

Royal African Company Share Prices during the South Sea Bubble¹

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Price bubbles provide a unique opportunity to test whether investors act rationally and have sufficient knowledge of the economic environment in which they trade. We focus our attention on the 1720 South Sea bubble episode as experienced by a company not involved in governmental debt financing—the Royal African Company. Following the example of the South Sea Company, the Royal African Company lent its funds to equityholders at a preferential rate. Recognizing this benefit along with the announced dividends explains a large portion of the bubble. Furthermore, the unexplained residual does not behave like an exploding bubble, casting doubt that speculative excess motivated market participants in 1720. Our findings are indeed consistent with investor rationality, and the unexplained residual suggests that we are missing information that was available to the British financial market in 1720. © 2001 Elsevier Science

1. INTRODUCTION

The rise, fall, and present volatility of American stock markets has led many to question whether these changes are the result of a bubble economy.² The

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² Much has been written in the past 18 months, especially by *The Economist*, on the issue of speculative excesses in the American stock market.

internet crash has generated an interest in historical precedents from the Tulip Mania of 1634–1637 to the Crash of 1987, focusing on whether the dramatic rise and collapse of asset prices during these periods were related to underlying fundamental movements or to speculative excesses influenced by other factors. Central to this historical debate is the South Sea Bubble. Early work by Scott (1951) and Dickson (1967) saw the South Sea Bubble emerging out of market manipulation and the international transmission of a shock, where outsiders were not privy to the full information available. While Scott saw people making incorrect, albeit rational, decisions, Dickson saw stock purchases tapping into a growing addiction to gambling. Neal (1990) formally tested whether the South Sea Bubble was a rational bubble and found that the changes in share prices in 1720 included a rational bubble. In contrast, Garber (1990) argues that there were fundamental explanations for the Tulip Mania (1634–1637), the Mississippi Bubble (1719–1720), and the South Sea Bubble (1720). Most recently, Chancellor (1999) finds that speculative excess drove the market, especially during 1720.

In *The Rise of Financial Capitalism*, Neal documents the share prices of the South Sea Company, East India Company, and Bank of England over the period of the Bubble. He argues convincingly that this episode arose from attempts to accommodate the government's financial needs after the Glorious Revolution. War had created a costly debt structure for the government with illiquid assets in the hands of the public. To lower the cost to the government of this debt and to provide debtholders with liquid and easily transferable assets, the system needed a new financial instrument. Ultimately, this instrument was found in the Consol. According to Neal, the conduct of the South Sea Company in this episode created an environment that allowed for a rational bubble, as defined by Tirole (1982), to appear.³

Although all stocks rose and collapsed, the financial episode of 1720 received its name from the South Sea Company, because during the two decades leading up to 1720, it was the monied companies (those involved in purchase of government debt)—the South Sea Company, the East India Company, and the Bank of England—that stood out. These companies had undertaken debt for equity swaps, where those holding the illiquid government debt exchanged it for more liquid shares. In much of the literature, the focus has been on these companies. However, we examine this episode from a different perspective, focusing on the Royal African Company, a joint-stock trading company, which was not one of the monied companies. In doing so, we examine a trading company that was not directly involved in the government debt for equity swap, but rather a company more representative of the general market. By examining such a company, we can see to what extent movements in the share prices of its

³ In his model, Tirole (1982) is examining a rational bubble with a finite horizon. He assumes that expectations are myopic and secondly that there are several “generations” of traders entering the market. We use a more general specification.

stock were driven by a bubble or by fundamental movements, without having to account for the payments received by monied companies for governmental liquidity operations. Although there is a discrepancy between the observed market price and the price rationally predicted by fundamentals, we find no overwhelming evidence for the existence of a bubble in Royal African share prices during these few months of 1720.

In the analysis that follows, it must be noted that we are using a very specific definition of the term “bubble.” We assume that all market participants have full knowledge of the fundamental structure of the economy and process information completely rationally. Or alternatively, investors price assets correctly because they have a correct specification of the true economic model and unbiased estimators of its coefficient. Individuals could violate either of these two assumptions. If the first assumption fails, then investors misprice the securities and one may get rational bubbles. If the second assumption does not hold, then investors are essentially acting irrationally and one could get irrational speculative bubbles or manias.

We find that there is discrepancy between the price rationally predicted by fundamentals and the observed market price. Such a discrepancy could arise from the presence of a rational or an irrational bubble. We find, however, that this discrepancy does not grow at an exponential rate and then crash, as would be the case in an irrational bubble, animal spirits, manias, or speculative excesses, where individuals were initially overly optimistic and then deadly pessimistic. We also find that the discrepancy does not grow on average at the same rate as the discount factor which would be the case in a rational bubble. Yet the discrepancy exists. We attribute this mixed result to the fact that we do not have access to all information available to market participants in 1720. We feel confident, however, that we are not missing information important enough to turn this discrepancy into an irrational exploding bubble. While a study of this one company will not settle the debate between proponents of manias, rational bubbles, and fundamental movements, our results push the debate back toward a discussion of fundamental movements and rational bubbles and away from speculative excesses and irrational exuberance.

2. ROYAL AFRICAN COMPANY—HISTORY OF THE FINANCIAL STRUCTURE

The Royal African Company received a royal charter in 1672 giving it a legal monopoly of English trade along the coast of Africa from modern-day Senegal to Angola and between Africa and the West Indies. The fact that this Company and others received charters has been much discussed in the literature, where it is often argued that, as a result of these charters, the companies were inefficient rent-seeking monopolists.⁴ However, what has received much less attention is the

⁴ This argument is standard in the early histories of the companies, for example, Davies' (1957)

fact that a company had to have a charter in order, legally, to sell shares and to receive limited liability.⁵ Indeed, the benefit of raising capital in this way and the protection from liability may actually be more valuable than any possible monopoly rents. In addition, these companies were often only technical monopolies in that the state could always sell rival charters and because outside England they faced competition from other countries.

At the time the Royal African Company received its charter, it was the second largest of the joint-stock companies after the East India Company. Unlike the East India Company, the Royal African Company never generated quite the same level of political debate. This occurred in large measure because it did not become one of the monied companies (the Bank of England, the East India Company, and the South Sea Company) involved in the financing of government debt.⁶ Thus from the perspective of examining market behavior, the Royal African Company provides us with a case study of a company more free, perhaps, of political regulation and debate than the big three. It also provides us with an opportunity to examine a firm only tangentially involved in the circumstances leading to the South Sea Bubble (Neal, 1990).

The Company charter called for a paid-up capital of £100,000 sold in £100 denominations, where £100 was the book value.⁷ The initial public offering was oversubscribed, resulting in an initial capital stock of £111,100. The book value of the capital stock was expanded by a stock split in 1691 to £444,400 (Scott, 1951, Vol. 2, p. 32). In 1693, the Company issued a further £180,850 of stock, bringing the book value of the capital stock to £625,250. Then 4 years later, in October 1697, the Company issued a further £475,800 of shares. As a result, by the end of the century the book value of the capital stock stood at £1,101,050.

The Royal African Company was a profitable venture through the 1670s and 1680s. Although we have no consistent share price series for this period, the few documented prices are all well above par, reaching £173 at the end of the 1680s. The wars of the 1690s led to serious losses and, by the end of the decade, the price per share had fallen to £14.⁸ As a result of its financial problems, the

history of the Royal African Company or Rich's (1958) history of the Hudson Bay Company. This argument is reiterated in Jones and Ville (1996). An alternative perspective is given in Carlos and Nicholas (1996).

⁵ It was not until the mid-1850s with the General Limited Liability Act that companies could achieve limited liability status without individual parliamentary approval.

⁶ Starting after the creation of the Bank of England, there was, in effect, competition between companies for the right to be involved in refinancing operations. In the case of the South Sea Company, there might have been a winner's curse where the price the South Sea Company paid for the right to undertake the debt/equity swap was higher than the return it made from the operation.

⁷ The book value of £100 provides an index against which to measure the market price.

⁸ All trading companies were seriously affected by these wars, but the Royal African Company may have been even more seriously affected. The Navy tried to provide protection to the merchant marine by having ships sail in convoys with naval protection. However, the timing of Royal African trade was such that it was not able to take advantage of the convoys and thus was more open to piracy.

Company began to license traders for the African and West Indian trade, which over time resulted in a dramatic decline in its market share (Carlos and Kruse, 1996).

