Cliometrica (2013) 7:61–85
DOI 10.1007/s11698-012-0081-z

ORIGINAL PAPER

Time or spot? A revaluation of Amsterdam market data prior to 1747

Brian Beach · Stephen Norman · Douglas Wills

Received: 29 September 2011 / Accepted: 5 March 2012 / Published online: 18 March 2012

Abstract Scholars historically believed that the market price data reported for Amsterdam markets were spot prices prior to 1747. Neal (The rise of financial capitalism: international capital markets in the Age of Reason. Cambridge University Press, Cambridge, 1990) provided econometric evidence that the prices were time. A newly constructed dataset, containing a much higher frequency of observations from Amsterdam markets, allows us to resolve this dispute. We provide conclusive evidence that the prices report were actually spot, as originally believed.

Keywords Early financial markets · Spot and forward markets

JEL Classification C22 · G14 · N23

1 Introduction

Few economists would dispute the importance of the development of capital markets in London during the eighteenth century which replaced, eventually, Amsterdam as the financial center of the world. There is much less agreement about why and, particularly, the role of the Dutch in the growth of London's financial markets. Dickson (1967) attributed much of the success of this development to Dutch expertise brought over by William in 1688. While consistent with that argument, North and Weingast (1989) placed greater emphasis on the institutional changes brought about from the Glorious Revolution. Larry Neal's seminal work (1990), while largely accepting the Dickson's argument (Carlos and Neal 2011,

B. Beach
University of Pittsburgh, Pittsburgh, PA, USA

S. Norman (✉) · D. Wills
University of Washington, Tacoma, 1900 Commerce St, Tacoma, WA 98402, USA
e-mail: normanse@uw.edu

p. 29), brought empirical rigor to the debate demonstrating how modern and interrelated the London and Amsterdam capital markets were by the early 1700s. Recent scholarship has disputed both the impact of the institutional changes (Sussman and Yafeh 2006) and the role of the Dutch (Murphy 2009). This scholarship has deepened our institutional knowledge not only of London markets but particularly of Amsterdam (Spufford 2006; Pointras 2000, 2009) and the interrelationships of the markets (Koudijs 2011). Another interesting puzzle is how long it took London capital markets to overtake Amsterdam as the latter was important well into the 1700s, long after England had risen to dominance (Israel 1989).

Good empirical data and an understanding of the institutional arrangements that generated such data are an important component of these debates. It is in these areas that this paper makes a contribution. Neal's data set was derived from London's *Course of the Exchange* combined with prices collected by Van Dillen (1931) from the Dutch newspaper *Amsterdamsche Courant*. Data from the latter source were far from complete significantly limiting the number of joint observations, a problem Neal discusses in detail. Recently, numerous additional issues of the *Amsterdamsche Courant* were located by the authors, covering the years 1724–1727, 1730–1737, and 1740–1741. This additional information significantly increases the number of joint observations available, which in turn increases the precision of the empirical results used to analyze relationship between these two markets.

The higher frequency data enable us to resolve an issue related to what the prices reported in Amsterdam actually represented. Van Dillen (1931) argued that prior to 1747, prices were spot and time afterward. Neal (1990), based on the data available at the time, produced evidence that prices were always time, even prior to 1747. This paper conclusively demonstrates that before 1747, the prices reported in Amsterdam were spot, as Van Dillen originally claimed. This issue is important because how prices in the two markets are analyzed depends on whether one is comparing two spot prices or one spot and one time price. Two spot prices can be compared directly, while comparing a spot price to a time price requires that the cost of carry component (compensation to the seller for not being paid immediately) of the time price be accounted for. This issue was addressed in detail in Neal (1990).

2 Market data from the eighteenth century

Prices listed on the London exchange are available from periodical *The Course of the Exchange,* which was published twice a week throughout most of the eighteenth century. Van Dillen (1931) collected prices for Amsterdam from those published in the newspaper *Amsterdamsche Courant.* Unfortunately, data from Van Dillen is less frequent providing, on average, two observations per month. As Neal (1990) reports, this reduced the original 30,000 observations from *The Course of the Exchange* from 1723 to 1794 to only 1679 joint observations. This data set has been the standard in studying the financial market integration between London and Amsterdam since Neal's original work and was later used by researchers, such as Dempster et al. (2000).

Recently, the authors of this paper located original issues of the *Amsterdamsche Courant* covering the years 1724–1727, 1730–1737, and 1740–1741. The prices from Amsterdam were transcribed from these issues of the *Amsterdamsche Courant*. The number of observations in the Van Dillen data set from these years is 317 for both the Bank of England and the East India Company. The newly constructed data set increases the number of observations from this time span by 801 and 802 additional observations for the Bank of England and East India Company, respectively. This yields a total of 1,117 and 1,118 observations for the two stocks and represents more than three times the number of observations from the Amsterdam market for these years compared with using the Van Dillen data during this time period. Figure 1 provides a visual illustration of the increase in Dutch data. The figure plots the Amsterdam stock prices for the Bank of England from 1724 to 1727. The first plot uses the Van Dillen data and the second plot uses the data set constructed by the authors. While the two plots follow the same general pattern, the increase in the number of observations reveals changes in the stock price which are not evident when using the Van Dillen data.

In addition to the new issues of the *Amsterdamsche Courant*, the authors located microfilm copies of *The Course of the Exchange*. This publication reported the London stock prices for both the Bank of England and the East India Company, among other information. The stock price data were transcribed from each newspaper, and a detailed comparison by the authors was made with the newly transcribed data and the data used by Neal. In the case of the Amsterdam stock prices, there were 81 differences between the stock prices in the *Amsterdamsche Courant* and the data used in Neal. About half of these inconsistencies are minor errors related to the date associated with the stock prices. The remaining differences are either errors made by Van Dillen in the original transcription of the data or other errors in recording the data. In the case of the English data, there were 67 differences between the original data and the prices transcribed in the newly constructed data set. While almost all of these differences were relatively minor, the data used in this paper are an improvement over previously used data in that many incorrect transcriptions have been removed.[1]

3 Time or spot?

Trading in British Funds on the Amsterdam exchange was subject to the same trading practices as domestic funds (Wilson 1941). de Pinto (1771) describes how Dutch speculation in British financial securities took place. Pointras (2000) has translated an appendix of de Pinto's *Jue d'Actions en Hollande* containing a very detailed account of how British stocks were traded in Amsterdam. de Pinto writes:

> Trading on the Stock Exchange in Holland is like a wager that is done over a period of three months, without cash outlay, until the rescontre or, in other

[1] The "Appendix" contains more details regarding the discrepancies between previous data sets and the price reported in *The Course of the Exchange* and *Amsterdamsche Courant*.

