

STX

77 COPY 2



BEBR

FACULTY WORKING
PAPER NO. 1177

The Integration and Efficiency of the
London and Amsterdam Stock Markets in
The Eighteenth Century

Larry Neal

BEBR

FACULTY WORKING PAPER NO. 1177

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

September, 1985

The Integration and Efficiency of the London and Amsterdam Stock Markets in the Eighteenth Century

Larry Neal, Professor
Department of Economics

The author acknowledges with gratitude helpful comments on earlier drafts by George Alter, Jeremy Atack, Robert Eagly, Barry Eichengreen, John James, Donald McCloskey, John McCusker, and James Riley as well as discussants in seminars at the University of Chicago, University of Illinois and Indiana University. Research support was given by the Research Board and the Bureau of Economic Research of the University of Illinois and the National Science Foundation, (SES 83-09211).



Digitized by the Internet Archive
in 2011 with funding from
University of Illinois Urbana-Champaign

ABSTRACT

In the early eighteenth century, a special form of economic integration occurred between the two leading mercantile cities of Europe, Amsterdam and London. An international capital market developed, the significance of which has been largely overlooked in the more recent historical and the economic literature. This paper lays the basis for a greater appreciation of the role of this early international capital market in particular, and such markets in general, by explaining its operation in theoretical terms and analyzing its results in quantitative terms.

It concludes that these two markets were efficient and well-integrated from the second quarter of the eighteenth century on. The spot prices quoted in the London market followed a random walk process consistent with efficient markets. The forward prices in the Amsterdam market were highly correlated with them. The semi-annual dividend payments in London then produced regular patterns in the Amsterdam prices both from the Le Bachelier effect and the practice of London quoting prices ex dividend during the preparation of dividend payments while Amsterdam quoted them with dividend.

In the early eighteenth century, a special form of economic integration occurred between the two leading mercantile cities of Europe, Amsterdam and London. An international capital market developed which led to ever wider-ranging capital markets for each center over the succeeding centuries. It may also have facilitated the progress of economic integration for northwestern Europe in terms of markets in goods and labor. The significance of this, however, seems to have been largely overlooked in the more recent historical and the economic literature. This paper lays the basis for a greater appreciation of the role of this early international capital market in particular, and such markets in general, by explaining its operation in theoretical terms and analyzing its results in quantitative terms.

Shares of the great chartered joint stock corporations in England were traded simultaneously on the stock exchanges of London and Amsterdam at the end of 1723 and continued to be traded through peace, war, and revolution into the nineteenth century. Little evidence remains of this activity save for the prices of the shares but these exist in great quantity. Using modern theory and quantitative techniques, a great deal of interest can be inferred from them. Section I explains how this unique form of capital market integration came into existence and how the two markets operated separately and jointly. Section II summarizes what the evidence available to us tells about the operation of the respective capital markets. It shows that, at least for the multiply listed stocks, the two stock

markets were economically efficient by modern standards throughout the eighteenth century, although some doubt may remain about the operation of the Amsterdam market. Section III then tackles the challenging task of explaining the small, but persistent, differences in prices that existed between the two markets. The regression results show technical differences in the operations of the two markets largely account for both the persistence with which Amsterdam prices were above London prices, and for the existence of apparently unexploited profit opportunities in the Amsterdam market. It turns out that exchange rate fluctuations were also often a major influence on price differences, sometimes reflecting large movements in the capital markets and sometimes causing adjustments in them. The concluding section draws some of the implications of this chapter of history for our understanding of the integration of international capital markets especially in terms of information flows and government interventions.