From 1700 to 1712, the Company's financial situation worsened even though the Company sought new capital to taxing its existing shareholders, requiring them to hold Company bonds. Despite these actions, the Company was essentially bankrupt by 1712. The price of the Company shares was £2 on a book value of £100. Rather than winding up the business, the Company underwent a major financial reorganization, dramatically writing down the existing capital stock and exchanging all bonds outstanding for shares.⁹ As a result of the reorganization, the book value of the capital stock of the Company was written down to £451,350, with approximately 4500 shares. Share prices rebounded to £60 but then stabilized in the £20 range from 1715 to 1720. The Royal African Company share price began 1720 at £24 (Scott, 1951, Vol. 2, pp. 28–35).

The pattern of dividends paid to shareholders mirrors the pattern of stock prices and the Company's financial circumstances. From 1676 to 1682, the Company paid annual dividends of 10.5% on the par value of its capital stock. During the 9 years from 1682 to 1691, it paid out five dividends of roughly the same amount. The following year, it paid 3% on the new capital, which was equivalent to 12% on the old capital. For the next 10 years, no dividends were paid. Then starting in 1702, the Company paid 0.5% for 3 years and 1.5% in 1706 and 1707. Thereafter no further dividends were paid to the shareholders (Scott, 1951, Vol. 2, pp. 33–35). Thus on the eve of the South Sea Bubble, the Royal African Company was a trading company with a checkered financial history.

3. ROYAL AFRICAN COMPANY—COMPANY FINANCIAL CONDUCT IN 1720

The data used here come from the Company transfer books for 1720 and John Castaing's *Course of the Exchange*.¹⁰ The transfer ledgers give the date on which a stock transfer was registered, the names of buyers and sellers of Company stock, whether an agent signed in lieu of either buyer or seller, and the volume of shares exchanged. Occasionally the address and occupation are listed.¹¹ Castaing's *Course of the Exchange* lists the bid/ask spread for a number of companies active in the London market. The *Course of the Exchange* was published on a Tuesday and Friday and gave the price for that day and for the

⁹ It was very difficult to wind up a joint-stock chartered company because there was no defined mechanism for doing so.

¹⁰ These data, compiled by Larry Neal, are available from the Inter-University Consortium for Political and Social Research at the University of Michigan at www.icpsr.umich.edu. See "Course of the Exchange, London 1689–1823 and Amsterdamsche Beurs, Amsterdam, 1723–1794."

¹¹ To prevent any one clerk from knowing everyone who was purchasing and selling, the Royal African Company divided up its transfer books. In one of these books, the clerk noted address and occupation; in the other books, the clerks did not.

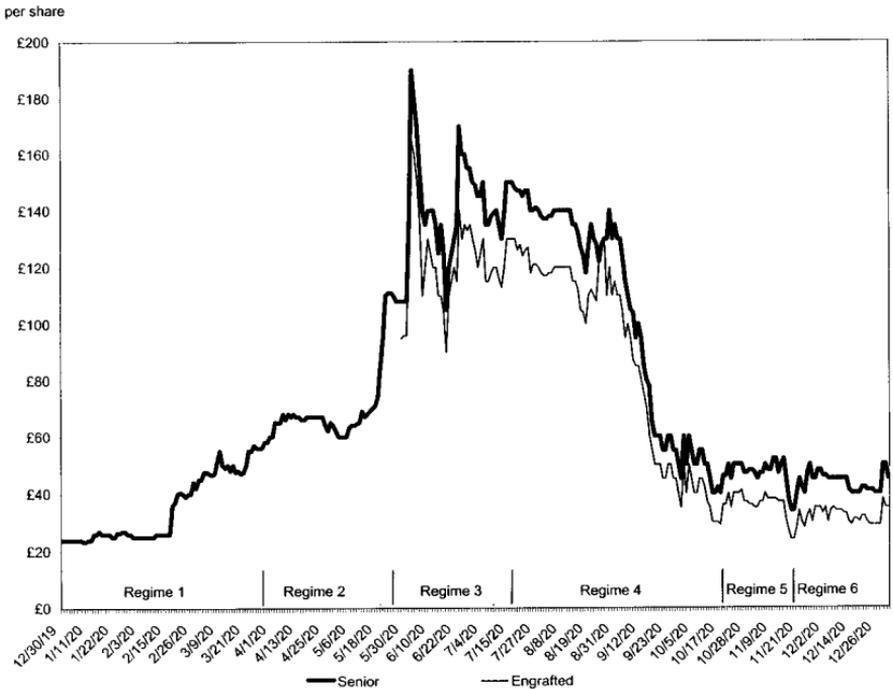


FIG. 1. Prices of Royal African Company senior and engrafted shares.

preceding 2 days of trade. There was no trading on a Sunday. Castaing also notes when the market was closed for holidays, religious and secular, and when there were no transfers. The compilation used here takes an average of the spread. When the market was closed, we take the previous day's price as the current price. Thus, we have information on the share prices, transactions volumes, and the names of buyers and sellers for all of 1720.¹²

The price for Royal African Company stock is given in Fig. 1 and, as noted above, the price opening January 1720 was £24. By the beginning of March it had risen to £50, by April to £60, where it stayed until the middle of May. By June, the share price was £140. The price fluctuated through June, July, and August, hitting a high of £195 at the very beginning of June. Then from the beginning of September, it fell to £60 by the end of the month. It closed the year at £45. The pattern of prices for Royal African Company shares closely resembles the price path for South Sea Company shares, as shown in Fig. 2. Visual inspection strongly suggests an episode common to both companies and that both may have been experiencing the same financial conditions. However, visual inspection is not sufficient to allow a determination of whether a bubble was present in the

¹² We cannot, however, match up the exact price at which each individual trade took place. The transfer books were maintained so that the Company would know who owned shares and does not list the price at which the transaction took place.

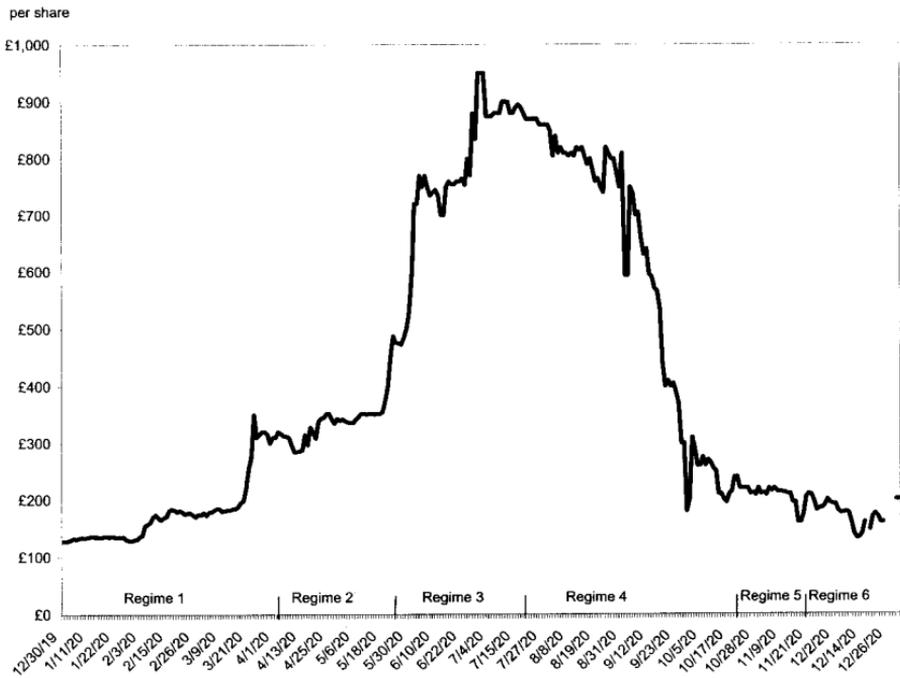


FIG. 2. Prices of South Sea Company shares.

share prices of the Royal African Company or whether the path of prices follows some fundamental movements.

In January 1720, there were roughly 4500 shares of Royal African Company stock potentially available for trade in the market for a book value of £450,000. During 1720, the total number of transactions in the stock was about 1100 with a value of £667,207 across 583 sellers and 603 buyers. Thus the capital stock turned over one and one-half times. The average book value of stock traded per transaction was roughly £600, while the average amount traded per person for the year was £1100. The difference arises from the fact that there were some buyers and sellers with multiple transactions during the year.¹³ The largest number of transfers, 297, took place in March 1720. This peak coincides with the first rise in the price of Royal African Company shares. The market continues to remain active in June, July, and August with 186, 128, and 71 transactions, respectively. There were another 41 transactions in September but only two further transactions in the last 3 months of the year.

