented in Figure 4 under two different regression model specifications. As shown in Figure 4a and Figure 4b, we find significant evidence of exuberance in South Sea share prices under the assumption with/without an intercept. When the intercept is included, the null hypothesis of no explosive behaviour in share prices is rejected at the 1% level ($7.5447 > 2.7313$). From Figure 4a, we find an exuberant episode between February 1720 and mid-August 1720. When the intercept is excluded, the null hypothesis of no explosive behaviour in share prices is still rejected at the 1% level ($4.2411 > 4.1326$). In this case, we identify an exuberant episode from mid-November 1719 to mid-September 1720 in Figure 4b.

In both cases, such an exuberant episode is closely related to the rapid growth and burst of the famous South Sea Bubble. Although there are some differences regarding the origination and collapse dates for the two models as shown in Figure 4a and Figure 4b, the general conclusion still holds. These results suggest evidence of exuberance in the South Sea Company share prices, which coincides with the well-documented South Sea episode in history. Thus we provide some signs of exuberance to support the famous South Sea episode in 1720 by applying the PSY to the daily South Sea share prices between August 1719 and November 1720.

(a) South Sea Company

under the model with an intercept



(b) South Sea Company

under the model without an intercept

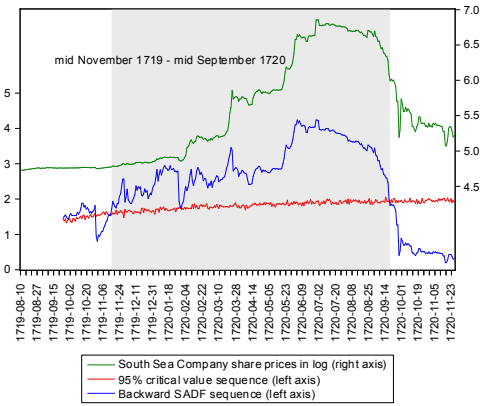


Figure 4: Date-stamping strategy of South Sea share prices between August 1719 and November 1720 (Julian dates) based on different model formulations.

4.2.1. Other British share prices

It is well-known that the South Sea Bubble is related to the spectacular rise and fall in South Sea stock prices. However, as discussed in Frehen et al. (2013), the South Sea Company does not experience the largest price increase and several other major companies also experience significant increases and falls during 1720. For example, the East India share prices increased over 100% and the Bank of England share prices surged by 60% before they fall back (Hopit, 2002). The stock market is, in fact, speculative in 1720 as suggested by Figure 1b and Figure 1c. A close inspection of Figure 1c demonstrates that the several share prices are far more than doubled during 1720. Especially, share prices of Royal African Company, Royal Exchange Assurance and London Assurance rise to more than ten times higher than the initial prices at the peak. Carlos et al. (2006) also point out that the Royal African Company is more speculative than other joint stocks during the South Sea episode. On the

other hand, the share of Bank of England is widely regarded as the least speculative stock among the major joint-stock companies (Carlos & Neal, 2006).

We, therefore, test for explosiveness in stock prices for the other six major corporations in the British market. Figure 5 displays the identified episodes suggested by the GSADF test based on the regression model formulation with/without an intercept for all eight companies considered in our study. Several interesting results can be concluded from Figure 5. First, comparing Figure 5a with Figure 5b shows the exclusion of the intercept in the model formulation has affected the asymptotic theory and date-stamping strategy of the PSY approach. This is demonstrated by the fact that the exact timing in the origination and bursting of these episodes are different under the two formulations. Second, the South Sea Company is the first one experiencing exuberance in the British market. As discussed earlier, we can identify the potential collapse episode or the collapse and recovery episode in Figure 5a under the assumption with an intercept. Hence, we focus on the date-stamping outcomes in Figure 5b based upon the model specification without an intercept. As demonstrated in Figure 5b, the South Sea Company experiences the first exuberant episode in the British market, and such an episode is closely followed by those of Million Bank and other companies. We also notice that the South Sea episode is not the first one to burst and it lasts the longest period. This finding is not surprising due to the impact of the South Sea episode and in line with Frehen et al. (2013), who conclude the South Sea Bubble is not the first one to crash by graphically inspecting share prices alone. Third, several British share prices exhibit exuberant episodes that last for a few months only as noted in Figure 5b (e.g., London Assurance, Million Bank, the Royal African Company, the Royal Exchange Assurance and South Sea Company). Generally speaking, these results suggest that the British market is speculative on a more general ground as the South Sea Company is not the only one experiencing explosive behaviour. There are signs of exuberance in the British market in 1720 as presented in Figure 5b.