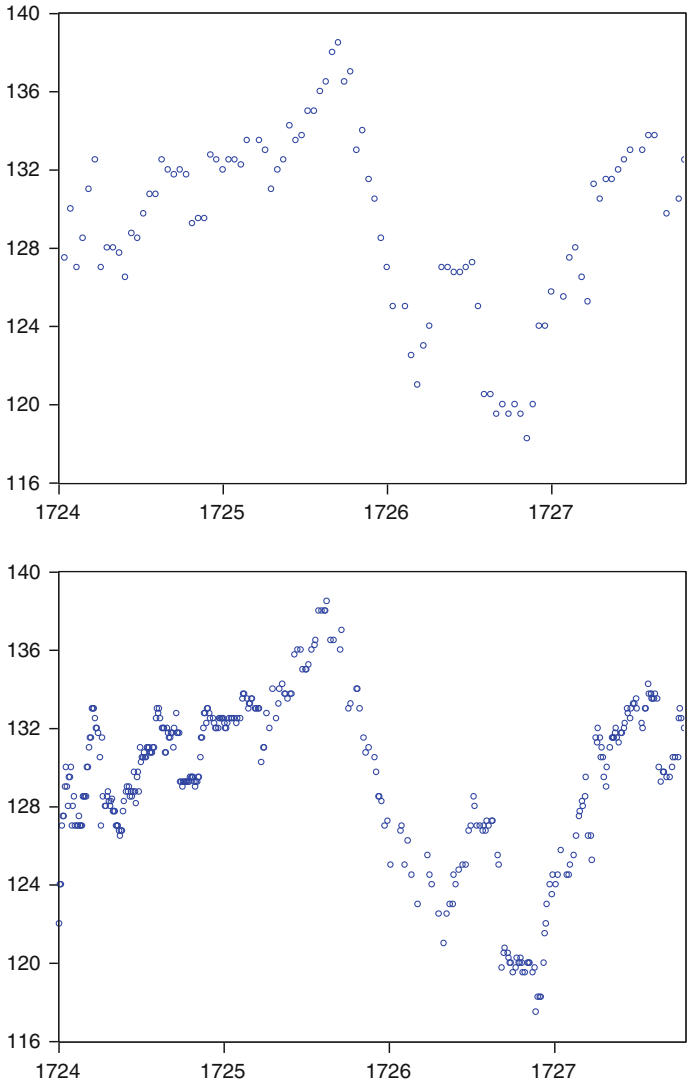

Fig. 1 Dutch price of BOE stock (1724–1727). The *first graph* shows the price of the Bank of England stock as reported in the Amsterdamsche Courant and collected by Van Dillen (1931). The *second plot* shows same price of Bank of England stock in the newly constructed data set by the authors

words, during the term for which the purchase or sale of the stock in the English Funds is made.

rescontre is defined as the term for which we do [forward] purchases or [forward] sales of funds (stocks) and for which we give premiums to receive [puts] on the associated funds or stock.

There are 4 terms in a year at which time we do the rescontre which is like an account balance that is made in order to settle or liquidate a position. Payment

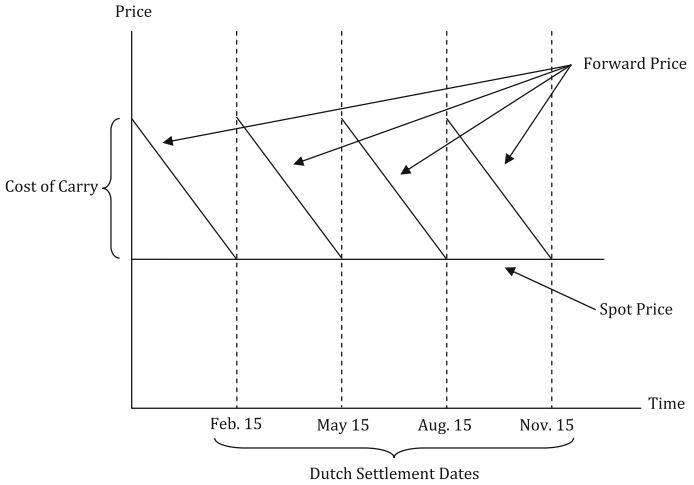

Fig. 2 Relationship between spot and forward prices

is made or received according to a negative or a positive variation in the stock price.

The rescontre or settlement dates for British stocks were adapted from trade in shares of the VOC and occurred on the 15 of February, May, August, and November of each year. These settlement dates were relevant only to time shares that were traded in Amsterdam, as the time shares traded in London were not constrained by the same institutions. Dutch trading of time shares was very popular and in part due to the ability to use shares as collateral for short-term loans (Dickson 1967, p. 335).

There is no dispute that London prices were always spot and that the prices report in Amsterdam after 1747 were time. However, there is disagreement on what was the case prior to that time with Van Dillen asserting the prices were spot. Neal (1990) provided evidence that the prices were time. As he argued, "If the Amsterdam prices quoted on the English securities were for future delivery, then in general they should lie above the London cash prices quoted on the same day," (Neal 1990, p 153). Furthermore, this difference should decrease over time. In equilibrium, ruling out arbitrage opportunities the following relationship holds,

$$F_t = S_t(1 + C)$$

where F_t is the futures price at time t and S_t is the spot, and C can be thought of the cost of carry. In this case, the cost of carry is the compensation to the seller for waiting to be paid represented by the interest rate. As such, the shorter the time period until the settlement date, the lower the value of C.[2] With four settlement dates a year, Fig. 2 depicts the relative price relationship between forward and spot

[2] Negative costs of carry or convenience yields are also a possibility. In this case, the relationship between the number of days until the settlement date and the price difference would be negative. It is unlikely that such a relationship would be a dominant feature of the data of such a long period of time. Nevertheless, the empirical tests in this paper are suited to detect such a relationship.

prices. If the reported Amsterdam prices were time prices, then those prices, relative to London, should rise immediately after settlement dates and then converge, as the date gets closer to the next settlement date.

This relationship between time and spot prices provides two empirical tests of whether the prices reported in Amsterdam were forward or not. First, regressing the Amsterdam price minus the London price on the number of days until the settlement date would determine whether there was evidence of the cost of carry relationship. More specifically, the following regression equation could be used to test the number of days until the settlement date explains the difference in prices between Amsterdam and London,

$$p_t^A - p_t^L = \beta_0 + \beta_1 DSET + \varepsilon_t. \tag{1}$$

Here, p_t^A is the price of the stock in Amsterdam at time t, p_t^L is the price of the stock in London and time t, $DSET$ is the number of days until the next settlement date, while ε_t is the error term at time t. If the estimated coefficient on the number of days until the settlement date was positive and statistically significant, then this would imply that the reported Dutch prices were time not spot.

A second test exploits the fact that the largest difference between the prices, if one was time, would be immediately following the settlement date and the smallest difference would come just before the settlement date. Thus, a simple comparison of means should also indicate whether the Amsterdam prices where spot or time. The following hypothesis test could be used,

$$\begin{array}{l} H_0 : \mu_2 \leq \mu_1 \\ H_1 : \mu_2 > \mu_1 \end{array}, \tag{2}$$

where μ_2 is the mean of the price differences between Amsterdam and London in a period of time after the settlement dates and μ_1 is the mean of the price differences between Amsterdam and London in a period preceding the settlement dates. It would follow then that rejecting the null hypothesis would provide evidence the reported price in Amsterdam was time, not spot.

4 The dividend complication

For the aforementioned two tests to be conducted, one complication must be accounted for in the data, namely the payment of dividends and its effects on the stock prices in both markets. For both the Bank of England and the East India Company, dividends were paid out twice a year, albeit at different times for the separate stocks. The dates were common knowledge and occurred at the same time every year. The owner of a time contract was entitled to any dividend declared while owning the contract (Wilson 1941, p. 99; Pointras 2000). As such, both spot price and time prices would immediately reflect the dividend by permanently falling in value by the amount of the dividend on the day the stock goes ex-dividend (as shown in Fig. 3). After the ex-dividend date, the buyer in either a spot exchange or time contract would have no claim to the declared dividend.

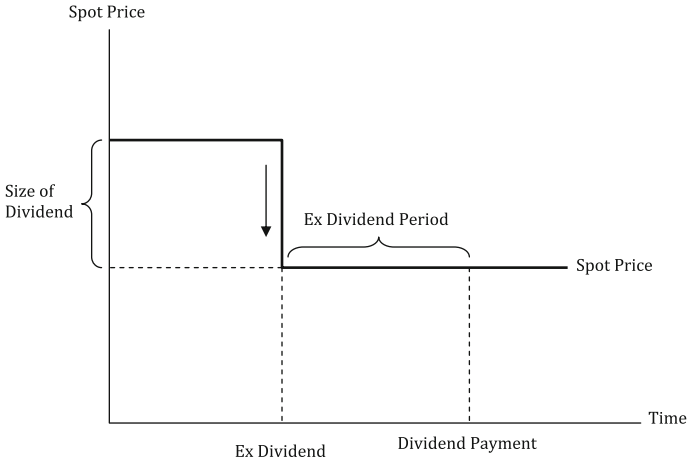

Fig. 3 Effect of dividend payments on spot prices

Preliminary investigation of the data showed that the effect of the dividend payments on both stocks did not occur at the same time in London and Amsterdam. The payment of the dividend was first reflected in the London price, and then, after a period of weeks, the payment was reflected in Amsterdam. Figures 4 and 5 plot the prices of both stocks near the dividend dates. Each line of the graph corresponds to the prices before and after every dividend payment in the data set. The prices were standardized by subtracting the mean of the prices for each dividend and then dividing by the standard deviation of the prices for each dividend. This provides a clearer view of the price changes as some periods were very volatile. The figures show that for both stocks, London price was the first to reflect the payment of the dividend followed by the Amsterdam price. The fact that the London and Amsterdam prices did not reflect the payment of the dividend at the same time caused a very large, but temporary, price difference between the two markets on a regular basis. This can be seen in Fig. 6 which plots the differences in the Amsterdam and London prices near the dividend dates.