In April 1720, the Royal African Company offered a large new stock issue to

¹³ Many of the top 10 buyers and sellers of Royal African Company shares were goldsmith bankers or others involved in financial services who acted as brokers for the stock. For example, William Mead, Solomon Fernandez Nunes, and George Middleton were each very important players in the financial sector.

the value of £1,569,600, almost four times the value of the existing stock.¹⁴ In all previous issues, the Company itself had sold the new stock. In this case, it used an underwriter. In an agreement dated April 7, 1720, Joseph Taylor paid £75,696 for the whole issue. Thus Joseph Taylor bought the issue at 4.82% of its book value.¹⁵ The Company did, of course, receive £75,696 as a new cash infusion. As stock was sold in units of £100 book value, there were now 15,690 new or “engrafted” shares available. As was common at this time, purchasers of these engrafted shares paid for them in a series of installments: 5% payable on June 1, 5% payable on September 1, and 7% payable on December 1, 1720.¹⁶ The initial selling price was, thus, lower than the book value, but higher than the price paid by Joseph Taylor.

Although this was a seasoned equity issue and not an IPO, the issue has a number of features of an IPO. In particular, there is the underpricing of the issue by Joseph Taylor upon its offering to the public. Another IPO feature comes from the way in which Joseph Taylor and the Duke of Chandos sought to place a large percentage of the offering prior to sale. In any capital market, a new issue would typically depress the share price if there has been no change in the underlying value for the shareholders. In order, therefore, to obtain agreement for a new issue, the senior shareholders of the Royal African Company had to be compensated. The agreement drawn up did, in fact, promise them a dividend of 10% of their book value 1 year hence, in April 1721. No dividend was promised on the newly issued stock.¹⁷ This difference in dividend payments on the senior and engrafted stock led to different market prices for these shares.

At the end of May, Castaing began to list the price of the engrafted stock, also shown in Fig. 1. The first price listed was £95 and this rose to £135 by June 1. The engrafted stock hit a high of £163 at the beginning of June. Then in September, it too began to fall ending the year at £35. Given there were few differences in the rights of senior and engrafted shares, the correlation between

¹⁴ To differentiate between the existing shares and the new issue, we label the existing shares “senior” and the new issue “engrafted.” In the subsequent analysis, we use the subscript *s* to refer to the senior issue and the subscript *e* to refer to the engrafted issue.

¹⁵ This agreement with Joseph Taylor occurred 1 week before the first South Sea Company money subscription for £2,250,000. Little is known about Joseph Taylor other than that he was a merchant in the City. He appears nowhere else in the available records of the Royal African Company. However, one Joseph Taylor, esq., of London bought £500 of Bank of England stock on April 27, 1720. There is another record for a Joseph Taylor, merchant, of Surrey who bought £4100 of Bank of England stock on May 5, 1720. We do not know if these are all the same Joseph Taylor.

¹⁶ Buying by installments was the procedure. The Minute Book of the Royal African Company Court of Assistants (T70/90) gives the installments as noted in the text. In undated, unsigned loose pages at the back of Minute Book of the General Court (T70/101), the reported installments pattern has an up-front payment of 5%. The potential existence of this extra 5% does not change the model or the results presented in the next sections and the initial selling price still remains lower than the book value and higher than the price paid by Joseph Taylor.

¹⁷ It was because of this dividend that the Company had to record the stock transfers of the engrafted stock in a separate transfer book until after the dividend payment.

the movement of both stock is very high at 0.9962.¹⁸ There was a total of 4336 transactions in the 8-month period from May to December 1720, with the engrafted issue turning over 2.38 times.¹⁹ The market for the engrafted issues was deeper than that of senior shares because there were more shares available and there was also more turnover. The three months—June, July, and August—experienced very high levels of activity with over 2220 individual transactions (Royal African Company, T70, 200, 201, 202).

In July 1720, the Royal African Company decided that “it would be for the advantage of the Company that the cash which at present lies dead, should be lent upon stock in the Company, viz, upon the old stock at eighty pounds per cent and upon the engrafted stock at sixty pounds per cent for three months, after the rate of four pounds per cent per annual interest” (Royal African Company, T70/90, 20 July 1720). This decision was announced 1 week after the registration of redeemable annuities at the Bank of England and 1 month after the books of the South Sea Company were closed in preparation of payment of a £10 per share dividend.²⁰ In effect, the Company was allowing its shareholders to mortgage their stock.²¹ The Company did, however, restrict the amount of stock that could be so mortgaged to £1000.

This move on the part of the Company could, of course, have increased the amount of money available for overall market purchases because there was no restriction on how the money would be used.²² At the same time, this move did reduce the amount of Royal African stock available for sale.²³ The mortgaged shares were held in trust by the Company Secretary, Robert Gray. Transactions to and from Robert Gray are plotted in Fig. 3.

Although the Company had specified a loan of 3 months, by October it was clear that there had been a change in general market conditions with share prices falling and rather than having its shareholders default, the Company extended the

¹⁸ Shareholders of the senior and engrafted stock had essentially the same rights. However, the senior shareholders had been promised a dividend in April 1721 and as explained below, they could also mortgage a greater amount of stock back to the Company.

¹⁹ The transfers are recorded from May 2; however, prices for the shares are not listed in *The Course of the Exchange* until May 28.

²⁰ The closing of the books meant that no transfers could be registered. This was standard practice at the time and was done to allow companies to determine current ownership of shares and payment of dividends.

²¹ An interesting question is where the money for this mortgage program came from. The company did have the money it received from Joseph Taylor, but it clearly needed more than this to run the program. Unfortunately, we do not have the complete cash books for the company. The quotation given does say that the company has cash on hand. How much and from where it came is unknown.

²² Because we are working with the transfer books for the Royal African Company, we only know if those who mortgaged stock purchased more Royal African Company shares because that would be listed in the transfer books. However, part of a larger project entails the creation of asset ownership by individuals which would provide information on portfolio holdings by individuals before, during, and after the South Sea Bubble.

²³ In our analysis, we ignore this upward pressure on price from the loan. By doing so, our results remain conservative estimates.

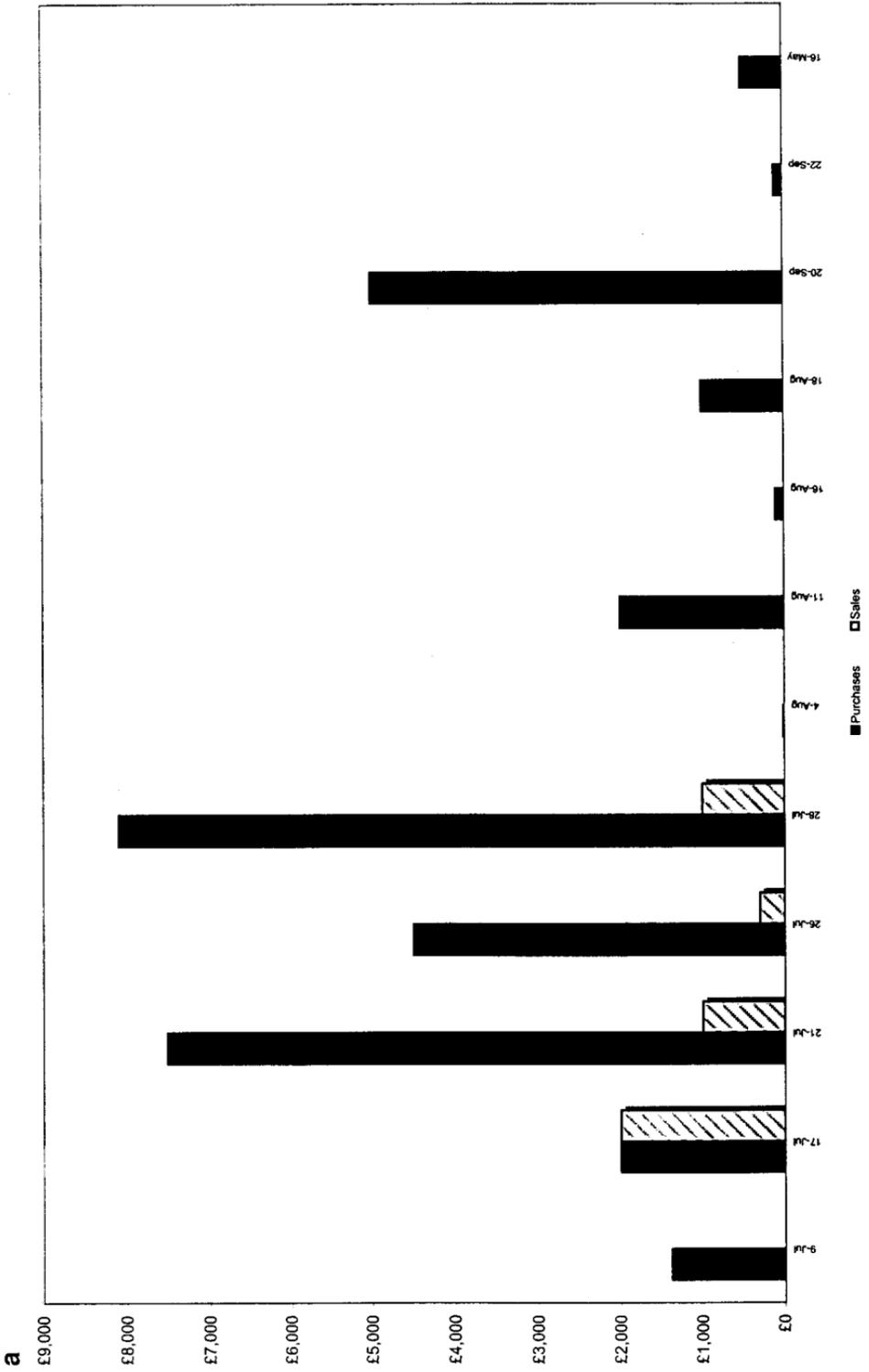


FIG. 3. Robert Gray's purchases and sales. (a) Senior stock. (b) Engrafted stock.