The date-stamping outcomes under two model specifications for the Bank of England, London Assurance, Million Bank, East India Company, the Royal African Company and the Royal Exchange Assurance are provided in Figs 6, 7, 8, 9, 10 and 11, respectively. We firstly present the results for the Bank of England. It seems that there is evidence of exuberance in Bank of England share prices as suggested by Figure 6. Under the assumption with an intercept in the regression model, the null hypothesis of no explosive behaviour is rejected at the 1% level ($3.7915 > 2.7313$), indicating the presence of exuberance between May 1720 and June 1720. However, the null cannot be rejected at the 10% level under the model without an intercept in the regression, suggesting no strong evidence exuberance. Therefore the test results suggest a short-lived exuberant episode in the share price of Bank of England under the model with an intercept only.

335 We find evidence of exuberance in London Assurance share prices under both models in Figure 7. The null of no explosive behaviour under the assumption with and without an intercept is rejected at the 1% and 10% level, respectively. As shown in Figure 7a, we observe several short-lived exuberant episodes and a collapse and recovery episode. The episodes identified from Figure 7a are quite different from the one identified from Figure 7b. In particular, we observe an exuberant episode during mid-May
340 1720 and early September 1720 in Figure 7b.

The date-stamping outcomes for Million Bank under two models are shown in Figure 8a and Figure 8b. As can be seen from both figures, we observe strong evidence of exuberance in share prices. The exuberant episode in the share price of Million Bank lasts much longer than those identified from other companies. In fact, this exuberant episode lasts almost as long as the South Sea episode, which
345 is clearly shown in Figure 5b. This is a unique feature of the Million Bank episode.

Figure 9 presents the date-stamping outcomes for share prices of East India Company. The null hypothesis of no explosive behaviour is rejected at the 1% level under the assumption with an intercept, where the GSADF statistic is 3.9619 and critical value is 2.7493. However, under the model without an intercept, the null hypothesis cannot be rejected at the 10% level as the test statistic is smaller
350 than the critical value ($3.0021 < 3.1911$). As can be seen from Figure 9a and Figure 9b, we only observe some evidence of a short-lived exuberant episode between May 1720 and July/August 1720.

Some interesting results are obtained from the Royal African Company. As presented in Figure 10a and Figure 10b, we find evidence of exuberance in share prices of Royal African Company. The null hypothesis of no explosive behaviour under the assumption with/without an intercept is rejected at
355 the 1% and 5% level, respectively. Our results seem to suggest exuberant episodes in share prices. It should be pointed out that Carlos et al. (2002) find no significant evidence to support the existence of a bubble in the Royal African Company share prices during the South Sea episode.

The date-stamping outcomes for the Royal Exchange Assurance are provided in Figure 11. We obtain similar date-stamping outcomes under two model specifications as shown in Figure 11a and
360 Figure 11b. We identify two exuberant episodes under both models: the first one during February 1720 and the second one between May 1720 and August 1720. Under both models, we find evidence of exuberance in share prices.

Overall, we present the date-stamping outcomes for six major British corporations, and the corresponding results suggest the presence of exuberance in these share prices. Such a finding indicates
365 that the British stock market during the South Sea episode in 1720 is exuberant. Among the six major share prices considered, we find evidence of a short-lived exuberant episode in share prices of Bank

of England and East India Company. However, the evidence of experiencing an exuberant episode in these two corporations is not as strong as the evidence obtained from other four corporations (e.g., London Assurance, Million Bank, Royal African Company and Royal Exchange Assurance). We find significant evidence of exuberance in these four corporations especially when the intercept is excluded from the regression model. We believe that the South Sea episode does spillover to other share prices as indicated by Figure 5b. This additional analysis also implies that South Sea Company is not the only one that is experiencing a rapid rise and sudden crash in 1720.