I

It is traditional to date the beginning of the English National Debt, referring to long-term funded debt, in 1693. In that year, Act 4 William and Mary c.3 imposed a special duty on beer, ale, and other liquors to guarantee payment of the interest on a million pound loan which was to be

floated at 10% interest.¹ By this action, William simply applied to his new domain the same techniques for raising credit that he had employed as Stadhouder in the Netherlands. A crucial element in the set of financial practices brought to England in William's train was the resale of shares in joint stock corporations, i.e., the initiation of our modern stock exchanges. While chartered joint stock companies existed in England prior to William, it appears that trade in their shares increased considerably in the early 1690s and certainly the number of companies increased markedly in that decade. This followed a very active period of stock trading in the Amsterdam Beurs in the 1680s.

To aid him in raising money for his War of the League of Augsburg against Catholic France, William brought with him numerous financial advisors and military contractors from Holland. These men included a high proportion of Jews and Huguenots who were eager to apply in a relatively backward England the financial techniques and institutions that had been

¹ Alice Clare Carter, *The English Public Debt in the Eighteenth Century*, (1968), p. 5.

4

developed over the past century in Amsterdam.² Their activities eventually came to concentrate on shares of the Bank of England (founded in 1694), the New East India Company (1698), the United East India Company (a consolidation of the Old and New East India Companies which occurred in 1702), and the South Sea Company (1711). The charters of each permitted foreigners to own shares and this right was upheld by the Crown and the companies despite occasional challenges from members of Parliament.³ The shares of these three great companies were liquid assets for both English and foreign owners because an active resale market existed for them. The trading activity occurred in the London Stock Market and in the Amsterdam Beurs.

² Van Dillen gives a few of the more noteworthy examples of the Jewish financial investors. Moses Machado went with the king to England in 1688 and became his prime contractor for the campaign in Ireland; Joseph de Medina had a large contract as military supplier in 1713; while Sir Solomon de Medina was the greatest army contractor of his day, financing in particular the campaigns of the Duke of Marlborough. (J. G. Van Dillen, "De economische positie en betekenis der Joden in de Republiek en in de Nederlandse koloniale wereld," in H. Brugmans and A. Frank, eds., *Geschiednis der Joden in Nederland*, (1940), p. 584.)

Further, our earliest description of the operation of the Amsterdam stock exchange, Josef Penso de la Vega's *Confusion de Confusiones*, appears to be a highly florid elaboration of an earlier technical manual that he had prepared on the various techniques and regulations employed in the Effectenbeurs. The purpose of this manual most likely was to inform his countrymen who had gone to London and who wished to participate in the speculation that was beginning there. Hermann Kellenbenz, introd. to Josef de la Vega, *Confusion de Confusiones*, (1957), p. xiv.

³ For details, see Larry Neal, "Efficient Markets in the Eighteenth Century? The Amsterdam and London Stock Exchanges," in Jeremy Attack, ed., *Proceedings of the Business History Conference*, (1982).

The prices at which shares changed hands on the London market are available to us on a daily basis in John Castaing's Course of the Exchange.⁴ This remarkable data source began publication in March 1697 and continued to appear twice-weekly, on Tuesdays and Fridays, through the entire eighteenth century under a variety of publishers.⁵ Each issue gave price quotations for the past three trading days on each of the major securities traded by the brokers in Exchange Alley. The list was headed by the shares in the three leading joint stock companies but included the other chartered companies as well as quotations on various issues of government debts and annuities.

For the prices on the Amsterdam Beurs, we have available a series of price quotations taken every two weeks for the shares of the Bank of England, the East India Company and the South Sea Company. These were

⁴ The first regular publication of stock prices on the London Stock Exchange appears to have been John Houghton's *Collection for Improvement of Husbandry and Trade*, which began publication March 30 (O.S.), 1692 and each week provided the Wednesday prices for the shares of eight chartered corporations until it ceased publication in June; when it resumed in January 20, 1692/3 it continued to give Wednesday prices. With the issue of January 22, 1696/7 changed format and the dates were no longer for the preceding Wednesday of that week, but rather for a preceding Tuesday or Friday. This makes it appear that they were merely copied from Castaing's definitive *Course of the Exchange* which began publication erratically in 1697 and then continuously from the beginning of 1698 on Tuesdays and Fridays.

