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Do 18th Century 'Bubbles' Survive the Scrutiny of 21st Century Time Series Econometrics?

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Abstract

Applying the methods of Phillips, Shi and Yu (2015, PSY), while considering the possibility of non-stationary volatility (Harvey *et al.* 2016), evidence of exuberance in share prices is confirmed for the South Sea Company, and established for a number of other 18th century financial organisations, for the first time. The timings of these bubble episodes show signs of possible contagion.

Keywords

exuberance
GSADF test
bubble
South Sea Company
Mississippi Company

JEL Classifications

C12; N2

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1. Introduction

Financial history reports the presence of bubbles in a range of commodity markets, for example, Tulipmania of 1634-1637, the Stock Market Crash of 1929, Japan's asset price bubble in the 1980s, the 1990s NASDAQ bubble. Renewed interest in the existence of bubbles has been rekindled with the consequences of the GFC, and recent empirical developments, including the date-stamping tests methods proposed by Phillips, Shi & Yu (2015, PSY), has introduced a degree of rigour (and flexibility[1]) into their identification.

In this paper we subject two famous price series; the South Sea Company and the Mississippi Company and six other under-researched 18th century financial series, to the rigours of the 21st century tests of Phillips, Shi, and Yu.

2. Background

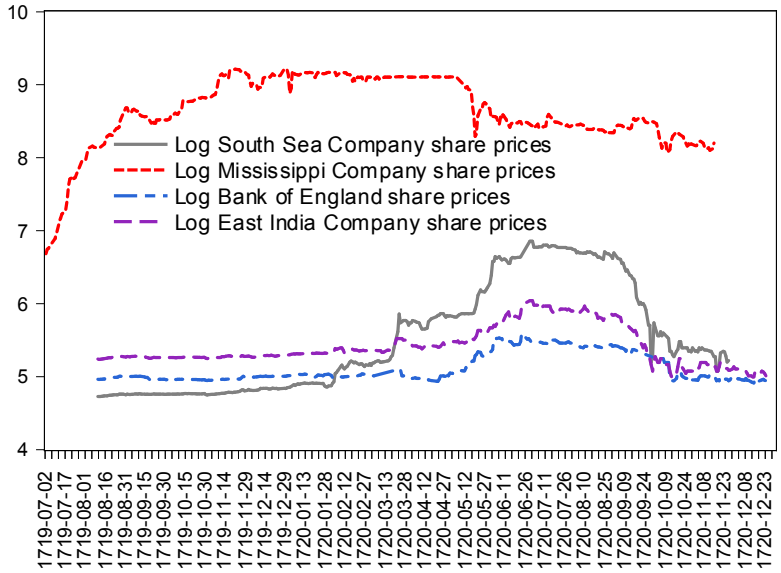
The motivation of the Mississippi and the South Sea schemes was to refinance the national debts accumulated during the War of the Spanish Succession, see Hamilton (1947) and Dickson (1967). The Mississippi 'bubble' resulted from John Law's 'system' to acquire the French national debt accumulated by the wars of Louis XIV, using equity. Similarly, the South Sea Bubble involved a company (the South Sea Company) that acquired some outstanding British government debt in 1720. Several studies have investigated the Mississippi, the South Sea or related companies for bubbles see Neal (1990), Carlos et al. (2002) and Temin & Voth (2004).

3. Data

The log daily share prices for the relevant companies are obtained from Frehen et al. (2013) and shown as Figure 1; the Mississippi Company share price in livres between 2 July 1719 and 14 November 1720 (T=385) is shown as Figure 1a, where T is sample size; the South Sea Company share price in pounds between 10 August 1719 and 23 November 1720 (T=393) is also shown as Figure 1a with the Bank of England (T=393) and East India Company (T=417). Figure 1b also shows the time series plot of the share price per pound for London Assurance (T=307), Million Bank (T=348), Royal African Company (T=418) and Royal Exchange Assurance (T=294).

[1] Multiple bubble episodes can be identified punctuated by periods of calm.