5. Conclusion

In this paper, we present some interesting results for historical stock prices in France and Britain during 1719-20. Many existing studies in the literature focus on testing some recent bubble episodes. Instead, we look at the most remarkable historical events - the Mississippi and South Sea Bubbles during 1719-20. The motivation of this study is to explore evidence of explosive behaviour in the relevant share prices during these great episodes using the PSY of Phillips, Shi & Yu (2015) as these historical episodes still draw attention to many people nowadays. Our study provides new insight into the Mississippi and South Sea Bubbles. First, depending on the regression model specifications, we find evidence of exuberance in share prices of both Mississippi Company and South Sea Company. Such a finding coincides with the well-known Mississippi and South Sea Bubbles in the history. This is the first empirical study to investigate the Mississippi and South Sea episodes using the PSY in the literature, which contributes to the novelty of our study. Second, we also find evidence of exuberance in share prices for the other six major British corporations. The South Sea Company is not the only one that is experiencing an exuberant episode in the British market. Our results seem to agree that there are signs of exuberant episodes during the first international stock market boom. Moreover, the timing of these relationships is provided as some possible evidence of spillovers or contagion in exuberance in the financial market more generally during this period. Our findings will be of interest not only to scholars who work on testing financial bubbles but also economic historians who are interested in the rage of speculation in the Mississippi and South Sea share prices. Future work may consider investigating these historical episodes using alternative approaches.

References

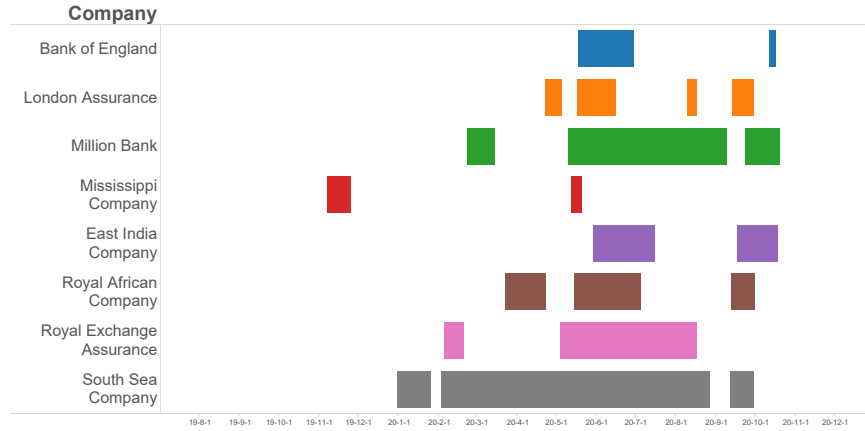
- Ahamed, L. (2009). *Lords of Finance: The Bankers Who Broke the World*. New York: Penguin Press.
- Blanchard, O. J., & Watson, M. W. (1982). Bubbles, rational expectations and financial markets. In P. Wachtel (Ed.), *Crises in the economic and financial structure*. Lexington Books, Lexington, MA.

- Brunnermeier, M. K., & Schnabel, I. (2016). Bubbles and central banks: Historical perspectives. In M. D. Bordo, Ø. Eitrheim, M. Flandreau, & J. F. Qvigstad (Eds.), *Central Banks at a Crossroads: What Can We Learn from History?*. Cambridge University Press.
- 400 Carlos, A. M., Maguire, K., & Neal, L. (2006). Financial acumen, women speculators, and the Royal African company during the South Sea bubble. *Accounting, Business & Financial History*, 16, 219–243.
- Carlos, A. M., Moyen, N., & Hill, J. (2002). Royal African Company share prices during the South Sea Bubble. *Explorations in Economic History*, 39, 61–87.
- 405 Carlos, A. M., & Neal, L. (2006). The micro-foundations of the early London capital market: Bank of England shareholders during and after the South Sea Bubble, 1720–25. *Economic History Review*, 59, 498–538.
- Chancellor, E. (1999). *Devil take the hindmost: A history of financial speculation*. Plume New York, NY, USA:.
- 410 Chong, J., & Hurn, A. (2016). Testing for speculative bubbles: Revisiting the rolling window, .
- Dale, R. (2004). *The first crash: Lessons from the South Sea Bubble*. Princeton University Press.
- De Long, J. B., & Shleifer, A. (1991). The stock market bubble of 1929: Evidence from closed-end mutual funds. *Journal of Economic History*, 51, 675–700.
- 415 DeMarzo, P., Kaniel, R., & Kremer, I. (2007). Technological innovation and real investment booms and busts. *Journal of Financial Economics*, 85, 735–754.
- Dickson, P. G. M. (1967). *The Financial Revolution in England: A Study in the Development of Public Credit, 1688-1756*. Macmillan.
- Fostel, A., & Geanakoplos, J. (2012). Tranching, CDS, and asset prices: How financial innovation can cause bubbles and crashes. *American Economic Journal: Macroeconomics*, 4, 190–225.
- 420 Frehen, R. G., Goetzmann, W. N., & Rouwenhorst, K. G. (2013). New evidence on the first financial bubble. *Journal of Financial Economics*, 108, 585–607.
- Garber, P. M. (1990). Famous first bubbles. *Journal of Economic Perspectives*, 4, 35–54.
- Garber, P. M. (2001). *Famous First Bubbles: The Fundamentals of Early Manias*. MIT Press.
- 425 Hall, R. E. (2001). The stock market and capital accumulation. *American Economic Review*, 91, 1185–1202.