⁵ John J. McCusker, *Money and Exchange in Europe and America, 1600-1775; A Handbook*, (1978), p. 31. A full history of the publication can be found in Larry Neal, "The Rise of a Financial Press in Western Europe, 1677-1796," *Proceedings of the Business History Conference*, 13 (1985), forthcoming. In 1811, when it was published by Wetenhall, it became the official price list of the London Stock Exchange.

6

published by the Dutch economic historian, J.G. Van Dillen in 1931.⁶ Van Dillen drew these data from the Amsterdamsche Courant, a Dutch newspaper which appeared thrice-weekly. Starting July 14, 1723 it began to give price quotes for shares of the Dutch East India and Dutch West India Companies with the agio rate for the Bank of Amsterdam. Beginning with the issue for August 9, 1723 (N.S.), the Courant began giving in addition quotes for the three English joint-stock companies. These continued to appear regularly in each issue, with quotes for other Dutch and English securities coming in for a time and then leaving, until December 19, 1794 with the French occupation of Amsterdam and the founding of the Batavian Republic. The official price list for stocks on the Amsterdam Beurs began publication the following year.⁷

This fortnightly series by Van Dillen reduced the number of joint observations for each of the English companies from over 30,000 for just the London market to only 1,676. For each date in the Amsterdam series, I took the London quotation on the same trading day for each of the three

⁶ J.G. van Dillen, "Effectenkoersen aan de Amsterdamsche beurs 1723-1794," *Economisch-historisch Jaarboek*, dl. 17, (1931), pp. 1-34.

⁷ Johannes de Vries, *Een Eeuw vol Effecten, Historische schets van de Vereniging voor de Effectenhandel en de Amsterdamse Effectenbeurs, 1876-1976*, (1976), p. 19.

stocks.⁸ Graphing both the levels and first differences of the prices in each market against each other for each company makes it evident that the two markets were very closely correlated from the beginning of the series. These graphs are far too long to reproduce here but the visual effect of nearly perfect congruence is indicated perhaps in Table 1. This gives the correlation coefficients between the levels and the first differences of the price series in Amsterdam and London for the Bank of England, the East India Company, and the South Sea Company. These correlation coefficients are quite consistent for the levels across the four peacetime periods that occurred between 1723 and 1794.⁹ And they are consistently high for each of the three companies. The correlations for the first differences are naturally much lower but also show much more variation by company and by time period. One's first question upon finding two distinct price series for the same financial asset -- were the two markets in which prices were struck closely integrated? -- is answered here with a resounding affirmative

⁸ This exercise was complicated by two features: 1) the Dutch had been on the Gregorian calendar since the middle/end of December 1582 while the British did not shift until September 2/13, 1752; and 2) the Amsterdam market traded Sunday through Friday while the London market traded Monday through Saturday. To deal with the first feature, I counted back eleven days to find the corresponding London quotes before September 13, 1752; the second feature was dealt with by matching the Saturday quote in London to a Sunday quote in Amsterdam whenever one appeared.

⁹ From Keller's *Dictionary of Dates* (1934), I chose October 19, 1739 as the start of the first war period (War of Jenkins Ear) and October 1748 as the end (Treaty of Aix-la-Chapelle). Hostilities began for the Seven Years War in August 1756 while for financial purposes in the capitals they ended with the Treaty of Paris signed February 10, 1763. I took March 13, 1778 as the effective date of hostilities in Europe arising from the American War for Independence since this was when the Treaty of Alliance of France and the United States was communicated to England. This ends with the Preliminary Treaty with the United States signed in Paris on November 30, 1782.

if one looks only at the levels. The first differences, however, raise more interesting questions about the sources of the varied patterns that occurred. The striking thing is the absence of any trend in any of the three stocks toward closer integration over the course of the century.