(a)



(b)

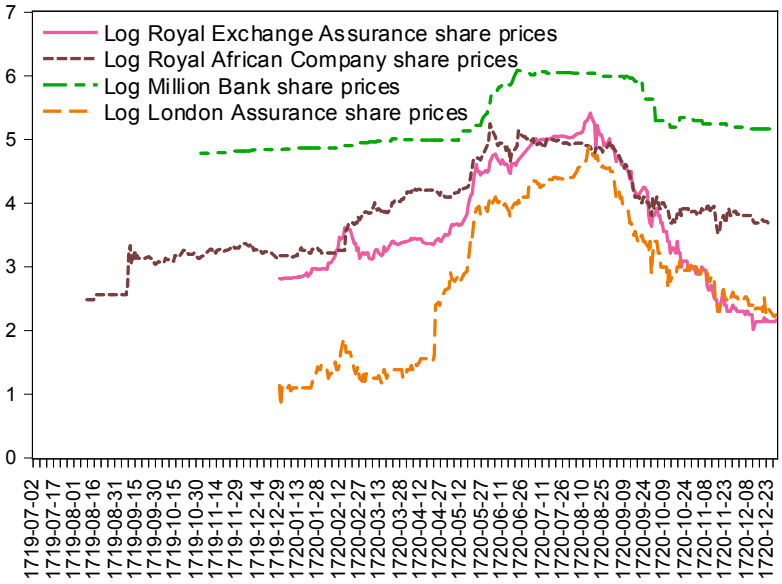


Figure 1: The time series plot of the log daily stock prices (Julian dates).

4. 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 asymptotic drift is specified as:

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

where d is a constant and the localizing coefficient η is great than $1/2$. The alternative hypothesis is a mildly explosive process:

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

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

The following regression model is estimated:

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

where α is an intercept.

The generalized sup ADF (GSADF) test relies on repeated estimation of the ADF test regression 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 the range of r_1 and r_2:

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

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

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

where 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. Critical values are obtained by following the method of Harvey et al. (2016), which uses a wild bootstrap with 2000 replications, to take into account the presence of any possible heteroscedasticity.[2]

[2] The wild-bootstrap critical values are generated using an add-in package for the EViews, see Caspi (2017, forthcoming).

The PSY procedure 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*. Otherwise, we may only conclude that a finding of explosive behavior in a price series is evidence of *exuberance*, and such an episode is described as *an exuberant episode*, see Hu & Oxley (2016).

5. Results

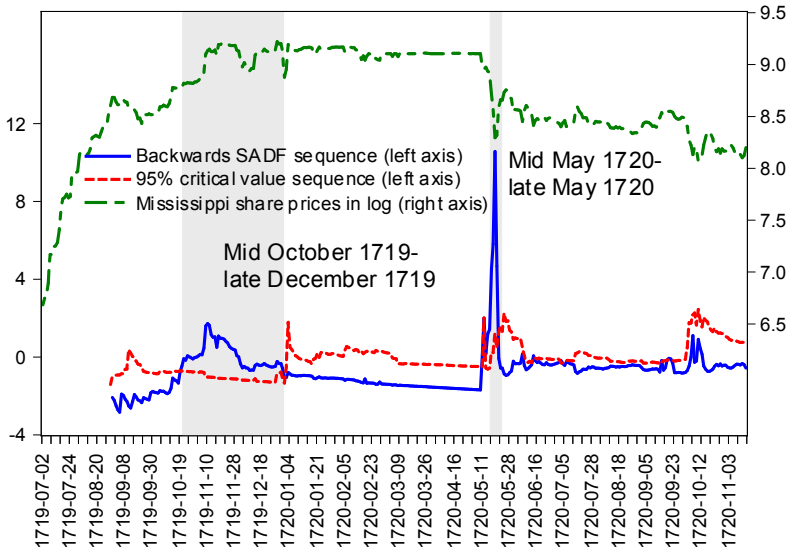
We present our bubble detection results for two most famous Mississippi and South Sea share prices in Figure 2. Results for the date-stamping outcomes for the Mississippi share price are presented as Figure 2a. The null of no explosive behaviour is rejected at the 1% level as the GSADF test statistic is much greater than the critical value (10.5665>4.8017), suggesting very strong evidence of explosive behaviour and the date-stamping outcomes in Figure 2a seem to provide 'some evidence', where the test statistic (blue solid line) exceeds the critical value sequences (red dashed line) in May 1720. However, we should not interpret such results as evidence of exuberance in the share prices due to the fact that rejection is caused by a 'collapse and recovery' episode (not exuberance) in May 1720, which is clearly shown in Figure 2a. During this period, the share price (green dashed line) declined sharply from mid May and rebounded at the end of May 1720.[3]