There are at least three ways to handle this complication. The cleanest method, and one the new data set allows us to implement, is to simply exclude the time periods in which a dividend was paid. Only using non-dividend time periods allows us to exclude any complicating issues from the dividend and other institutional factors. Also the fact that the new data set has a much higher frequency means that there should be much less concern about eliminating the observations that were affected by the payment of the dividends in the two markets. A second approach would be to include a dummy variable that would control for a dividend period. A third way would be to add back the dividend amounts to prices in both London and Amsterdam at the appropriate times thus eliminating any dividend induced distortions in the price differences between the two markets. The first approach is used in the following section and the latter two approaches are discussed in greater detail later in the paper.

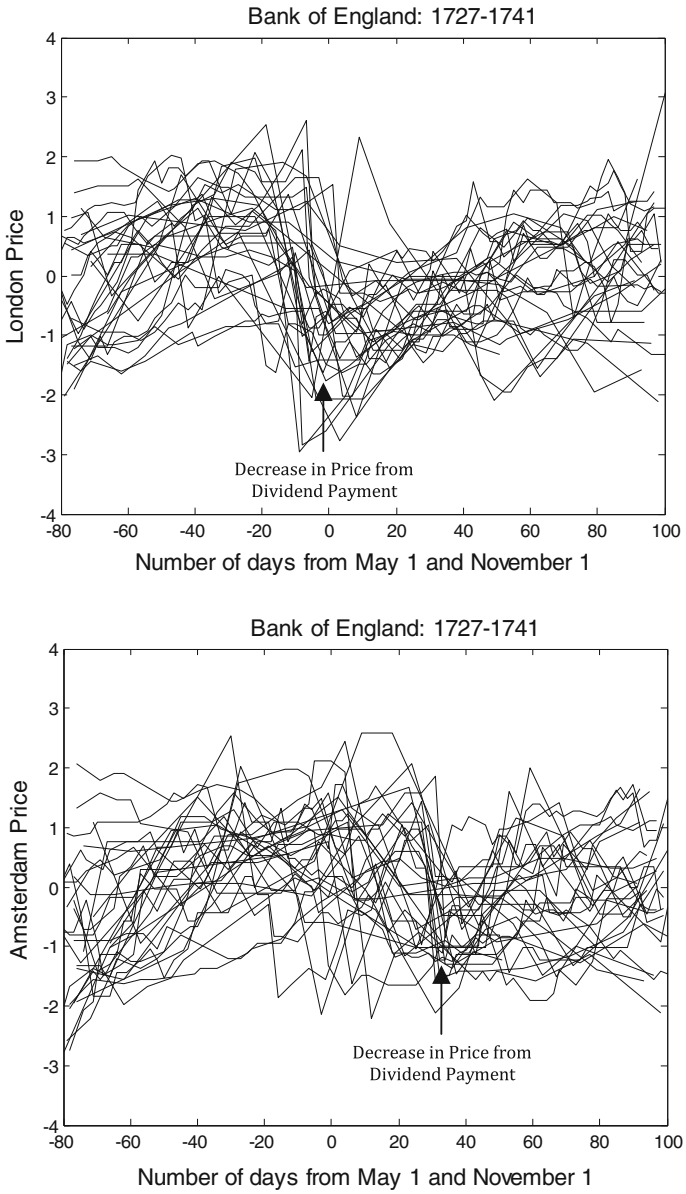

Fig. 4 Standardized BOE prices near dividend payments

5 Testing time versus spot

As discussed above, because there were four settlement dates per year but only two dividends per year, there were 6 months where the difference in prices between the two markets was not affected by the dividend payments in either London or

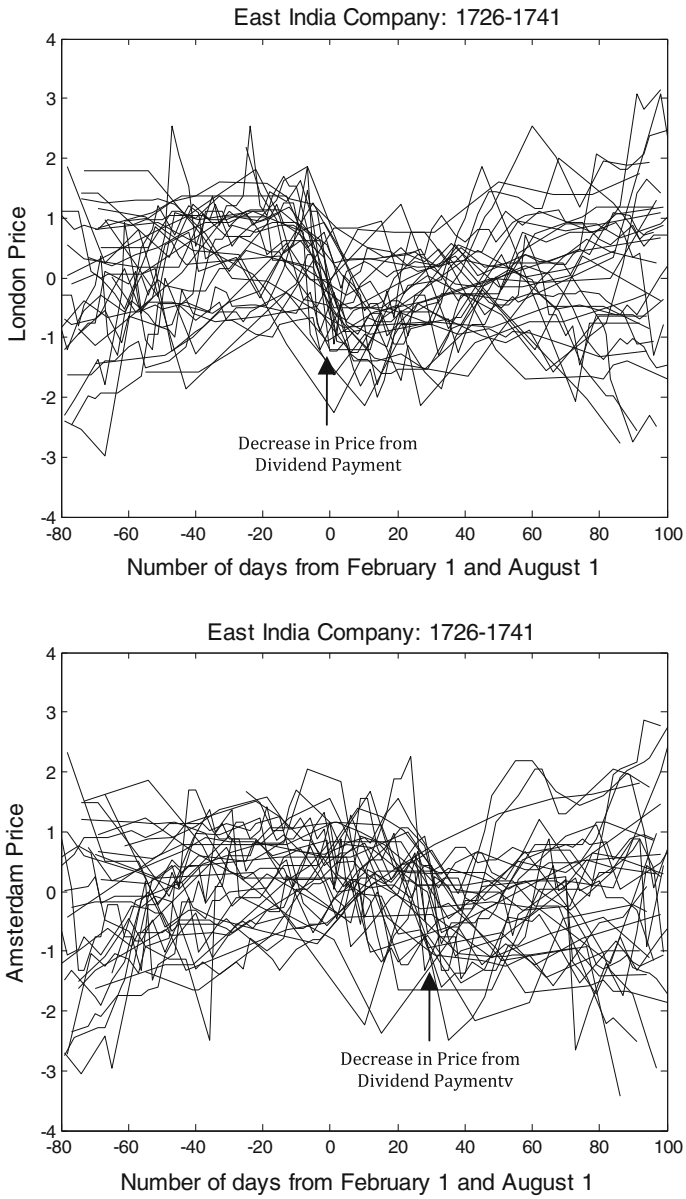

Fig. 5 Standardized EIC prices near dividend payments

Amsterdam. These time months are illustrated in Fig. 7. As a result, if the sample were restricted to the six months with no dividend price effects, there would still be a meaningful amount of variation in *DSET* that would be able to explain the price differences. Figure 8 plots the price differences between versus the days until the settlement dates using only data from non-dividend months. It is clear that there is a