-- TABLE 1 ABOUT HERE --

The apparently close and stable integration of these two capital markets will not be surprising to 18th century historians, enamored as they are by the leisurely modernity of the Age of Enlightenment. Mail packet boats left London regularly for Amsterdam on a twice-weekly basis and dispatches from London four to seven days old appeared each week in the Amsterdam and other Dutch newspapers. Dutch investors were represented among major holders of Bank of England stock from the beginning. Their holdings grew until 1751 with a "Dutch rush" occurring between 1721 and 1726. They continued to receive dividends and capital bonuses even when the Netherlands had become the Republic of Batavia in 1795 and then departments within the Napoleonic empire in the first decade of the 19th century ¹⁰

How large were these investments by the Dutch in the English public debt? In the most recent summary of the available studies, Wilson relies on

¹⁰ John Clapham, *The Bank of England, A History*, v. I, "1694-1797", London: Macmillan, 1945, pp. 278-289.

Dickson's benchmark figures for 1723-24 and 1750.¹¹ Dickson found that in 1723-24 the total foreign holdings of stock in the "Big Three" companies amounted to 9.3 percent of the total capital while by 1750 the total of foreign holdings in the same companies (by now South Sea annuities had replaced the original stock) amounted to 19.2 percent.¹² Looking more closely at the growth of foreign holdings in Bank of England stock, Dickson found that it was not until the South Sea Bubble that foreigners, especially the Dutch, began to invest. He concluded that

As a result of the South Sea Bubble this trend was markedly accentuated [towards holdings of government and company stock]. By 1723-24 foreign holdings of English government securities had reached -- for the first time -- a really substantial size. They were to go on increasing in amount until the massive foreign disinvestment of the last twenty years of the eighteenth century.¹³

Even though the result of modern scholarship has been to reduce the proportions of English Funds held by foreigners from the heights of 40% or more reported to Lord North in 1776,¹⁴ the new lower bounds that have been established still exceed the proportions of foreign trade and foreign

¹¹ Charles Wilson, "Dutch Investment in Britain in the 17th-19th Centuries," in *Credit Communal de Belgique, Collection Histoire Pro Civitate*, no. 58, "La Dette Publique aux XVIIIe et XIXe Siecles." (1980), p. 201.

¹² P.G.M. Dickson, *The Financial Revolution in England: A Study in the Development of the Public Credit, 1688-1756*. London: Macmillan, 1967, p. 312 and p. 321.

¹³ *Ibid.*, pp. 311-12.

¹⁴ Alice Carter, "The Dutch and the English Public Debt in 1777," *Economica*, 20 (1953), pp. 159-161.

labor in the English economy of the eighteenth century.¹⁵ The evidence is persuasive that economic integration between these two great mercantile powers occurred first through the movements of capital.

II

The more interesting questions of the ebb and flow of Dutch investments in the English securities, particularly whether they were destabilizing and speculative as contemporary English opinion had it, or whether they were passive and on the whole stabilizing, remain unanswered. Evidence to deal with these questions lies primarily in the price data for the two markets described above. It should be noted, however, that the Bank of England was responsible for recording transfers of ownership in "government stock" which included shares of the Bank itself, the East India Company, annuities, and Consols. In principle, these records could be used to link foreign movements of capital to sustained rises or falls in the market price of British company shares. To date the only use of these records has been by Carter and then for only a three month period at the beginning of

¹⁵ N.F.R. Crafts, "British Economic Growth, 1700-1813: A Review of the Evidence," *Economic History Review*, 36 (1983), p. 197 puts exports as a proportion of national income for Great Britain between 8 and 12 % during the eighteenth century and not over 15% until 1801. Neil Tranter, "The labour supply, 1780-1860," in D. N. McCloskey and R. Floud, eds., *The Economic History of Britain since 1700*, v. I (1981), p. 211, puts the maximum share of foreign immigrants, mainly Irish, in the labor force at much lower levels.