The date-stamping outcomes for the South Sea share price are presented as Figure 2b. The null hypothesis of no explosive behaviour is rejected at the 1% level (6.8010>3.1459), indicating strong evidence of exuberance. As shown in Figure 2b, we observe an exuberant episode between mid November 1719 and late September 1720. Such an exuberant episode is closely related to the rapid growth and burst of the well-known South Sea Bubble. Thus we provide some signs of exuberance to support the famous South Sea episode in 1720 by applying the PSY procedure, which is the novel in the literature.

The South Sea Bubble is related to the spectacular rise and fall in the South Sea stock price, 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 price increased over 100% and the Bank of England share price surged by 60% before they fall back (Hoppit, 2002). Carlos et al. (2006) also point out that the

[3] We also apply the PSY procedure to the Mississippi share price under the regression model without an intercept using wild bootstrapping. We identify an exuberant episode between September 1719 and May 1720, which coincides with the traditional view of the Mississippi Bubble, see Hu & Oxley (2017). This result will be further investigated in the future.

(a) Mississippi Company



(b) South Sea Company

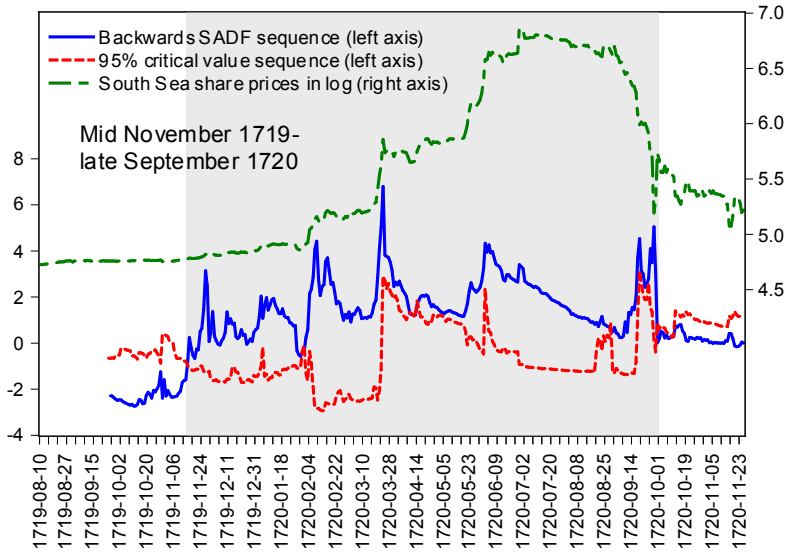


Figure 2: Date-stamping strategies for the Mississippi and South Sea share prices between 1719 and 1720.

Royal African Company is more speculative than other joint stock companies during the South Sea Bubble. We, therefore, test for explosiveness in stock prices for the other six major corporations in the British market. Figure 3 displays the identified exuberant episodes for all eight companies considered in our study. It is known that the PSY procedure can sometimes lead to the identification of collapse episodes, rather than bubbles, see Hu & Oxley (2016). However, Phillips & Shi (2017, forthcoming) now recommend that users of their procedure be careful to identity such episodes ex-post, hence we only present and plot the exuberant episodes (not those identified as collapses) in Figure 3.