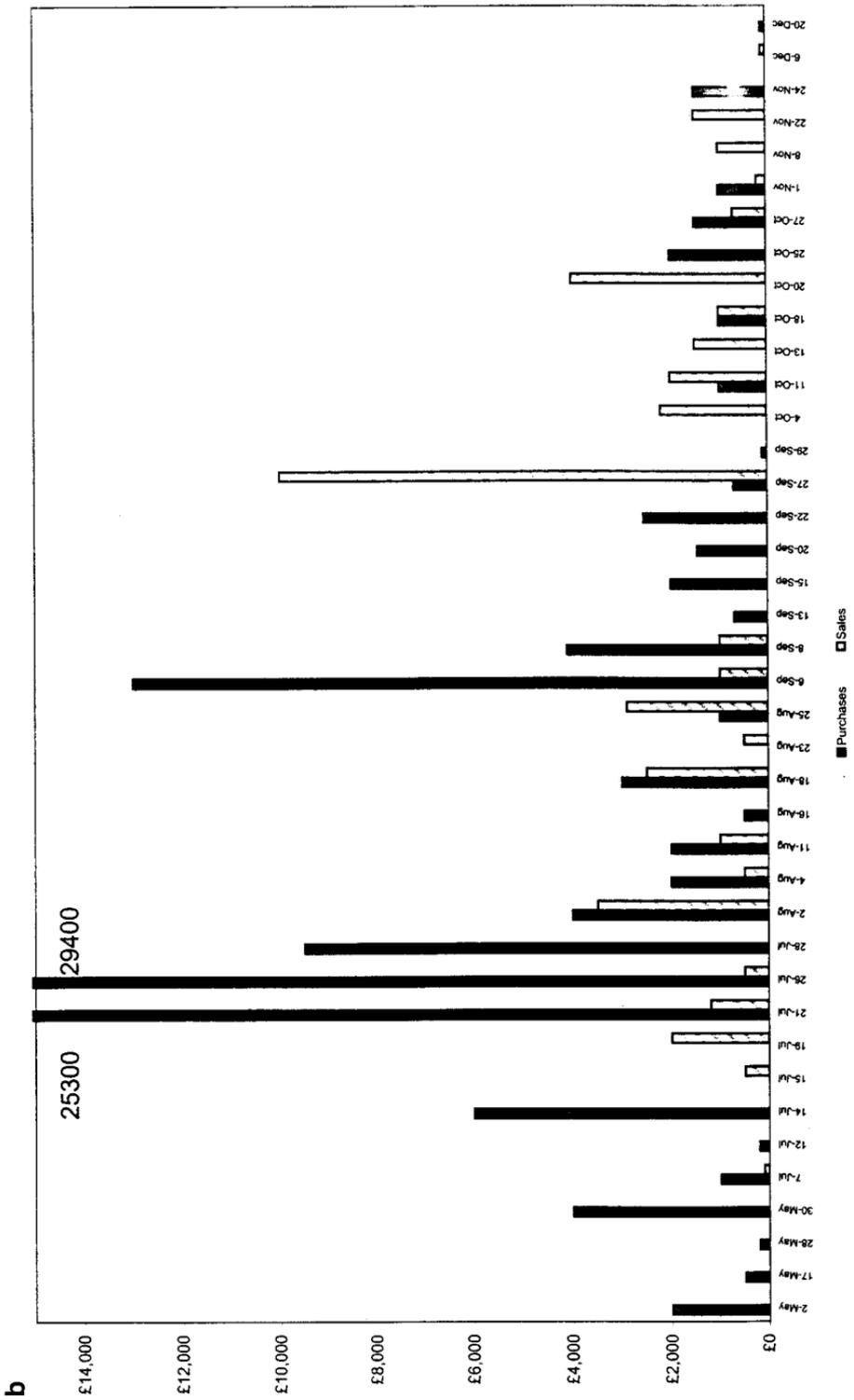


FIG. 3—Continued

date for loan repayment. Then in November, the Company announced a new schedule for the last payment of 7% owed on the engrafted shares, payable now in two separate payments of 4% and 3%, respectively.

The financial conduct of the Company just described can, in effect, be broken down into six different pricing regimes. In Table 1, we list these pricing regimes for the Royal African Company. In addition, we show the financial events for the South Sea Company during the same time periods. The Royal African Company began 1720 with only one type of stock, which we name regime one. For the purpose of our analytical model, the second regime began with the announcement of the engrafted issue and the promised dividend to the holders of senior stock. The third regime occurred with the sale and listing of the price in the *Course of the Exchange* of the engrafted stock in May. But as noted above, purchasers paid for these in three payments specified by the Company. The fourth regime began when the Company made the loan available to its shareholders. The fifth regime started when the Company extended the loan maturity. The final regime commenced with the change in the repayment of the final 7% due on the engrafted stock. In the following section, we use these regimes to examine whether the bubble apparent in the share prices of the Royal African Company stock was a bubble or arose from movements in fundamentals.

4. THEORETICAL MODEL

In order to extract a bubble from market prices, we need to have a model both of stock prices and of the conduct of shareholders. As we noted above, we begin by assuming that all market participants know the fundamental structure of the economy and that they process information in a rational and unbiased manner.²⁴ Or alternatively, investors price assets correctly because they have a correct specification for the true economic model and unbiased estimators of its coefficients. We would argue that the size and structure of the London capital market made information easily accessible to all participants (Carlos, Key, and Dupree, 1998).

In order to distinguish the portion of the stock price that can be explained by fundamentals from the bubble portion, one needs a pricing model based on fundamentals. Direct econometric tests of bubbles require comparison between the market price of an asset and its fundamental price where one can price a share as the expected discounted stream of dividends.²⁵ However, for the case of the Royal African Company, there were very few payouts. In fact, the problem we

²⁴ Relative to Neal who, following Tirole (1982), assumed that expectations were myopic and sequential traders looked only at the expected trading options in that period and the subsequent period but did not believe they were locked in for longer, the structure here is that used in more general examinations of these types of questions and we believe a good starting point.

²⁵ Econometric approaches to this issue can be found in Kleidon (1986), Campbell and Shiller (1987), Shiller (1989), Flood and Hodrick (1990), White (1990), Rappoport and White (1994), and Donaldson and Kamstra (1996).

TABLE 1
Royal African Company Pricing Regimes during The South Sea Bubble of 1720

	Royal African Company	South Sea Company
Regime 1	1 Jan-6 Apr	1 Feb
Regime 2	7 Apr-27 May	14 Apr
	Existing senior stock	Parliament passes the South Sea Bill
	Announcement of engrafted stock dividend	First money subscription (£1,500,000)
	1 year hence on senior stock	
Regime 3	28 May-20 Jul	28 Apr
	Sale of engrafted stock	Registration of 2/3 of irredeemable annuities
		Second money subscription (£1,500,000)
		Announcement of terms for registrants (£400/share)
		Third money subscription (£5,000,000)
		Books closed for 2 months to pay £10 dividends
		Registration of redeemable annuities (at Bank of England)
Regime 4	21 Jul-20 Oct	4 Aug
	Loan to shareholders	Registration of remainder of irredeemable and redeemable annuities (at Exchequer)
		Announcement of terms for registrants of 14 July and 4 August
		Fourth money subscription (£1,250,000 at £1,000 per £100 share)
Regime 5	21 Oct-17 Nov	15/17 Oct
Regime 6	18 Nov-30 Dec	
	Extension of loan deadline	Notification to South Sea Directors of the amounts registered on 14 July and 4 August
	Change in payment schedule on engrafted stock	

Note. Regimes refer to Royal African Company, see text. For South Sea Company see Neal (1990), Table 5.2.

face with the Royal African Company is very similar to the problem encountered recently in pricing internet companies: stockholders of internet companies have not received nor appear to expect any immediate dividends, or profits for that matter. Yet, these companies were valued at very high levels. Some say that the stock valuation of internet companies represented a bubble. But this argument seems difficult to validate because a bubble is the difference between the price observed in the market and a fundamental price. While this fundamental price is typically computed using data on historical dividend payments, internet companies have generally not yet paid dividends.²⁶

Alternatively, fundamentals can be extracted using earnings series, investment series, and payout ratios. Computing the Royal African Company fundamental stock price from earnings is unfortunately not feasible.²⁷ Although a lack of dividend payments is a similarity between current internet companies and the Royal African Company, this is only a superficial comparison. Internet companies are young and lack an historical record, whereas the Royal African Company had available a long historical record of no regular dividend payments. So we continue to use dividends to price fundamentals, as some dividends were paid. Given the overall structure of the data, we must keep in mind that this method is likely to underestimate the fundamental price and overestimate the size of the bubble. Any fundamental price we derive will be a conservative estimate in the sense that we are setting ourselves up to find a bubble.