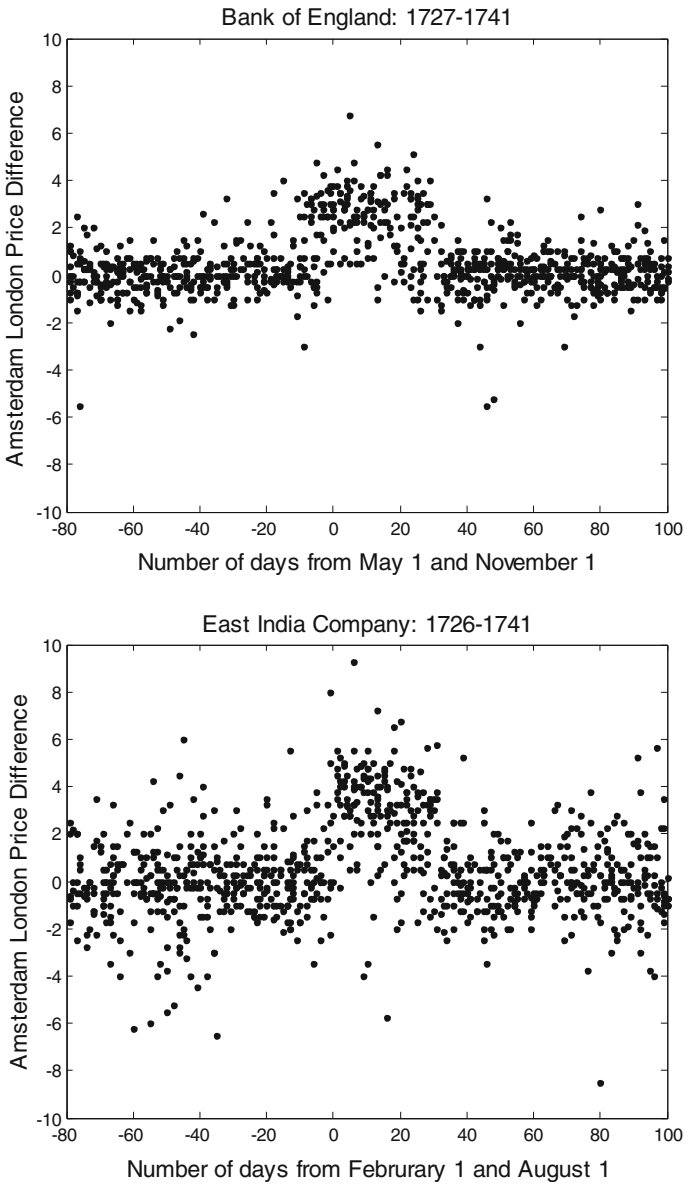

Fig. 6 Price differences near dividend payments

wide variation in the number of days until the next settlement date. Thus, if there is any relationship between the price difference and the number of days until the settlement date, the variation in the explanatory variable should not prevent the relationship from being detected. The regression from (1) was estimated using the

Bank of England (Beginning in 1727)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
			D	D	D				D	D	D
	S			S			S			S	

East India Company (Beginning in 1724)											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
D	D	D				D	D	D			
	S			S			S			S	

Fig. 7 Months affected by dividend payments and settlement periods. The letter "D" indicates months observed in the data where the London price has decreased because of the dividend but the Amsterdam price has not yet dropped. The letter "S" indicates months where the settlement dates occurred. For the Bank of England between 1724 and the first half of 1726 the ex-dividend periods began to be quoted at the end of March and September. This changed in the latter half of 1726, when the ex-dividend prices were found starting near the end of April and October. In the case of the East India Company, the ex-dividend periods began in the middle of January and July for the years 1724 and 1725. From 1726 on the ex-dividend periods started at the end of January and July

data from the months reported in Fig. 7.[3] The results of the regression estimation are reported in Table 1. The number of days until the settlement date shows no sign of explaining the price differences in either stock price suggesting that the Amsterdam prices were spot.

If the Amsterdam prices were time, then it would be possible to calculate the size of β_1 in (1) based upon the interest rates in Amsterdam in the 1700s. The average Dutch share price of BOE and EIC during our sample is about £140 and £160, respectively. Assuming an interest rate of 3 % (see Homer and Sylla 2005, p. 173), the daily cost of carry would be approximately £0.012 and £0.013 for each stock.[4] The t statistics reported in Table 1 are based upon the null hypothesis that $\beta_1 = 0$. An alternative specification for the null hypothesis test could be that $\beta_1 \geq 0.01$. In other words, the default assumption could also be that the Dutch price is time. An important question would then be if this null hypothesis could be rejected, suggesting that the Dutch price is spot. It may be that the standard error on the estimate of β_1 is so large that neither null hypothesis can be rejected.[5] The 95 % confidence interval for the estimate of β_1 is $[-5.27 \times 10^{-3}, 2.49 \times 10^{-3}]$ and $[-1.13 \times 10^{-2}, 1.95 \times 10^{-3}]$ for BOE and EIC, respectively. The upper bound on each confidence interval is well below the implied daily cost of carry values. In fact, the Dutch interest rate would have to be approximately one half of one percent before the daily cost of carry would lie within the estimated confidence intervals. As such the null hypothesis that $\beta_1 \geq 0.01$ can be rejected, again suggesting that the reported Dutch prices were not time.

[3] All regressions estimated in this paper use Newey–West standard errors which correct the standard errors of the estimates for the presence of autocorrelation and heteroskedasticity.

[4] The daily cost of carry is found by multiplying the annual interest rate by the share price and dividing by the number of days in a year.

[5] We thank an anonymous referee for pointing this possibility out to us.

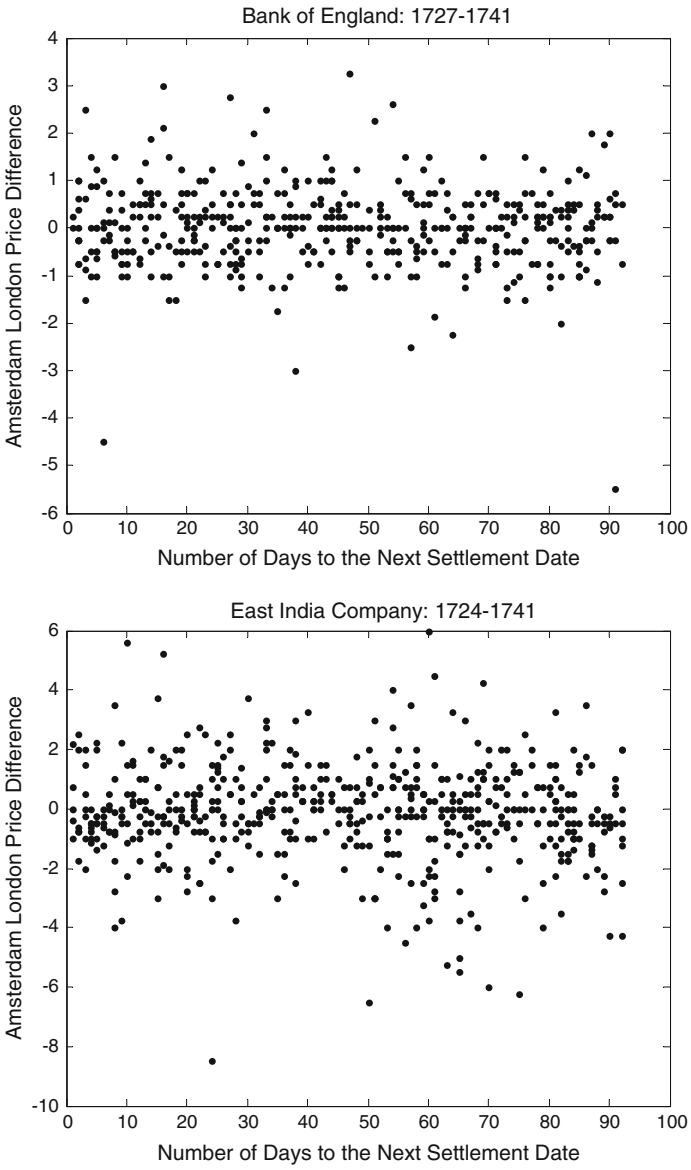

Fig. 8 Price differences (non-dividend months, pre 1747)

If the regression in (1) is a valid test of determining whether Dutch prices were time or spot, the same regression used with prices after 1747 should provide evidence of time prices reported in Amsterdam. The price differences and number of days until the next settlement date are plotted in Fig. 9 using the data from Neal (1990) for the years 1747–1794 for the months that were not affected by the dividend payment. Compared with Fig. 8, there is a clear positive relationship

Table 1 Regression results based upon non-dividend months (pre 1747)