- Hamilton, E. J. (1947). Origin and growth of the national debt in Western Europe. *American Economic Review*, 37, 118–130.
- Hobijn, B., & Jovanovic, B. (1999). The information technology revolution and the stock market.
 430 *American Economic Review*, 89, 116–122.
- Hobijn, B., & Jovanovic, B. (2001). The information technology revolution and the stock market: Evidence. *American Economic Review*, 91, 1203–1220.
- Hoppit, J. (2002). The myths of the South Sea Bubble. *Transactions of the Royal Historical Society (Sixth Series)*, 12, 141–165.
- 435 Hu, Y., & Oxley, L. (2016). Exuberance, Bubbles or Froth? Some results using very long run historical house price data for Amsterdam, Norway and Paris. *Working Papers in Economics 16/08, University of Waikato, Department of Economics*, .
- John, A. H. (1958). The London Assurance Company and the marine insurance market of the eighteenth century. *Economica*, 25, 126–141.
- 440 Kingston, C. (2007). Marine insurance in Britain and America, 1720–1844: A comparative institutional analysis. *The Journal of Economic History*, 67, 379–409.
- Laitner, J., & Stolyarov, D. (2003). Technological change and the stock market. *American Economic Review*, 93, 1240–1267.
- Murphy, A. E. (1997). *John Law: Economic theorist and policy-maker*. Oxford University Press.
- 445 Neal, L. (1990). *The Rise of Financial Capitalism: International Capital Markets in the Age of Reason*. Cambridge University Press.
- Nicholas, T. (2008). Does innovation cause stock market runups? Evidence from the great crash. *American Economic Review*, 98, 1370–1396.
- Pástor, L., & Veronesi, P. (2009). Technological revolutions and stock prices. *American Economic Review*, 99, 1451–1483.
 450
- Phillips, P. C. B., Shi, S., & Yu, J. (2014). Specification sensitivity in right-tailed unit root testing for explosive behaviour. *Oxford Bulletin of Economics and Statistics*, 76, 315–333.
- Phillips, P. C. B., Shi, S., & Yu, J. (2015). Testing for multiple bubbles: Historical episodes of exuberance and collapse in the S&P 500. *International Economic Review*, 56, 1043–1078.

- 455 Scott, W. R. (1911). *The constitution and finance of English, Scottish and Irish joint-stock companies to 1720* volume III. Cambridge University Press.
- Scott, W. R. (1912). *The constitution and finance of English, Scottish and Irish joint-stock companies to 1720* volume I. Cambridge University Press.
- Shiller, R. J. (2005). *Irrational exuberance*. (2nd ed.). Princeton university press.
- 460 Stiglitz, J. E. (1990). Symposium on bubbles. *Journal of Economic Perspectives*, 4, 13–18.
- Supple, B. (1970). *The Royal Exchange Assurance: A History of British Insurance 1720-1970*. Cambridge University Press.
- Temin, P., & Voth, H.-J. (2004). Riding the South Sea Bubble. *American Economic Review*, 94, 1654–1668.
- 465 Velde, F. R. (2003). Government equity and money: John Law’s system in 1720 France. *Federal Reserve Bank of Chicago Working Paper 2003-31*, .
- Velde, F. R. (2009). Was John Law’s system a bubble? The Mississippi Bubble revisited. In J. Attack, & L. Neal (Eds.), *The origins and development of financial markets and institutions: From the seventeenth century to the present* (pp. 99–120). Cambridge University Press.
- 470 Wang, Z. (2007). Technological innovation and market turbulence: The dot-com experience. *Review of Economic Dynamics*, 10, 78–105.