Several interesting results can be concluded from Figure 3. Firstly, the South Sea Company experiences the first exuberant episode in the British market, and such an episode is closely followed by those of the Royal African Company, London Assurance and other companies. We also notice that the South Sea episode is not the first one to burst and it lasts the longest period. Secondly, several British share prices also exhibit strong signs of exuberance (e.g., East India Company, London Assurance, Million Bank, the Royal African Company and the Royal Exchange Assurance) as the null of no explosive behaviour can be strongly rejected at the 1% level. We can clearly see that these companies experience exuberant episodes during the South Sea episode in Figure 3. Thirdly, there is little evidence of exuberance for the Bank of England as the null of no explosive behaviour cannot be rejected at the 10% level although a very short exuberant episode seems to exist between June 1720 and July 1720. This result is perhaps not surprising as the share price of Bank of England is widely regarded as the least speculative stock among the major joint-stock companies (Carlos & Neal, 2006). Finally, our results seem to draw a very interesting conclusion for this period in that the British share market was generally much more speculative, as the South Sea Company was not the only one experiencing exuberance in its share price.

6. Conclusion

We have subjected two famous and six less famous 18th century share price series to the rigours of 21st century tests in the form of Phillips, Shi & Yu's (2015) procedure. Exuberance is confirmed in the South Sea Company and established for several other British companies. We also identify the timing and collapse of each of these company's periods of exuberance. 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. The famous 'South Sea Bubble' survives the rigours of the 21st century tests and the 'tests' identify a new member of the bubbly club.

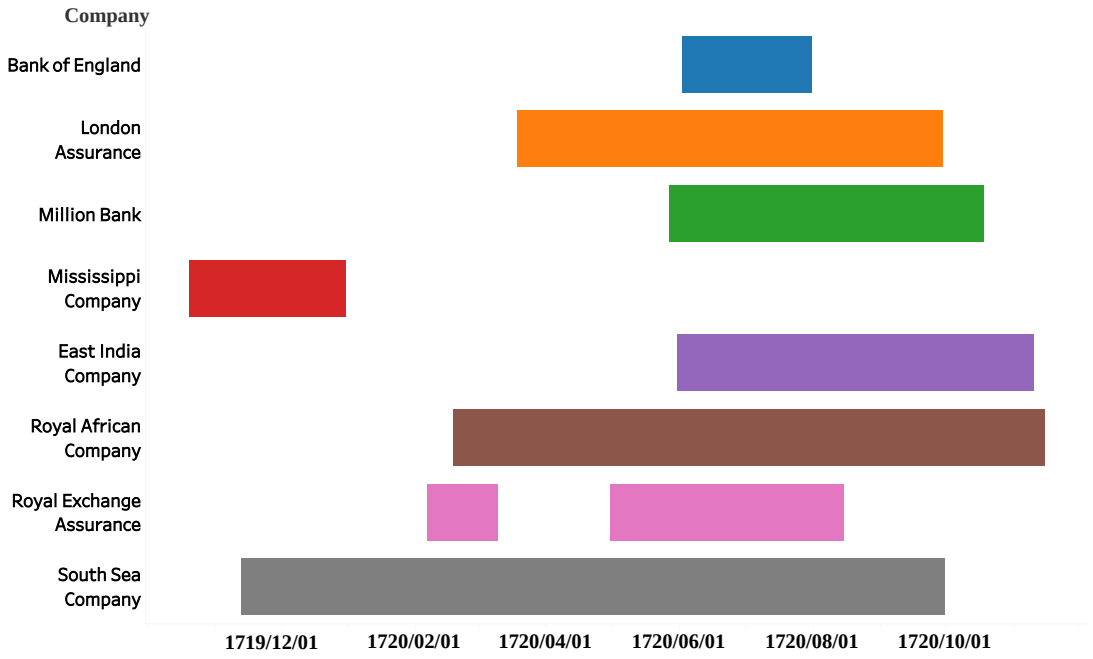


Figure 3: Date-stamping strategies for all eight companies using wild bootstrapping.

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