Variable	BOE (1727–1741)	EIC (1724–1741)
DSET	-1.39×10^{-3}	-4.71×10^{-3}
	(1.97×10^{-3})	(3.39×10^{-3})
	$[-5.27 \times 10^{-3}, 2.49 \times 10^{-3}]$	$[-1.13 \times 10^{-2}, 1.95 \times 10^{-3}]$
Constant	0.08	0.08
	(0.11)	(0.19)
Obs	457	544
R^2	0.00	0.01

The dependent variable in each case is the Amsterdam price minus the London price. Numbers in parentheses are the absolute value of the t ratios which are based upon Newey–West standard errors. Numbers in square brackets are 95 % confidence intervals. *DSET* is the number of days until the settlement date

between the two variables. The same post-1747 data were used to estimate (1), and the results of the regression can be found in Table 2. In both cases, the number of days until the dividend date is statistically significant. The average stock price for BOE and EIC over this time period was about 137 and 170, respectively. Using an interest rate of 3 %, the implied daily cost of carry values for BOE and EIC would be £0.011 and £0.014. The estimates from the regression are very close to the implied values. This shows that the regression in (1) is able to detect the cost of carry relationship that stems from comparing time and spot prices. Thus, if the relationship existed before 1747, the regression should have been able to find evidence in support of Dutch reported time prices.[6]

As stated previously, if London reported spot prices and the Dutch prices were time, then the largest price difference should be right after the settlement date and the smallest price difference should be right before the settlement date. The hypothesis test set forth in (2) was tested. Again, to ensure that the dividend payments did not affect this hypothesis test, only months which were not affected by the price decreases associated with the dividend payments were considered. The results of the hypothesis tests are provided in Table 3 where 15 and 30 days from the settlement date were considered. In all cases, the average price difference is actually larger in the periods before the settlement date which actually makes the estimating the t statistic unnecessary. Given that the estimated values of μ_2 are all less than μ_1, the claim that $\mu_2 > \mu_1$ will never be accepted. This evidence further supports the proposition that both Amsterdam and London reported spot prices. The same test was applied to the data from 1747 to 1794. The results are reported in Table 4. In all cases, there is strong evidence suggesting that the price differences were larger right after the settlement date compared with the price differences preceding the settlement date.

[6] It should also be noted that the number of observations use in the regressions in Tables 1 and 2 are roughly the same even though the second covers more than twice the number of years. This is a result of the higher frequency of observations in the newly constructed data set. This implies that any difference in the results cannot be attributed to a difference in sample size.

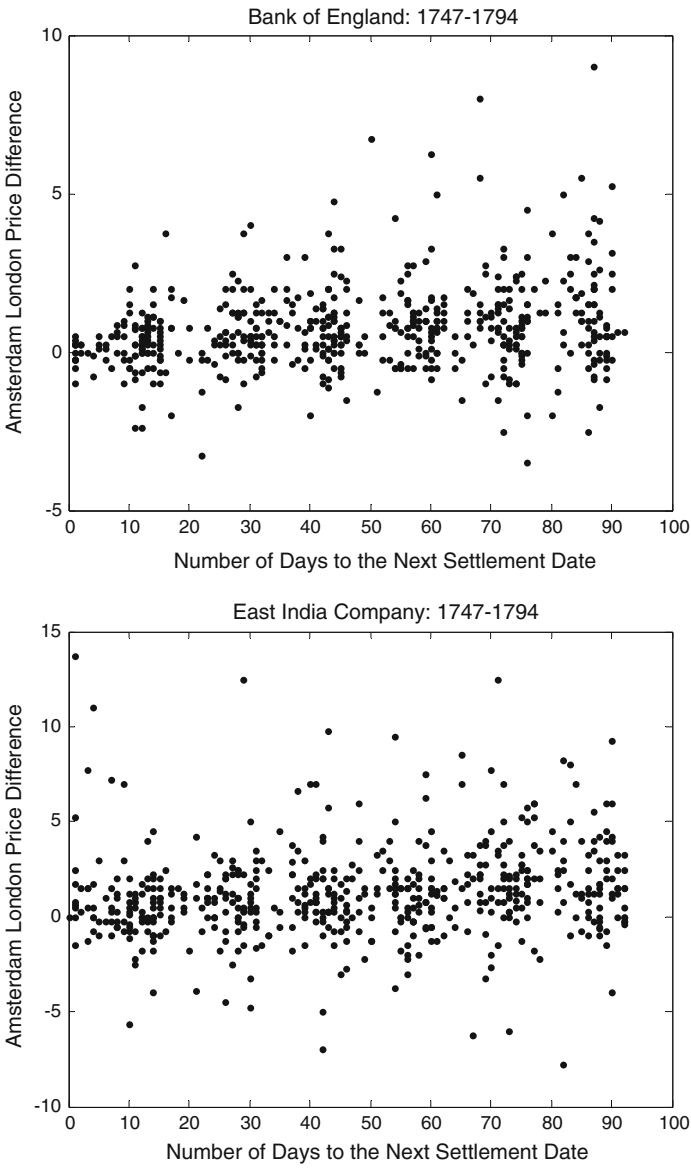

Fig. 9 Price differences (non-dividend months, post 1747)

This collection of results strongly suggests that the prices which were reported in Amsterdam were spot prices, not time. This is consistent with Van Dillen who reported that "…in comparing [the prices recorded in the *Amsterdamsche Courant*] with those found in brokers' notes preserved from 1725 to 1737 it appears that in that period the quotations are cash prices. In the year 1747 both prices are

Table 2 Regression results based upon non-dividend months (1747–1794)

Variable	BOE	EIC
DSET	1.17×10^{-2}***	1.46×10^{-2}***
	(2.22×10^{-3})	(5.02×10^{-3})
	$[7.38 \times 10^{-3}, 1.61 \times 10^{-2}]$	$[4.78 \times 10^{-3}, 2.45 \times 10^{-2}]$
Constant	0.17*	0.55**
	(0.10)	(0.24)
Obs	564	558
R^2	0.04	0.03

The dependent variable in each case is the Amsterdam price minus the London price. Numbers in parentheses are the absolute value of the t ratios which are based upon Newey–West standard errors. Numbers in square brackets are 95 % confidence intervals. *DSET* is the number of days until the settlement date

***, **, * Significance at the 1, 5, and 10 % level, respectively

Table 3 Comparison of means before and after settlement dates (1724–1741)

	15 Days before and after the settlement date		30 Days before and after the settlement date	
	BOE	EIC	BOE	EIC
μ_2	−0.08	−0.45	−0.09	−0.30
μ_1	-8.99×10^{-4}	−0.07	0.02	−0.06
$\mu_2 - \mu_1$	-7.51×10^{-2}	−0.38	−0.11	−0.23
t	−0.49	−1.68	−1.16	−1.33
	[0.68]	[0.95]	[0.88]	[0.91]
Obs_2	74	83	144	174
Obs_1	79	85	159	179

μ_2 and μ_1 are the mean of the Amsterdam price minus the London price after and before the settlement date, respectively. The t statistic is calculated assuming the two periods have unequal variances. The values in square brackets are the p value of the associated t statistic. Only observations from non-dividend affected months were considered

sometimes mentioned. After this year we find generally the forward rates."[7] This allows researchers who are analyzing the price difference in these two markets before 1747 to compare priced directly given that they are both spot. Prices post 1747 must be analyzed is a way that takes into account the cost of carry relationship between spot and time prices which were present in that time period.

[7] This same quotation is used in Neal (1990, p. 153), but there is one error. The sentence, "In the year 1747 both prices are sometimes mentioned." is reported in Neal with the year 1737 instead of 1747. An inspection of Van Dillen (1931) confirms that 1747 is the first year than Van Dillen reported observing time prices, not 1737.