(a) All eight companies under the assumption with an intercept in the regression model.



(b) All eight companies under the assumption without an intercept in the regression model.

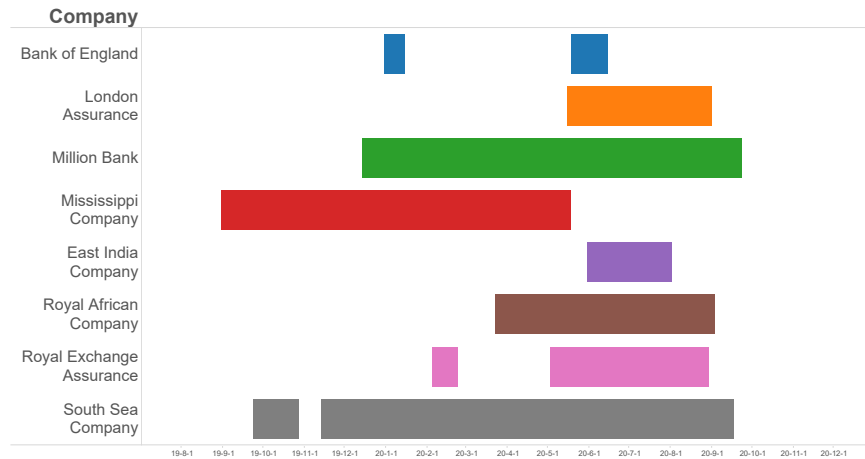
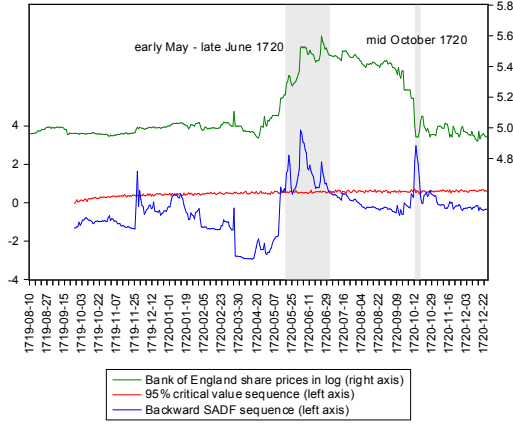


Figure 5: Date-stamping strategies of all eight companies based on the model formulation with/without an intercept.

(a) Bank of England

under the model with an intercept



(b) Bank of England

under the model without an intercept

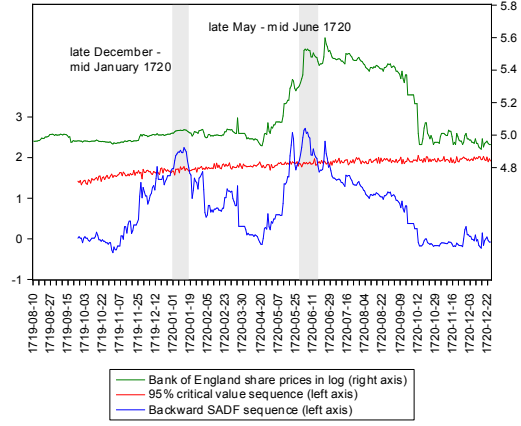
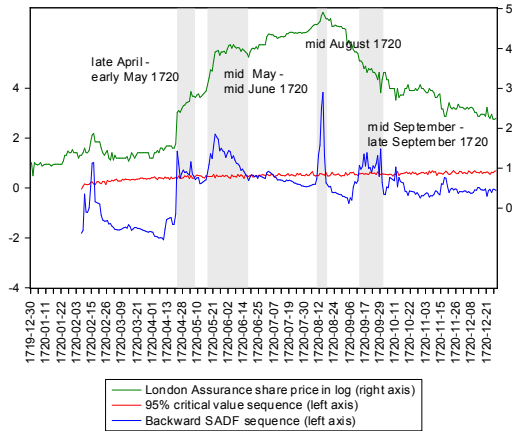


Figure 6: Date-stamping strategy of the Bank of England share prices between August 1719 and December 1720 (Julian dates) based on different model formulations.