Therefore, consider the following present-value model of stock prices,

$$p_t = E_t \left[\frac{p_{t+1} + d_{t+1}}{1 + r_{t+1}} \right], \quad (1)$$

where p is the observed market price, d denotes the dividend or payout on the stock, and r represents the discount rate. Solving forward, applying the law of iterated expectation, and invoking the transversality condition, we find that we are guaranteed a unique solution for the fundamental price p^f ,

$$p_t^f = E_t \sum_{i=1}^{\infty} \left[\frac{d_{t+i}}{\prod_{j=1}^i (1 + r_{t+j})} \right], \quad (2)$$

such that the fundamental price, p^f , is the expected discounted value of the dividend stream.

From Eq. (2), one can see that there are two possible sources for a rapid run

²⁶ Trueman, Wong, and Zhang (2000) provide a method to relate fundamentals to the market price of internet companies. They find that earnings are negatively related (instead of positively related) to the market value of internet companies. But they do find a positive relation between market values and gross profits because gross profit as opposed to earnings does not include expenses related to marketing, mergers and acquisitions, or research and development.

²⁷ Because the Royal African Company was a trading company, each ship sent out did not return for many months or even years. Given the nature of the accounting procedures of the period, it would be very difficult to determine accurately earnings for each calendar year.

up in asset prices from a shift in fundamentals. The first is an increase in dividends, d . There could also be a decrease in the discount rate, r . However, if investors know the true dividends and discount rates but are irrationally optimistic, then there will be mania or an irrational bubble. Alternatively, if investors are rational but do not have the correct information, then we can get mispricing or a rational bubble. The first issue is to see the extent to which fundamentals explain market prices and then to test whether we have a rational or irrational bubble.

The observed market price, p , of Royal African Company stock, graphed in Fig. 1, may contain a bubble B such that

$$p_t = p_t^f + B_t. \quad (3)$$

We can isolate the residual B by using Eq. (3), where the fundamental price p^f is computed using Eq. (2). A standard, straight-forward procedure is to compute the fundamental price p^f by forecasting the discounted stream of firm payouts, $x_i = d_{t+i}/(\prod_{j=1}^i (1 + r_{t+j}))$, using a time-series model. As noted in the previous section, the Royal African Company did not pay any dividend after its reorganization in 1712 and the last significant dividend paid out had occurred in 1692 (Scott, 1951, Vol. 2, 33–35). Observing zero dividends, shareholders may have expected zero dividends in the future. It need not follow that just because shareholders observed no dividends that Royal African Company shares are worthless. Shareholders' expectations of future payouts may well justify the observed market price, based on information unavailable to us now. Indeed, with the awarding of the Spanish *Asiento* to the South Sea Company under the Treaty of Utrecht (1713), Royal African Company shareholders may well have expected trade to expand as the Company would now have the property right to supply slaves to the South Sea Company. Despite this, today's econometrician trying to predict the Royal African Company share price using dividends cannot do otherwise than assign a fundamental price of zero and let the market price be equal to the unexplained residual, B .

During the course of 1720, the Company did announce dividends of various forms: a dividend on the senior stock of £10 per £100 book value to be paid in April 1721; the installment payments delay on the engrafted stock; and a preferential loan available to senior and engrafted shareholders. Shareholders may have expected other dividends in the future, but again we have no means of measuring this. Given the available information, the best that we can do is to determine the fundamental value of these various announced dividends, which is likely to underestimate the fraction of the market price that can be explained by fundamentals because we are not capturing all future expected payouts, and thereby overestimate the size of the residual, which biases our results in an acceptable manner.

As previously discussed, the Royal African Company's financial conduct defines six pricing regimes. Regime 1 began with the first available price observation on January 1, 1720, and ended on April 6, 1720, the eve of the

dividend announcement. During Regime 1, the Royal African Company had only senior (s) stock outstanding. As discussed above, because we have no information that can be used to forecast future expected dividends, the fundamental price for the senior stock is measured equal to zero, $p_{s,t}^f = 0$, and Eq. (3) simplifies to

$$p_{s,t} = B_{s,t}. \quad (4)$$

In this regime, therefore, the market price is equal to a residual.

Regime 2 is defined by the period April 7, 1720, to May 27, 1720. This is the period between the dividend announcement for senior shareholders and the eve of the first recording of the engrafted (e) share price. On April 7, 1720, the Royal African Company announced a dividend of £10 per £100 book value on its senior stock to be paid in April 1721. The market price on senior shares can be decomposed into the fundamental price and a residual,²⁸

$$p_{s,t} = 10e^{-r(4/01/21-t)/365} + B_{s,t}. \quad (5)$$

The continuously compounded discount rate is set to $r = \log(1.05)$ in accordance with Siegel (1992). Siegel finds that the real UK return during the 1800–1888 period averaged 5.03%. This rate is also well within the range of rates provided by Clark (1996) in his examination of rates of return in England, 1540–1800.

The simplification of a constant interest rate, r , has a very important implication. It abstracts from the economy-wide movements that make the interest rate fluctuate through time. For example, the events that surround the Bank of England, the East India Company, and the South Sea Company, to the extent that they affect the economic decisions of the Royal African Company shareholders, are not taken into consideration. It is quite possible that spillovers from the South Sea Company could have affected the discount rate used by Royal African shareholders but we have not priced this fundamental. We believe that an examination of all these companies simultaneously during 1720 might allow us to solve for a time-varying discount rate. In the present study, we perform sensitivity analysis using different discount rates but the results discussed below remain qualitatively unchanged. Nevertheless, this study should be viewed as a partial equilibrium analysis of the Royal African Company during the time of the South Sea Bubble.

Regime 3 covers the period from May 28, 1720, to July 20, 1720, and begins with the first listing on the *Course of the Exchange* of the engrafted stock issue. As noted above, payment for the issue was due in three installments of £5, £5, and £7 per £100 book value, on June 1, September 1, and December 1, 1720. The price structure for senior shareholders remains the same as in the previous regime. Market prices on the senior, p_s , and engrafted, p_e , stock can again be decomposed into a fundamental price and a residual,

²⁸ The dates are given as month/day/year.

$$\begin{aligned}
p_{s,t} &= 10e^{-r(4/1/21-t)/365} + B_{s,t} \\
p_{e,t} &= -5e^{-r(6/1/20-t)/365} \times 1_{(t < 6/1/20)} \\
&\quad - 5e^{-r(9/1/20-t)/365} - 7e^{-r(12/1/20-t)/365} + B_{e,t},
\end{aligned} \tag{6}$$

where $1_{(t < 6/1/20)}$ takes the value of one when $t < 6/1/20$ and zero otherwise.

Regime 4 covers the period from July 21, 1720, to October 20, 1720. On July 21, the Royal African Company offered a 3-month loan payable at an annual 4% interest rate. Shareholders could use their shares as collateral, but could mortgage no more than £1000 of book value. Senior and engrafted shareholders were differentiated in that senior shareholders could borrow up to 80% of their mortgaged amount, while engrafted shareholders could borrow no more than 60% of their mortgaged amount. In exploring the extent to which market prices for the senior and engrafted shares follow fundamental values, we assume that all shareholders mortgaged their shares in order to participate in the loan benefit. This assumption is not too extreme. An examination of the number of transfers made to Company Secretary Robert Gray, shown in Fig. 3, suggests that the majority of shareholders did in fact participate in the loan program.