Table 4 Comparison of means before and after settlement dates (1747–1794)

	15 Days before and after the settlement date		30 Days before and after the settlement date	
	BOE	EIC	BOE	EIC
μ_2	1.25	1.82	1.10	1.89
μ_1	0.21	0.82	0.33	0.82
$\mu_2 - \mu_1$	1.04	1.00	0.76	1.08
t	5.27	2.55	5.36	4.07
	[0.00]	[0.01]	[0.00]	[0.00]
Obs_2	93	84	196	180
Obs_1	90	93	159	174

μ_2 and μ_1 are the mean of the Amsterdam price minus the London price after and before the settlement date, respectively. The t statistic is calculated assuming the two periods have unequal variances. The values in square brackets are the p value of the associated t statistic. Only observations from non-dividend affected months were considered

6 Controlling for the dividend effects

As mentioned previously, there are at least two possible methods of controlling for the large price differences caused by the lag in the dividend effects between the two markets. First, a dummy variable could be used to control for this period. The other option is to add the dividends back into both the London and Amsterdam prices. Figure 10 demonstrates this method of adjusting for the different dividend effects where one market reports spot prices and the other market reports time prices and there is a lag in the effect of the dividend. The dividend effect is reversed by adding the amount of the dividend to each stock price. The difference between the adjusted prices then only reflects the compensation that sellers in the forward market would require for being paid at a later date.

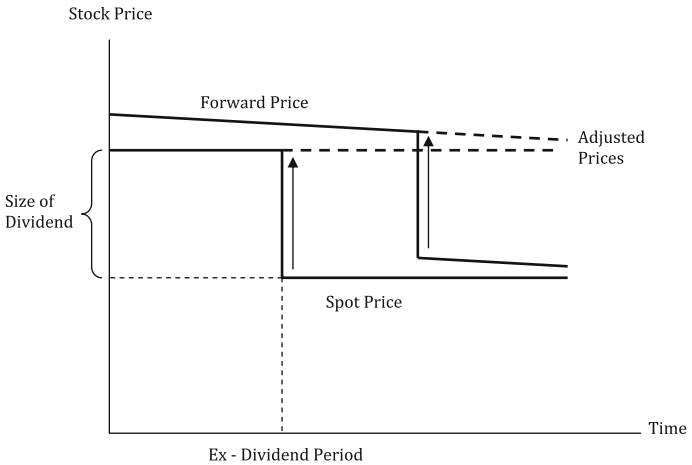

Fig. 10 Adding dividends back into stock prices

Econometrically, these two approaches are very similar and should lead to similar results. A major advantage of the second approach is that because the value of the dividend is known, it does not need to be estimated. By adding back the dividends into the stock prices, the dividend effect is controlled for precisely. If a dummy variable was used to control for the dividend payments, the effect of the dividend on the prices would have to be estimated. As a result, the dividend effect would be controlled for imprecisely given the nature of statistical estimation. For these reasons, the first approach is not used in this paper. To control for the dividend effects, the amount of the dividend is added back into the prices following the approach in Fig. 10.

While no information is available regarding the timing of the effect of the dividend payments on the Amsterdam prices, these dates can be inferred by identifying the observations near the London dividend date when the Dutch price drops by the amount of the dividend. Given that the dividend payments were relatively large compared with the distribution of price changes in the two stocks, the difference in the time that the payment of the dividends affected the stock prices in the two markets can be identified by analyzing the difference in prices between Amsterdam and London.

Again, Fig. 6 plots the price differences for the Bank of England and the East India Company right before and after the start of the ex-dividend periods. Given that the price differences are the Amsterdam prices minus the London prices, it is clear that the Amsterdam prices reflected the payment of the dividend after the London price. The lag appears to be around 30–40 days in each case.[8] The dividends for the Bank of England for this period were either 3 or 2.75 pounds, and for the East India Company, the dividends were either 4 or 3.5 pounds. Both of these dividend amounts are reflected in the large price differences depicted in Fig. 6. The price differences near the ex-dividend dates based upon the stock prices with the dividend payments added back into the prices are plotted in Fig. 11. Compared with Fig. 6, where the prices have not been adjusted for the dividend payments, the price differences appear to be much more uniform in behavior.

Table 5 reports the regression results using the full data set (all months) from 1724 through 1741 where the stock prices have been adjusted for the dividends by adding the dividends back into the prices. In both cases, the number of days until the next settlement date is not significant. Table 6 contains the results of the test of difference of means for using the full data set after adjusting for the dividend effects; again, there is no evidence of the cost of carry relationship.

[8] It should also be remembered the payment of the dividend in London did not take place until about 2 weeks after the beginning of the ex-dividend period. Thus, the time between the actual payment of the dividend and when the dividend was reflected in the Dutch prices was 2–3 weeks. The dates of the dividend payments were common knowledge and the actual size of the dividend payments varied little. This would suggest that the lag was not associated with any delay in information transmission between the two markets. The most likely source of the lag was some institutional arrangement in Amsterdam which determined time when a buyer was entitled to the dividend and when the dividend belonged to the seller.

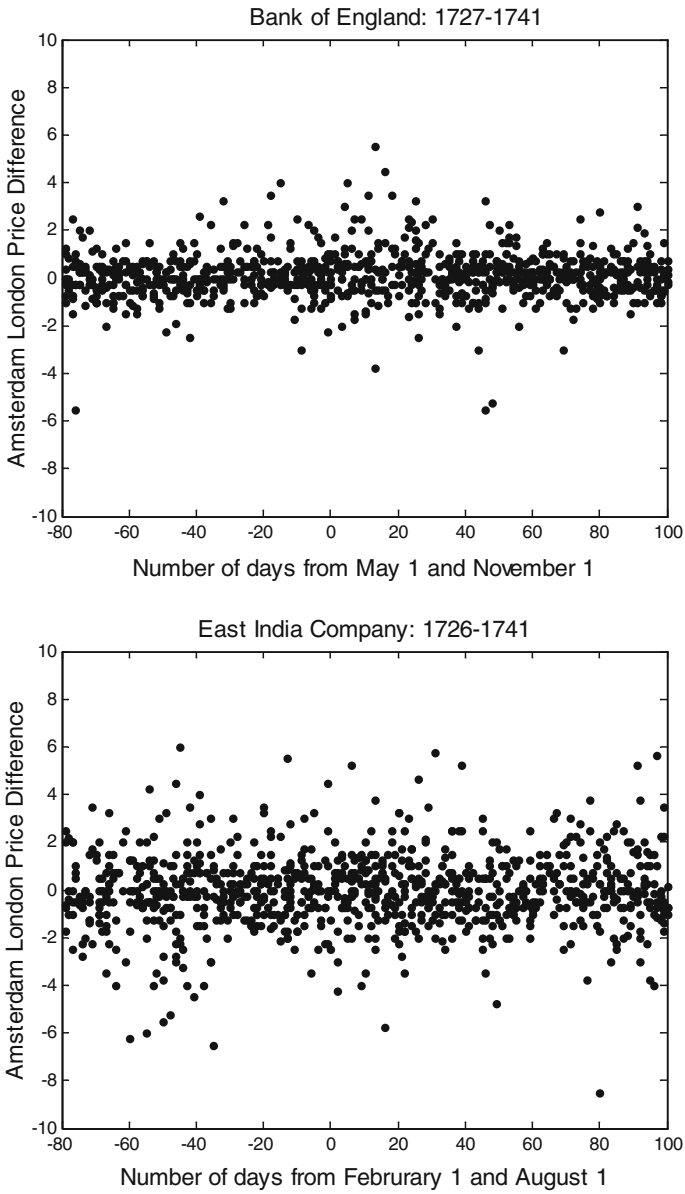

Fig. 11 Price differences with dividends added

In other words, after controlling for the payment of the dividends in both markets and using price date from all months of the year, there is no evidence that Amsterdam prices were time. This confirms the results of the previous section and again provides evidence that the Dutch prices during this time period were spot.

