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

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Abstract

Applying the methods of Phillips, Shi and Yu (2015, PSY), evidence of exuberance in share prices is confirmed for the Mississippi Company and South Sea Company, and for a number of other 18th century financial organisations, for the first time. There are signs of possible contagion in these historical shares.

Keywords

exuberance
GSADF test
bubble
South Sea
Mississippi

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 subject 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 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)

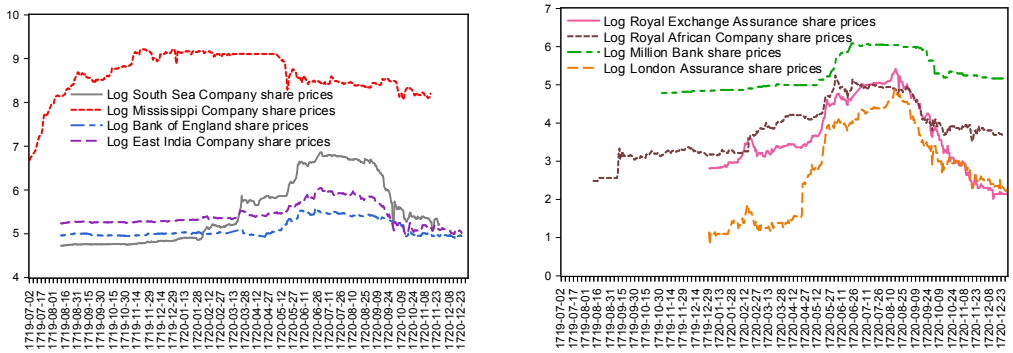

Figure 1: The time series plot of the log daily stock price (Julian dates).

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 asymptotically 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 end 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:

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

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. The wild bootstrap critical values are obtained using the method of Harvey et al. (2016) to take into account the presence of heteroscedasticity with 2000 replications.

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).

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. 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 that the regression equation without an intercept is preferred. Hence 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.

5. Results

Results for the date-stamping outcomes for the Mississippi share price are presented as Figure 2 under two specifications. Under the assumption with an intercept, the GSADF statistic suggests strong evidence of explosive behaviour at the 1% level, where the test statistic is much greater than the critical value (10.5665>4.8017). 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 could not interpret such results as evidence of exuberance in share prices due to the fact that the explosive behaviour is caused by a 'collapse and recovery' episode in May 1720, which is clearly shown in Figure 2a. Although there is a short exuberant episode between mid-October

1719 and late December 1719, we hardly conclude the presence of exuberance in the Mississippi share price as the so called 'explosive behaviour' is dominated by a 'collapse and recovery episode'.

If we compare test results obtain from the model specification with an intercept with those under the assumption without an intercept, as in Figure 2b, we obtain quite different results. The null hypothesis of no explosive behaviour is strongly rejected at the 1% level (4.4062>3.3611). We identify an exuberant episode between August 1719 and May 1720, which coincides with the traditional view of the Mississippi episode period. If we neglect a short break in May 1720, this exuberant episode will last until October 1720. 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 in the regression model. This result is important 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 approach. However, it also acts as an additional warning about naive interpretation of the PSY test.

(a) Mississippi Company
under the model with an intercept

(b) Mississippi Company
under the model without an intercept

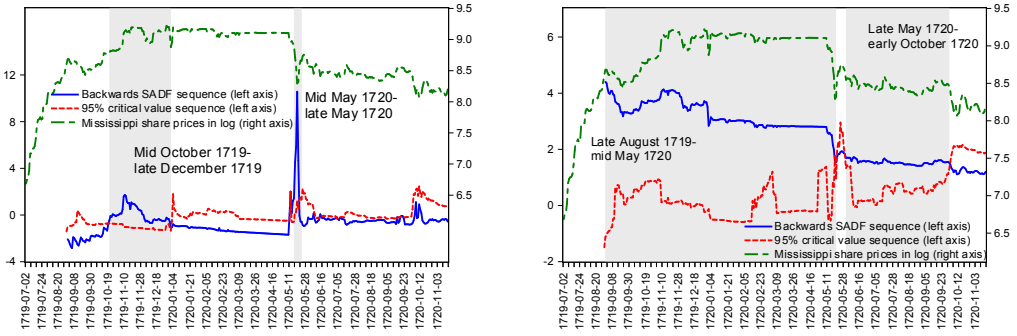

Figure 2: Date-stamping strategy of Mississippi share prices between July 1719 and November 1720 (Julian dates) based on two model formulations.