Of course, as is evident from the time path of prices during the latter half of 1720 (see Fig. 1), we recognize that shareholders had the option of never repaying the loan. Shareholders gave up a share as collateral and received a loan in return. After 3 months, shareholders would repay the loan if the share price exceeded the loan principal, δ , and interest, $e^{\iota(10/21/20-7/21/20)/365}$, payments. Thus the loan can be thought as a European call option on the share,

$$\begin{aligned}
p_{s,t}^f - \delta_s &= e^{-r(10/21/20-t)/365} E_t[\max\{p_{s,10/21/20} - \delta_s e^{\iota(10/21/20-7/21/20)/365}, 0\}] \\
p_{e,t}^f - \delta_e &= e^{-r(10/21/20-t)/365} E_t[\max\{p_{e,10/21/20} - \delta_e e^{\iota(10/21/20-7/21/20)/365}, 0\}],
\end{aligned} \tag{7}$$

where the loan price $p^f - \delta$ is equal to the expected discounted value of the loan benefit, where E is the expectation operator in a risk neutral world and where the continuously compounded interest rate charged on the loan is $\iota = \log(1.04)$.

We use the Black-Scholes pricing formula to value this option,

$$\begin{aligned}
c &= SN(d_1) - Xe^{-rT}N(d_2) \\
d_1 &= \frac{\log \frac{S}{X} + \left(r + \frac{\sigma^2}{2}\right)}{\sigma \sqrt{T}} \\
d_2 &= d_1 - \sigma \sqrt{T},
\end{aligned} \tag{8}$$

where $N(\cdot)$ is the standard normal cumulative density function, c is the call price equal to $p^f - \delta$, S is the share price, p^f , net of the present value of dividends, D , expected during the life of the loan, X is the loan repayment

$\delta e^{-t(10/21/20-7/21/20)/365}$, and T is the time to the repayment date of October 21, 1720. As previously discussed, the discount rate r is set equal to $\log(1.05)$ and the interest charged on the loan ι is set to $\log(1.04)$. We use the Black–Scholes formula to back out the fundamental price p^f given all other variable values.²⁹ Equation (3) is then used to determine the residual $B = p - p^f$.

The present value of dividends, D , accruing during the period of the loan must be subtracted from the share price, p^f . On the engrafted shares, the negative dividend representing the installment payment due on September 1, 1720, has a present value of

$$D_{e,t} = -5e^{-r(9/1/20-t)/365} \times 1_{(t \leq 9/1/20)}, \quad (9)$$

where $1_{(t \leq 9/1/20)}$ takes a value of one when $t \leq 9/1/20$ and zero otherwise.

The Black–Scholes formula, of course, relies on the assumption of frictionless markets (including no tax, no short-sales constraint, no wedge between the borrowing and lending rates, etc.). It also assumes a constant risk-free rate, r , and a constant volatility, σ , of the underlying share prices that we set equal to 0.2, which is a conservative value in today’s stock markets.³⁰ Although a constant underlying volatility is unlikely to be true, especially during the tumultuous time of the apparent bubble, the Black–Scholes formula provides a good benchmark for valuation of the loan benefit. A sensitivity analysis with respect to the volatility parameter yields similar qualitative results.

Regime 5 is defined by the period October 21, 1720, to November 17, 1720. At this time, the Company extended the loan repayment date initially set for October 21, 1720. It is unclear whether the shareholders, or the Company for that matter, knew exactly when the loan would now be due. Robert Gray’s letter sent to the shareholders simply stated that the Royal African Company “will allow a further time for payment” (Royal African Company, T70). To simplify our analysis, we assume that shareholders had perfect foresight of this extended date, which turned out to be March 21, 1721. The call options are now priced as

$$\begin{aligned} p_{s,t}^f - \delta_s &= e^{-r(3/21/21-t)/365} E_t[\max\{p_{s,3/21/21} - \delta_s e^{\iota(3/21/21-7/21/20)/365}, 0\}] \\ p_{e,t}^f - \delta_e &= e^{-r(3/21/21-t)/365} E_t[\max\{p_{e,3/21/21} - \delta_e e^{\iota(3/21/21-7/21/20)/365}, 0\}]. \end{aligned} \quad (10)$$

The Black–Scholes formula previously described is used to solve for the fundamental price, p^f , where the present value of dividends is now written as

²⁹ In some cases, the call option is so deep-in-the-money such that the option’s delta is equal to one. The search algorithm cannot find a call price, c , equal to the fundamental price, p^f , net of the loan principal, δ . In these cases, we approximate the solution using a second-order Taylor series expansion. An option that is so deep-in-the-money will always be exercised. In our context, shareholders will always choose to repay their loan. This occurs for a few observations at the height of the apparent bubble.

³⁰ We do not estimate σ from the data because the data may contain a bubble, such that an estimate of σ would be contaminated and not representative of the volatility of fundamental prices.

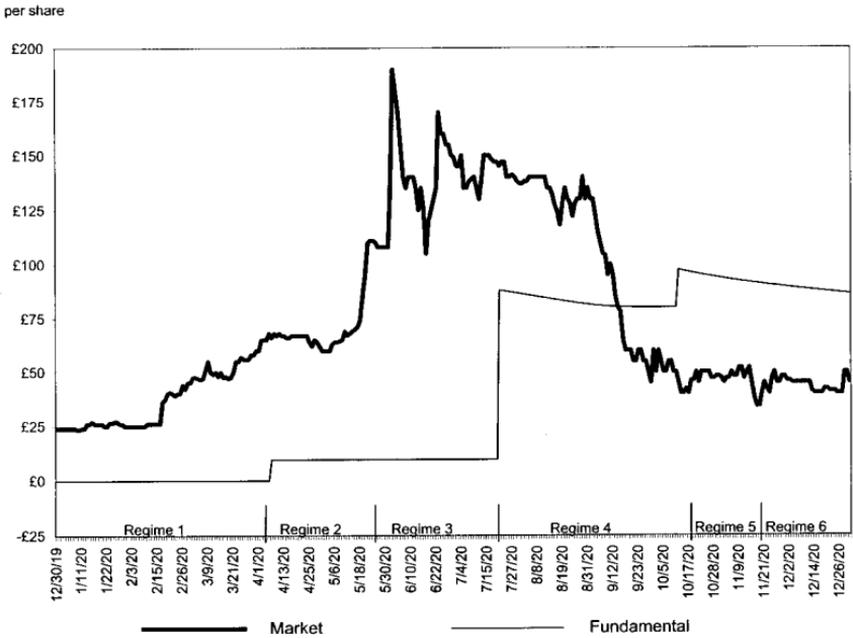


FIG. 4. Market and fundamental prices for Royal African Company senior shares.

$$D_{e,t} = -7e^{-r(12/1/20-t)/365}. \quad (11)$$

Finally, Regime 6 extends from November 18, 1720, to December 30, 1720. This regime begins with the Royal African Company announcement on November 18, 1720, that it would delay part of the £7 installment remaining on the engrafted stock, due December 1, 1720. Engrafted shareholders now benefited from paying only £4 on December 1, 1720. For the remaining £3, the Company announced that “for the ease of the Proprietors the remaining £3 will not be called for in less than two Months, and not without 14 days Notice, to be published in the Gazette” (*London Gazette*, 15–19 November, 1720). Again, to simplify our analysis, we assume that engrafted shareholders foresaw the later announced date of March 21, 1721. The fundamental price p^f in Regime 6 is computed as in Regime 5, with the exception of the present value of dividends accruing on engrafted shares,

$$D_{e,t} = -4e^{-r(12/1/20-t)/365} \times 1_{(t \leq 12/1/20)} - 3e^{-r(3/21/21-t)/365}, \quad (12)$$

where $1_{(t \leq 12/1/20)}$ takes a value of one when $t \leq 12/1/20$ and zero otherwise.