Table 5 Regression results—prices with dividends added back (1724–1741)

Variable	BOE	EIC
DSET	-1.34×10^{-3}	-3.21×10^{-3}
	(1.53×10^{-3})	(2.30×10^{-3})
	$[-4.33 \times 10^{-3}, 1.66 \times 10^{-3}]$	$[-7.73 \times 10^{-3}, 1.31 \times 10^{-3}]$
Constant	0.17	0.09
	(0.10)	(0.13)
Obs	1159	1138
R^2	0.00	0.00

The dependent variable in each case is the Amsterdam price minus the London price. Numbers in parentheses are the absolute value of the t ratios which are based upon Newey–West standard errors. Numbers in square brackets are 95 % confidence intervals. *DSET* is the number of days until the settlement date

Table 6 Comparison of means—prices with dividends added back (1724–1741)

	15 Days before and after the settlement date		30 Days before and after the settlement date	
	BOE	EIC	BOE	EIC
μ_2	0.61	0.77	0.33	0.44
μ_1	0.98	1.49	0.81	0.97
$\mu_2 - \mu_1$	−0.37	−0.72	−0.48	−0.53
t	−2.22	−2.96	−4.68	−3.32
	[0.99]	[0.99]	[0.99]	[0.99]
Obs_2	177	177	363	361
Obs_1	185	186	391	385

μ_2 and μ_1 are the mean of the Amsterdam price minus the London price after and before the settlement date, respectively. The t statistic is calculated assuming the two periods have unequal variances. The values in square brackets are the p value of the associated t statistic. Only observations from nondividend affected months were considered

7 Comparison with Neal (1990)

Neal (1990) contains an interesting result that does not coincide with the cost of carry model of spot and time prices. Neal concluded that the Amsterdam prices were time because he found the number of days until the dividend payment to be statistically significant in explaining the difference between the two prices. It is not clear why Neal used the days to the dividend payment, instead of the days until the settlement day, to test whether the prices reported in the *Amsterdamsche Courant* were spot or time. Nevertheless, Neal found the number of days until the dividend payment to be very statistically significant in all of the reported regressions. This result does not follow from the theoretical relationship between spot and time prices and should be explained in light of the previous results of this paper.

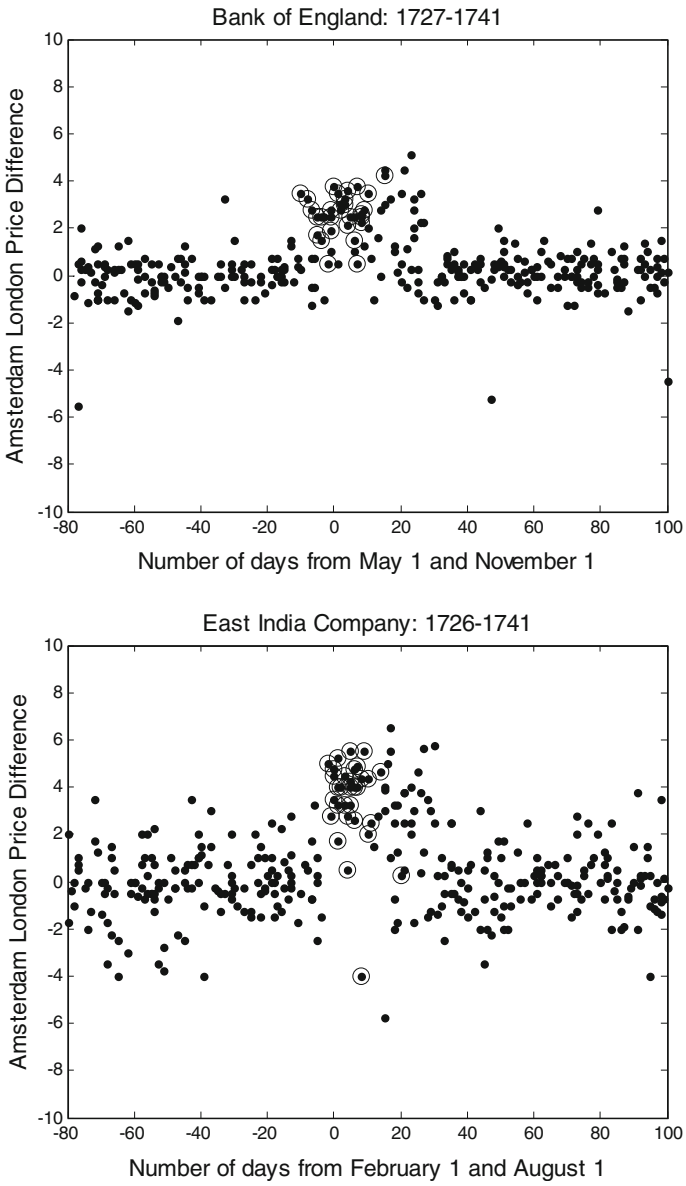

Fig. 12 Price differences with Neal's ex-dividend period observations

The dummy variable Neal used to control for the ex-dividend period was "set to unity for the first observation after the ex-dividend quotes begin in London" (Neal 1990, p. 160). Based upon this variable definition, Fig. 12 plots the price differences between London and Amsterdam for the Bank of England and the East India Company using the data employed by Neal. The observations which are circled are the first observation after the beginning of the ex-dividend period. The length of the

Table 7 Regression results based on the observations used in Neal

Variable	Unadjusted data		Dividends added	
	BOE	EIC	BOE	EIC
DDIV	4.81×10^{-3}	7.01×10^{-3}	1.07×10^{-3}	4.95×10^{-4}
	(3.82)***	(3.24)***	(0.94)	(0.22)
DSET	5.02×10^{-4}	2.66×10^{-3}	-8.63×10^{-5}	-2.34×10^{-3}
	(0.21)	(0.64)	(0.03)	(0.62)
EXDIV	1.92	2.76	−0.20	0.22
	(7.99)***	(6.77)***	(0.79)	(0.62)
Constant	−0.22	−0.58	−0.01	0.00
	(1.53)	(2.13)**	(0.07)	(0.02)
Obs	403	399	403	399
R^2	0.28	0.25	0.00	0.01

The dependent variable in each case is the Amsterdam price minus the London price. Numbers in parentheses are the absolute value of the *t* ratios which are based upon Newey–West standard errors. *DDIV* is the number of days until the dividend payment, *DSET* is the number of days until the settlement date, and *EXDIV* is Neal's dummy variable to control for the ex-dividend period in London

***, ** denote significance at the 1, 5, and 10 % level, respectively

time between when the price in London reflects the dividend and when it is reflected in the Amsterdam price is about 30 days. Unfortunately, the dummy variable Neal uses only controls for half of this period. As such, the dummy variable does not pick up the entire impact of the dividend.

The days to dividend variable was defined by Neal (1990, p. 160) to be, "the number of days from the given date to the day of the first ex-dividend quote appeared in the *Course of the Exchange*." Given this information, one possible reason for Neal's finding that the days until the dividend payment was statistically significant is that the Neal's ex-dividend dummy variable did not fully control for the difference in the effect of the of the dividend payments in the two markets. Because the days to dividend variable starts at the beginning of the ex-dividend period and counts down to zero, the large values for that variable are associated with the large price differences that are not fully controlled for using Neal's ex-dividend dummy variable. This positive relationship could be large enough to cause the coefficient on the dividend variable in the estimated regression to be statistically significant.

The following regression equation was used to test whether *DDIV*, the number of days to the dividend, payment helps explain the difference in prices between Amsterdam and London,

$$p_t^A - p_t^L = \beta_0 + \beta_1 DDIV + \beta_2 DSET + \beta_3 EXDIV + \varepsilon_t. \quad (3)$$

If the estimated coefficient on *DDIV* is statistically significant, then this would confirm Neal's result that the days to the dividend payment is a valid explanatory variable. Following Neal, the variable *EXDIV* is a dummy variable for the first

Table 8 Regression results based upon the new data set

Variable	Full data set with dividends added	
	BOE	EIC
DDIV	9.87×10^{-4}	8.68×10^{-4}
	(1.06)	(0.67)
DSET	-1.50×10^{-3}	-2.99×10^{-3}
	(0.97)	(1.26)
EXDIV	−0.26	0.18
	(1.14)	(0.78)
Constant	0.09	−0.01
	(0.72)	(0.05)
Obs	1159	1138
R^2	0.00	0.00

Numbers in parentheses are the absolute value of the *t* ratios which are based upon Newey–West standard errors. *DDIV* is the number of days until the dividend payment, *DSET* is the number of days until the settlement date, and *EXDIV* is Neal's dummy variable to control for the ex-dividend period in London

observation after the beginning of the ex-dividend period in London.[9] To begin, in an attempt to reproduce the results of Neal, only the observations that were available to Neal were used to estimate (3). The results in the first two columns of Table 7 show that like Neal, the number of days to the dividend (*DDIV*) and Neal's ex-dividend period dummy variable (*EXDIV*) are very statistically significant. In order to test the premise that the *DDIV* is statistically significant because *EXDIV* is misspecified, the same regression was estimated using the same data where the dividends were added back into the stock prices. The second two columns of Table 7 show that once the dividends have been added back into the stock prices, neither *DDIV* nor *EXDIV* are statistically significant. This suggests that the result in Neal (1990) is a result of not fully controlling for the dividend effects.