The date-stamping outcomes for South Sea share prices are presented as Figure 3 again under two different model specifications. As shown in Figure 3a and Figure 3b, we find significant evidence of exuberance in South Sea share prices under the regression with or without an intercept. When the intercept is included in the regression, the null hypothesis of no explosive behaviour in share prices is rejected at the 1% level (6.8010>3.1459). When the intercept is excluded, the null hypothesis of no explosive behaviour in share prices is also rejected at the 1% level (4.2411>3.6201). In both cases, we

identify an exuberant episode from November 1719 to September 1720. Such an exuberant episode is closely related to the rapid growth and burst of the South Sea Bubble. Although there are some differences regarding the origination and collapse dates for the two models as shown in Figure 3a and Figure 3b, the general conclusion still holds. These results suggest evidence of exuberance in the South Sea Company share price, 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 procedure to the daily South Sea share price.

(a) South Sea Company
under the model with an intercept

(b) South Sea Company
under the model without an intercept

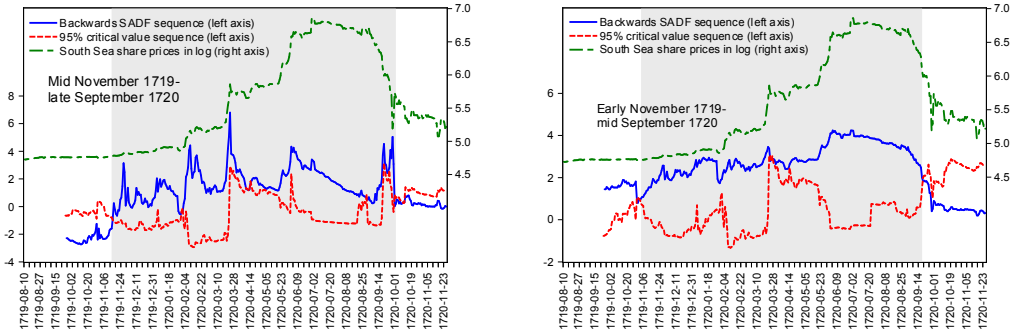

Figure 3: Date-stamping strategy of South Sea share prices between August 1719 and November 1720 (Julian dates) based on two model formulations.

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 rapid 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 Royal African Company is more speculative than other joint stocks during the South Sea Bubble. We, therefore, test for explosiveness in stock prices for the other six major corporations in the British market. Figure 4 displays the identified 'exuberant episodes' for all eight companies considered in our study based on the regression model with an intercept.[2] The PSY procedure could lead to some false identification episodes (collapse episodes or collapse and recovery episodes), see Hu & Oxley (2016).

[2]We also apply the PSY procedure to these British share prices based on the regression model without an intercept. Results are similar to those based on the regression with an intercept. Results are not shown here to conserve the space but available upon request.

As Phillips & Shi (2017) recommend users identifying such false identification episodes ex-post, we therefore only present and plot exuberant episodes in Figure 4.

Several interesting results can be concluded from Figure 4. First, 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. Second, 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 see that these companies experience exuberance during the South Sea episode in Figure 4. Third, there is little evidence of exuberance for Bank of England as the null of no explosive behaviour cannot be rejected at the 10% level. A very short exuberant episode between June 1720 and July 1720 is identified in the share price of Bank of England compared with those exuberant episodes of other British share prices. 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). Last, our results seem to draw a very interesting conclusion that the British share market is speculative on a more general level, as the South Sea Company is not the only one experiencing exuberance. Overall, the share market is exuberant in 1720.

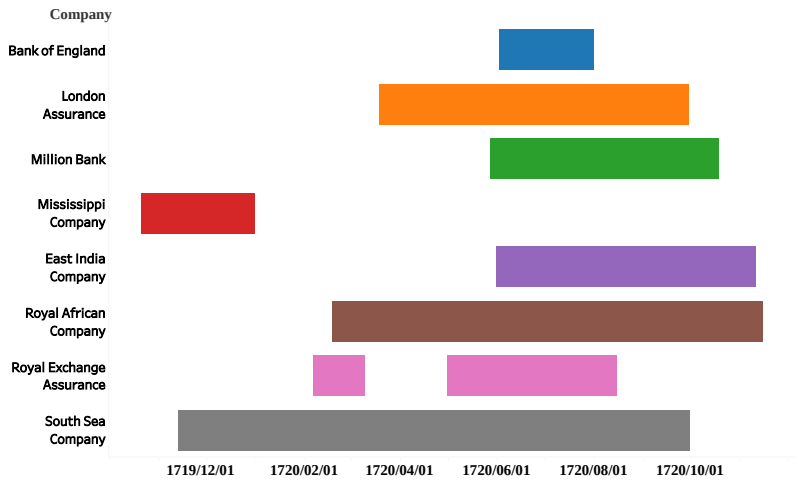

Figure 4: Date-stamping strategies of all eight companies based on the regression model with an intercept using wild bootstrapping.

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 Mississippi Company and the South Sea Company and established for several 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 two famous 'bubbles' survive the rigours of the 21st century tests and the 'tests' identify both some new members of the bubbly club and the relationship between their exuberant episodes.

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