5. RESULTS

Using the framework outlined above, we computed fundamental prices for both the senior and the engrafted shares. These were then compared with the market prices for each. The results are shown graphically in Figs. 4 and 5. In each

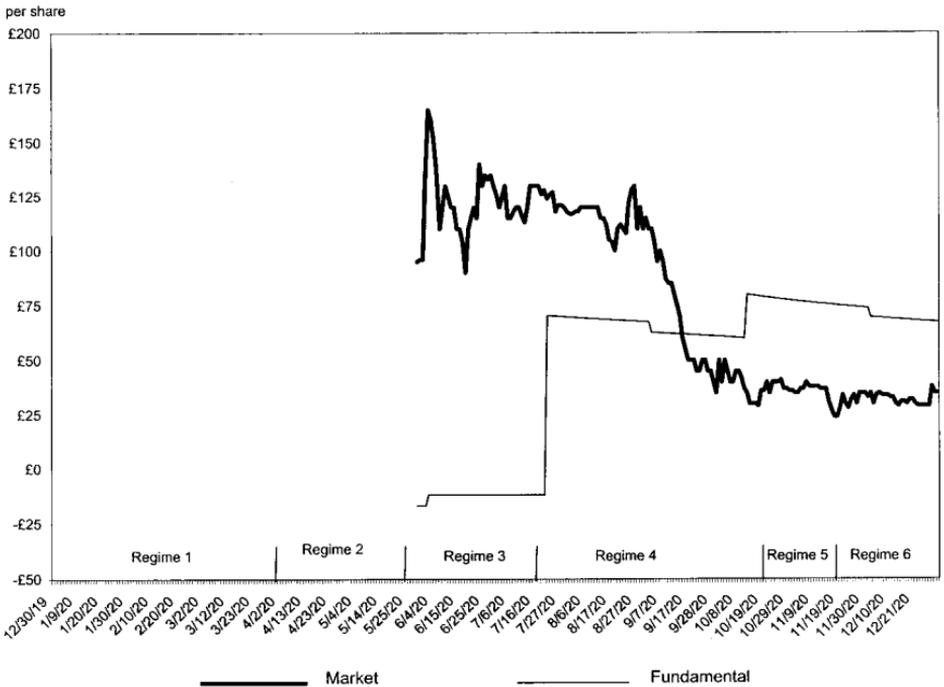


FIG. 5. Market and fundamental prices for Royal African Company engrafted shares.

figure, the distance between the two series represents the residual or the amount unexplained by fundamentals. Figure 4 graphs the market and fundamental prices of senior shares. It is clear that fundamentals do not fully explain the price observed in the market. On average, fundamentals, p_s^f , represents 68.39% of market prices p_s . The residual may, of course, be explained by a bubble or by information that is not observable to us. For example, in Regime 1, we assumed that, based on prior information, the shareholders of the senior stock did not expect any future dividends. Given the model, there was no fundamental observable to explain the market price. We thus attribute 100% of the market price to the residual. This procedure likely overstates the magnitude of the residual and understates the magnitude of fundamentals in explaining market prices because, as discussed above, shareholders could have expected future trade with Africa to expand. When we exclude Regime 1, fundamentals, p_s^f , explain, on average, 93.66% of the market price, p_s . Figure 5 provides a similar picture for the market and fundamental prices of the engrafted shares. Here our observations start in Regime 3, with the first price listing for the engrafted stock. For engrafted shares, fundamentals, p_e^f , explain more than 100% of market price, p_e , on average.

As Figs. 4 and 5 clearly show, these fractions of market prices explained by fundamentals are not constant over time. Fundamentals cannot fully explain the market price for the first three quarters of 1720, while they overshoot the market price for the last quarter when the apparent bubble has burst. More specifically

TABLE 2
Mean Fundamental-to-Market Price Ratios (in Percentages)

	Senior shares	Engrafted shares
Whole period	68.39	112.42
Regimes 2–6	93.66	—
Up to September	15.02	20.21
Regime 2 to September	25.16	—

for the first three quarters, fundamentals explain only 15.02% of the senior market price (or 25.16% excluding the first regime) and 20.21% of the engrafted market price. Table 2 summarizes these figures.

Another pattern discernible from Figs. 4 and 5 is the price run-up in February and the other run-up in June that are followed only by fundamentals a few weeks later. The £10 dividend to the senior shareholders was decided on April 7 at the Meeting of the Court of Assistants. The Minute books for the Court of Assistants show that there was discussion with Joseph Taylor prior to this date. Exactly when this discussion started is impossible to know because the Minute book covering the period just prior to the announcement is missing.³¹ What is clear from the existing documentation is that the discussions with Joseph Taylor had not been conducted in secret and that they had been ongoing for some time, although we do not know for how long. So it is very likely that information was available and senior shareholders had good reason to believe that this dividend would be announced. Likewise, the June run-up could be explained by the possibility that senior and engrafted shareholders expected the forthcoming loan benefit. Indeed, on April 21, the South Sea Company offered its shareholders a loan similar to the one later offered by the Royal African Company. Because we are not privy to exactly when discussions about these events became common knowledge, rather we just know the formal announcement dates, anticipation of these two events (i.e., the £10 dividend announcement and the loan benefit) is consistent with the share price run-ups seen in Figs. 4 and 5.

Figure 6 provides a composite picture of the residuals for the senior and engrafted shares, B_s and B_e . The senior and engrafted residuals average £33.21 and £27.84, respectively. If we wish to focus solely on the apparent bubble, we should exclude the last few months of 1720 when market prices had fallen. Table 3 documents that the mean residual increases to £65.85 on the senior shares and to £96.84 on the engrafted shares. All mean residuals are statistically different from zero at the 5% level. The two residuals are highly correlated, with a coefficient of 0.9973, which is not surprising because market prices of the senior and engrafted shares are also highly correlated (0.9962), as are the fundamental prices of the senior and engrafted shares (0.9990).

³¹ There is a complete run of Minute books from 1678 to 1716 and then from late March 1720 to 1752.

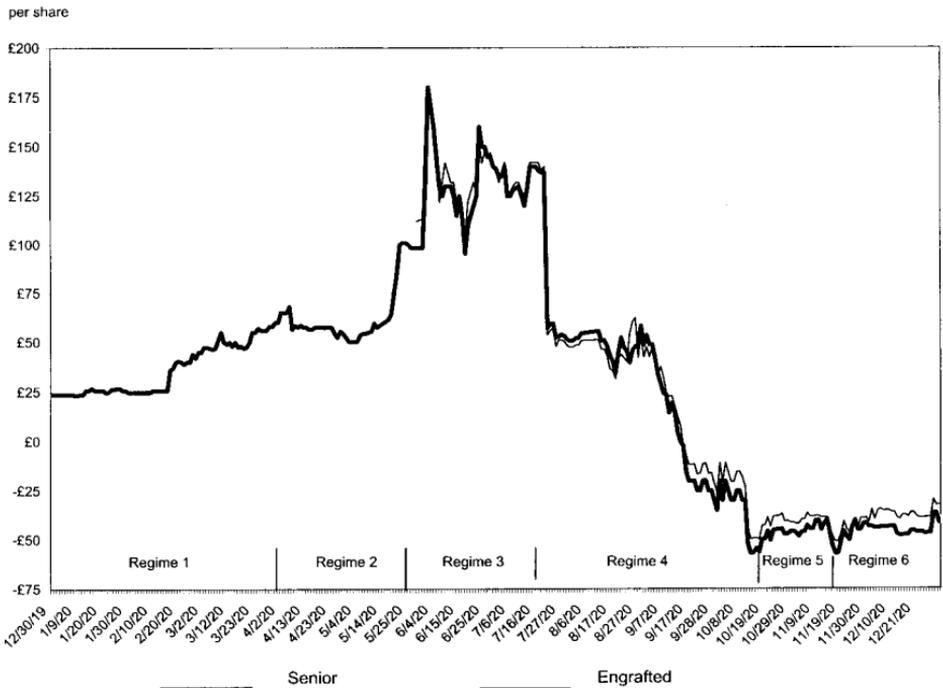


FIG. 6. Residuals for Royal African Company senior and engrafted shares.

All mean residuals in Table 3 are different from zero at the 5% level, but this does not necessarily mean that these residuals constitute a bubble. Figure 6 shows that the residuals are positive and mostly increasing; then they decrease and take on negative values. Figure 7 graphs the growth rates for the senior residuals. If these growth rates kept increasing up to the crash in the market prices, this would be consistent with the presence of an irrational bubble, but this does not appear to be the case. We can see that the growth rates are sometimes positive and other times negative, but do not accelerate as we would expect under an explosive bubble. The same could be said for the engrafted residuals in Fig. 8. The most likely type of bubble remains the rational one, in which market participants are not fully knowledgeable such that they misprice their shares.