It is also possible that the size of the sample might cause *DDIV* to be insignificant even when there might be a relationship between this variable and the price differences between Amsterdam and London. In other words, these two variables might really be related to the price differences but, with the data available to Neal, there might have not been enough observations to detect the relationship. To address this concern, the additional data constructed for this paper were used to estimate the regression specified in (3). The stock prices were adjusted for the difference in the effect of the dividend payments between the two markets by adding the dividends back into the stock prices. Table 8 reports the results of the regression estimation with almost three times as many observations used in these regressions compared with the data available to Neal covering this time period. The results of the estimation remain unchanged. Neither *DDIV* nor *DSET* are statistically significant in the case of both stock prices.

[9] Neal (1990) also includes a variable for the Dutch/English exchange rate. Given that market integration is not the focus of this paper and the fact that the exchange rate is likely uncorrelated with the explanatory variables used, the exchange rate variable was not used in this regression.

8 Conclusion

This paper contributes to the ongoing research relating to the relationship between the early financial markets in London and Amsterdam. Specifically, it has been shown that the prices of stock in the Bank of England and the East India Company traded in Amsterdam before 1747 were almost certainly reported as spot, not time. This result allows future researchers to appropriately model the prices in the two markets when addressing issues of financial market integration. The newly constructed data set in this paper, which contains higher frequency data when compared with previously used data, means that the empirical results contained here cannot be attributed to lack of statistical precision.

This paper also has made a contribution to the knowledge of the institutional characteristics of these two markets. Specifically, it has been shown that the effect of the dividend payments in these two markets resulted in large, albeit temporary, price differences which must be taken into account. A method of controlling for this dividend effect was described and implemented using the new data set. It was also shown that not correctly controlling for the dividend payments resulted in a spurious relationship relating to the price differences in these to markets.

Using this new data set and the institutional knowledge provided in this paper, future research can now focus on the nature of the financial market integration between Amsterdam and London. Information flows between the two markets could quiet possibly now be identified. It would be enlightening to identify how much of a role, if any, Amsterdam play in determining the prices of these jointly traded stocks.

Acknowledgments We would like to that Larry Neal and Peter Koudijs for help in located the data used in this paper. We are also grateful from the comments of the participants at the Western Economic Association International Annual conference and to the detailed comments from two anonymous referees. We would also like to acknowledge the excellent research assistance provided by Nicholas Lacsina. Much of Brian Beach's work on this paper was done while he was an undergraduate student at the University of Washington Tacoma.

Appendix: Data

Comparing photographed original issues of the Amsterdamsche Courant with the data sets constructed by Van Dillen and Neal reveals 86 differences between the stock prices published in the Dutch newspaper and the transcribed prices. Of those differences, 28 appear to be incorrect transcriptions made by Neal from the Van Dillen data set. Most of these differences are relatively small with the average difference being less than one pound. There were sixteen cases where Van Dillen's transcription differs from the published prices. The average price difference in those cases was 1.23. There were also 17 dates where the date of the stock price in the Van Dillen data set did not match the data from the Amsterdamsche Courant. In almost all of those cases the date was only off by a single day. In six cases, it appears the Neal incorrectly copied dates from the Van Dillen data. More puzzling was once date where Van Dillen has Dutch price information for the Bank of England and the East India Company, but the authors were not able to locate and

Table 9 Corrected outliers

Stock	Location	Date	Previous reported price	Reported price	Subsequent reported price	Adjusted price
BOE	London	3/14/1724	129.5	139.75	133	129.75
EIC	Amsterdam	10/13/1724	148.5	119	148	149
BOE	Amsterdam	5/11/1733	151.5	160	149.75[a]	151
EIC	Amsterdam	5/11/1733	161	151	161	160
BOE	Amsterdam	6/1/1733	151[a]	169.75	150	149.75
EIC	Amsterdam	6/6/1725	167	154.5	163.5	164.5
BOE	Amsterdam	3/21/1735	140.75	147.75	140.25	141.5
EIC	Amsterdam	3/21/1735	148.5	141.5	147.5	147.75
EIC	Amsterdam	6/6/1735	149.5	143.25	149.75	149.25
BOE	Amsterdam	9/18/1739	138	151.75	139	137.25
EIC	Amsterdam	9/18/1739	156	137.25	154	151.75

[a] Previous or subsequent prices which are also prices which have been adjusted

stock price information in the *Amsterdamsche Courant*. It is possible that those prices were obtained from another source.

The stock prices that Neal transcribed from *The Course of the Exchange* were also compared with microfilm copies of the British publication. From over 4,100 days with recorded prices, there were 67 incorrect prices in the Neal data set. There were also 21 cases where *The Course of the Exchange* reported "Nothing Done" and the Neal data set contained the most recent stock price. It is not clear what "Nothing Done" was intended to indicate. It is likely that this mean that, while the markets were open, no trading took place that day. Given the ambiguity, the decision was made to identify those cases as not having a reported price available instead of following Neal and using the previous price.

An inspection of the data revealed eleven outliers. The table below contains the date, the previous and subsequent prices, and the reported price. The final column contains the price which was adjusted to the most likely value considering the previous and subsequent prices. In all cases only a single numeral was changed to arrive at the adjusted price. The exceptions are the observations from 5/11/1733, 3/21/1735, 9/18/1739 where it appears that the prices from the Bank of England and the East India Company were substituted for each other (see Table 9).

References

Carlos AM, Neal L (2011) Amsterdam and London as financial centers in the eighteen century. Financial Hist Rev 18(1):21–46

de Pinto I (1771) Jue d'Actions en Hollande, Amsterdam (trans: G Pointras) (2000); reprinted by Gregg International Publishers (1969)

Dempster G, Wells J, Wills D (2000) Common features analysis of Amsterdam and London financial markets during the 18th century. Econ Inq 38:19–33

Dickson PGM (1967) The financial revolution in England. Macmillan Press, London
Homer S, Sylla R (2005) A history of interest rates. Rutgers University Press, Piscataway
Israel J (1989) Dutch primacy in world trade 1585–1740. Oxford University Press, Oxford
Koudijs P (2011) The boats that did not sail: news, trading and asset price volatility in a natural experiment. Unpublished paper, Stanford Graduate School of Business
Murphy A (2009) The origins of English financial markets. Cambridge University Press, Cambridge
Neal L (1990) The rise of financial capitalism: International capital markets in the age of reason. Cambridge University Press, Cambridge
North D, Weingast B (1989) Constitutions and commitment: the evolution of institutions governing public choice in seventeenth-century Britain. J Econ Hist 49(4):803–832
Pointras G (2000) The early history of financial economics, 1478–1776. Edward Elgar Publishing, Aldershot, pp 11–50
Pointras G (2009) From Antwerp to Chicago: the history of exchange traded derivative security contracts. Revue d'Histoire des Sciences Humaines 20
Spufford P (2006) From Antwerp and Amsterdam to London: the decline of financial centers in Europe. De Economist 154(2):143–175
Sussman N, Yafeh Y (2006) Institutional reforms, financial development and sovereign debt: Britain 1690–1790. J Econ Hist 66(5):906–935
Van Dillen JG (1931) Effectenkoersen aan de Amsterdamsche beurs 1723–1794. Economisch-historisch Jaarboek 17:1–46
Wilson CW (1941) Anglo-Dutch commerce and finance in the eighteenth century. Cambridge University Press, Cambridge