(a) London Assurance

under the model with an intercept



(b) London Assurance

under the model without an intercept

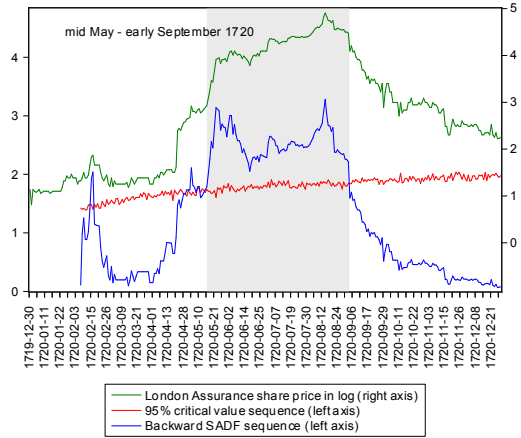


Figure 7: Date-stamping strategy of London Assurance share prices between December 1719 and December 1720 (Julian dates) based on different model formulations.

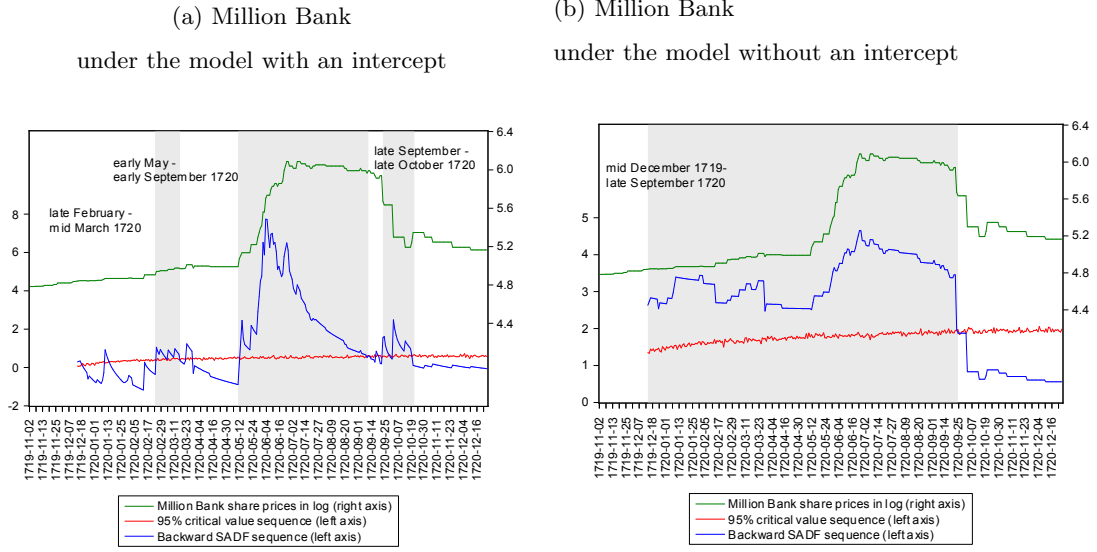


Figure 8: Date-stamping strategy of Million Bank share prices between August 1719 and December 1720 (Julian dates) based on different model formulations.