In both Figs. 7 and 8, the residuals' growth rates peak in mid-September. It must be noted that this peak is artificial as it occurs when the residuals are close

TABLE 3
Mean Residuals (in Pounds)

	Senior shares	Engrafted shares
Whole period	33.21	27.84
Up to September	65.85	96.84

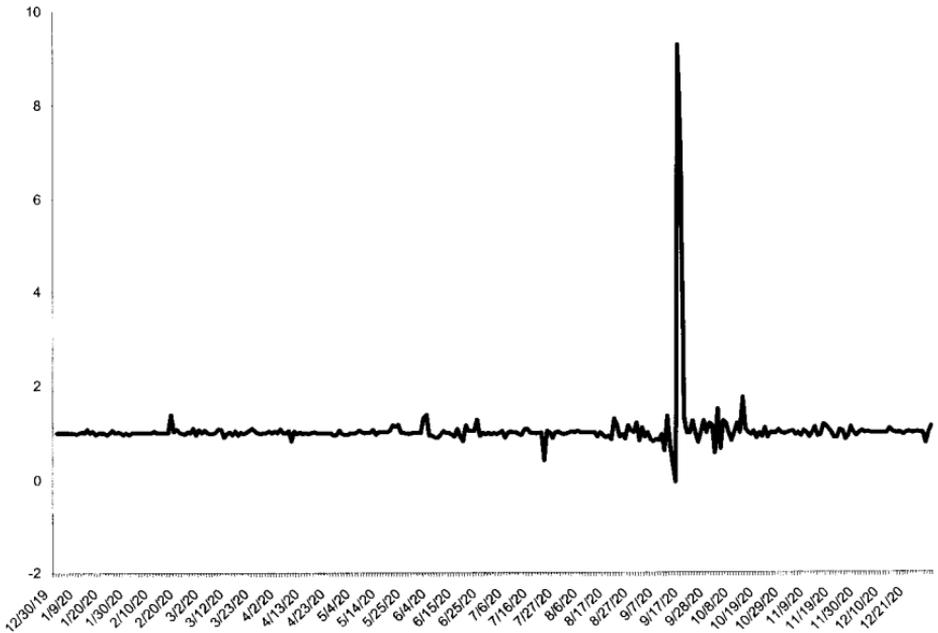


FIG. 7. Growth rate for Royal African Company senior share residuals.

to zero when crossing from the positive values to the negative ones as shown in Fig. 6. Thus any number divided by another that is close to zero is going to be large.

To test formally whether these residuals grow in a manner consistent with an irrational explosive bubble or in a manner consistent with a rational mispricing bubble, we examine the specification

$$B_t = \rho B_{t-1} + \epsilon_t, \quad (13)$$

where ρ would be equal to one plus the discount rate on average for the case of a rational bubble, or greater than that for the case of an explosive bubble. Irrespective of whether we consider a rational or an irrational bubble, B_t needs to be larger than B_{t-1} .

We enrich the specification by accounting for the possibility of a constant drift α and a time trend λ :

$$B_t = \alpha + \rho B_{t-1} + \lambda t + \epsilon_t. \quad (14)$$

Solving backward, we obtain

$$B_t = \alpha[1 + \rho + \rho^2 + \dots] + \lim_{n \rightarrow \infty} \rho^n B_{t-n} + \lambda[t + \rho(t-1) + \rho^2(t-2) + \dots] + \epsilon_t + \rho\epsilon_{t-1} + \rho^2\epsilon_{t-2} + \dots \quad (15)$$

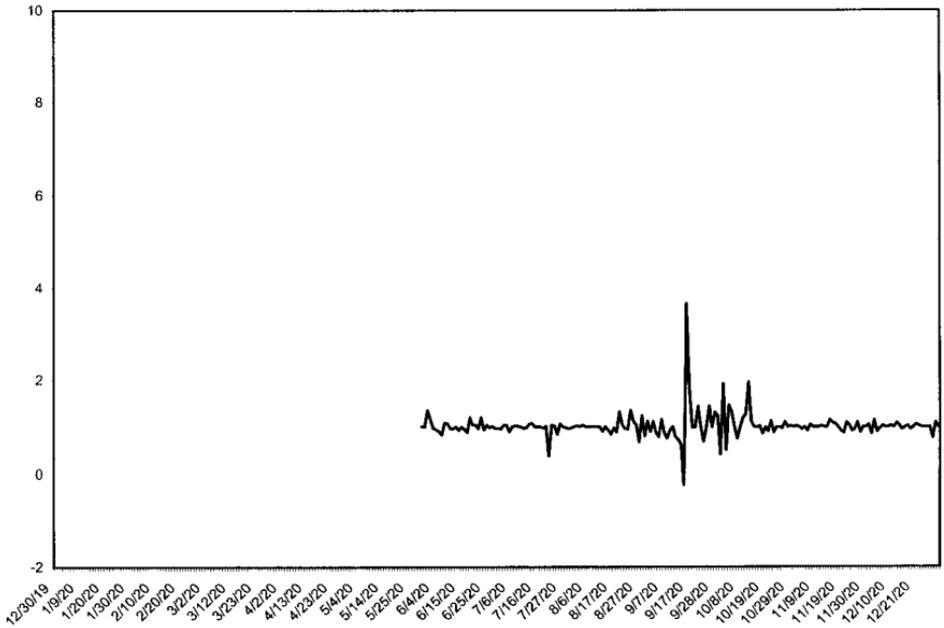


FIG. 8. Growth rate for Royal African Company engrafted share residuals.

In the presence of a bubble, we expect the series to grow with $\rho > 1$. However, if there is a unit root $\rho = 1$, Eq. (15) shows that the series could still grow if the drift α is different from zero or if the trend λ is different from zero. If it turns out that the series is less persistent $\rho < 1$, it could still grow if the trend λ is different from zero.

Table 4 reports that the null hypothesis of a unit root ($\rho = 1$) cannot be rejected for both the senior and the engrafted share residual series. The presence of a unit root seems robust to the regression specifications with a trend or without a trend. Phillips–Perron unit root tests yield the same qualitative results as the Aug-

TABLE 4
Augmented Dickey–Fuller Unit Root Tests

Regression specification	Senior residuals	Engrafted residuals
Constant; no trend		
$\rho = 1$	-0.7885 (-2.57)	-1.1145 (-2.57)
$\rho = 1, \alpha = 0$	0.4309 (3.78)	1.2673 (3.78)
Constant; trend		
$\rho = 1$	-1.5896 (-3.13)	-2.1332 (-3.13)
$\rho = 1, \alpha = 0, \lambda = 0$	1.3233 (4.03)	1.9954 (4.03)
$\rho = 1, \lambda = 0$	1.8641 (5.34)	2.3382 (5.34)

Note. 10% asymptotic critical values are reported in parentheses. The null hypothesis is rejected when the test statistic is outside (greater in absolute value) the critical value.

TABLE 5
Augmented Dickey–Fuller Unit Root Tests, Excluding the Last 4 Months of 1720

Regression specification	Senior residuals	Engrafted residuals
Constant; no trend		
$\rho = 1$	-1.7611 (-2.57)	-1.1113 (-2.57)
$\rho = 1, \alpha = 0$	1.5795 (3.78)	0.7676 (3.78)
Constant; trend		
$\rho = 1$	-1.6003 (-3.13)	-2.9529 (-3.13)
$\rho = 1, \alpha = 0, \lambda = 0$	1.0700 (4.03)	3.1007 (4.03)
$\rho = 1, \lambda = 0$	1.5764 (5.34)	4.4881 (5.34)

Note. 10% asymptotic critical values are reported in parentheses. The null hypothesis is rejected when the test statistic is outside (greater in absolute value) the critical value.

mented Dickey–Fuller tests reported in the tables. In addition, the presence of a unit root cannot be rejected if we exclude the last few months of 1720 when the apparent bubble has burst. This is reported in Table 5.

Tables 4 and 5 report that the senior and engrafted residuals do not grow over time. This is true even if we disregard the last few months of 1720. Indeed, the tables indicate that the constant α and the trend λ are both zero. These results clearly show that the case for any type of bubble, rational and especially irrational, is not strong. However, as we discussed above, we do report in Table 3 that these residuals are statistically different from zero, which requires explanation. We hypothesize that we do not have all the relevant pricing information available to market participants in 1720 due to limitations of the data source. If we had this information, we might be able to explain away the discrepancy and find that fundamentals fully explain the market movements for Royal African share price, or we might show that a rational bubble exists. It is possible that, due to the short time period under discussion here, market participants might have mispriced their Royal African shares for some period of 1720. In any case, we deem it very unlikely given the overall growth rate results that an irrational bubble exists. On balance, we would argue that the case for the existence of a bubble in these particular share prices during the South Sea episode is not overwhelming.

6. CONCLUSION

The year 1720 was an exciting and transformative period for the development of public finance in England and for the capital market. What makes this period so interesting is that the perception of a bubble in share prices was so strong that it led to the whole boom being named the South Sea Bubble, and so identifying it as one of the first capital market bubbles. Despite the movement in prices, we do need to consider whether these shifts were a response to changes in underlying fundamentals due to the policy decisions by the companies involved or to some form of exuberance on the part of market participants. In this article, we do not

examine those monied companies involved in the funding of the public debt; rather we analyzed the pattern of share prices for the Royal African Company—a trading company with a checkered past and some aspirations for the future. The market for these shares was liquid and deep. Although market prices change significantly over 1720, under reasonable assumptions, we do not find strong evidence for a bubble in the prices of the senior or engrafted shares. To the extent that our results adequately reflect the behavior of the fundamentals, these results call into question the latest arguments by Chancellor (1999) that the South Sea Bubble was the result of mania and speculative excesses.

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