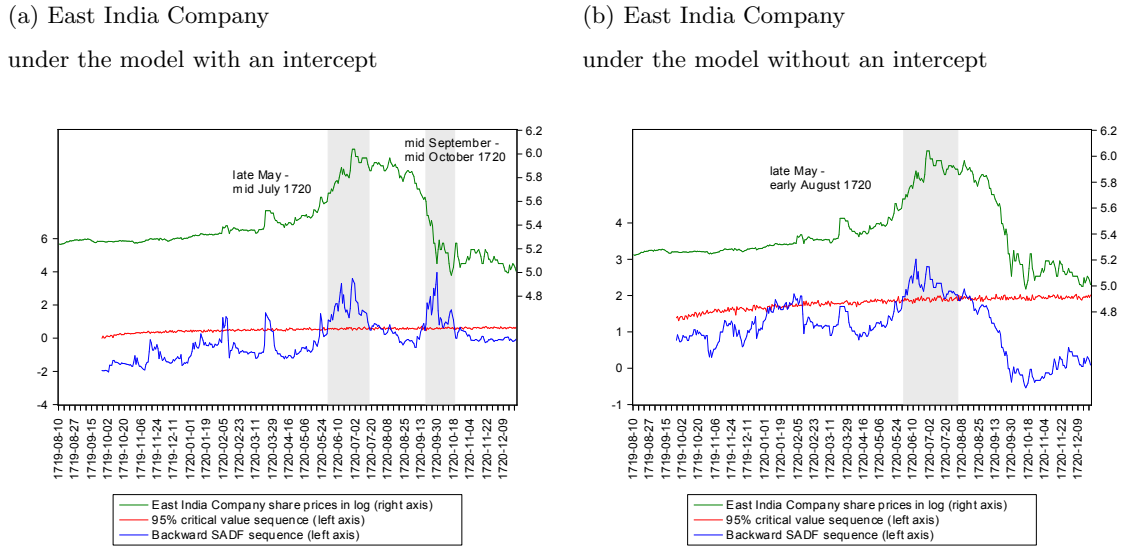
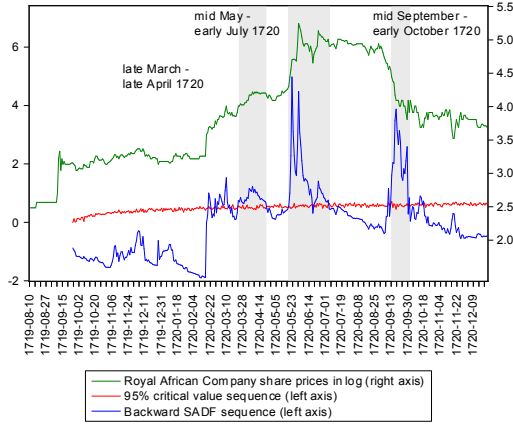


Figure 9: Date-stamping strategy of East India share prices between August 1719 and December 1720 (Julian dates) based on different model formulations.

(a) Royal African Company

under the model with an intercept



(b) Royal African Company

under the model without an intercept

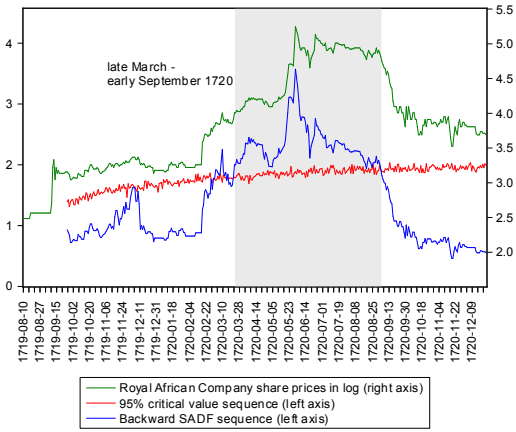
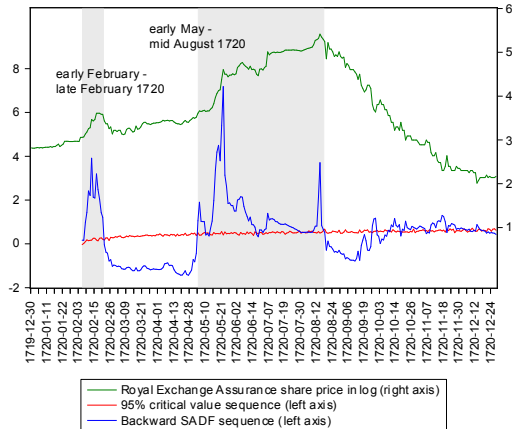


Figure 10: Date-stamping strategy of Royal African share prices between August 1719 and December 1720 (Julian dates) based on different model formulations.

(a) Royal Exchange Assurance

under the model with an intercept



(b) Royal Exchange Assurance

under the model without an intercept

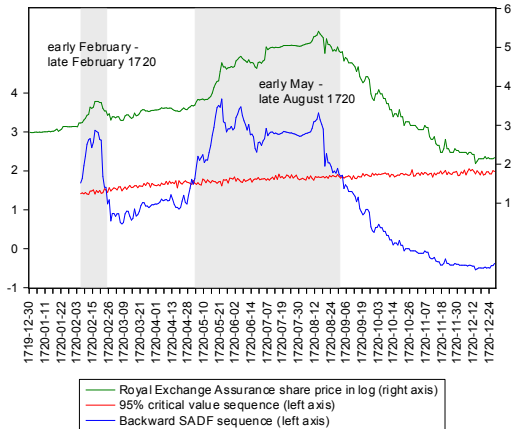


Figure 11: Date-stamping strategy of Royal Exchange Assurance share prices between December 1719 and December 1720 (Julian dates) based on different model formulations.