1755.¹⁶ The best that can be done at present is to search for evidence that either of the markets for English securities, the Amsterdam and the London stock exchanges, were less than efficient in setting prices.

Table 2 gives the initial results of time series analysis on the four main time series of interest -- the cash prices for Bank of England and East India Company stock quoted in London, and the forward prices for the same two stocks quoted in Amsterdam. Basically, we are interested in testing the proposition that the following equations are accurate descriptions of price movements in each case:

$$1) L_{it+1} - L_{it} = u_{t+1} ; i = 1, 3; t = \text{time}$$

$$2) A_{it+1} - A_{it} = u_{t+1} ; i = 1, 3; t = \text{time}$$

where L is the London price and A is the Amsterdam price.

The standard technique is to estimate AutoRegressive, Integrated, Moving Average (ARIMA) models for the changes in prices. If it can be found that some combination of autogressive and moving average processes yield consistently good descriptions of price changes, then presumably these processes could be discovered by interested speculators and used to make profits in the markets. For efficient markets to have existed, these models should show (0,0) -- i.e., that last period's price alone remains the best

¹⁶ Alice Clare Carter, "Transfer of Certain Public Debt Stocks in the London Money Market from 1 January to 31 March 1755," *Bulletin of the Institute of Historical Research*, 28 (November 1955), p. 203.

predictor of this period's price. The results of two different techniques for estimating ARMA models are shown in Table 2.¹⁷

-- TABLE 2 ABOUT HERE --

For the period as a whole, both methods are consistent in showing market efficiency in both markets for Bank of England stock and in the London market for East India Company stock. Both methods indicate that a (0,3), i.e., a third-order moving-average process, existed in the Amsterdam prices of the East India Company. This appears to be in place only after 1737, however. The remainder of the table shows the estimated ARMA models for each period of war and peace after Barnard's Act. Here the results are mixed, although most cases are clear random walks, i.e., ARMA (0,0). But it is only in the London market for East India stock that we find consistent evidence in each sub-period for an efficient market. In the two

¹⁷ Both the "B-J" and "H-R" methods are strictly mechanical procedures that estimate the autocorrelation coefficients and the partial correlation coefficients for up to 10 lags over the time series. The "B-J", or standard Box-Jenkins method, determines which of these coefficients are statistically significant from zero and then the investigator selects the most plausible model. (Box and Jenkins, *Time Series Analysis: Forecasting and Control*, San Francisco: Holden-Day, 1976.) The "H-R" method is a recursive process in which each autoregressive process up to order 10 is estimated and then the residuals of each estimate are used to calculate variances. The process which minimizes the expression:

$$o2k + 2k/n$$

where k is the order of autoregressive process and n is the number of observations. Then, using ordinary least squares regressions, ARMA models are estimated up to order $(p,5)$ where p is the order of AR model selected above. Finally, the residuals of the estimated ARMA models are used to calculate sample variances and (p,q) selected which minimizes:

$$\log(o2p,q) + (\log n/n)(p + q)$$

where q is the order of moving average process. (Hannan and Rissanen, *Biometrika*, 1983.) The tests are repeated on various subperiods, corresponding to the peacetime and wartime periods selected above.

markets for Bank of England stock we find sub-periods when some kind of ARMA process seems to have been at work. It is interesting, however, that these never occur in both markets for any given sub-period. The only sub-period when a (0,3) ARMA appears for East India Company stock on the Amsterdam exchange is 1739-1748, the War of the Austrian Succession. This is also when an anomalous (3,0) ARMA is found for Bank of England stock on the London market. Since only the coefficient on the third term was found to be significantly different from zero in each case, some data error was suspected. None was found, but another possible source of the anomaly was detected.

Table 3 shows the average length of time interval between each Amsterdam quote from the Amsterdamsche Courant, as well as the variance of the intervals and the number of observations in each wartime and peacetime period. The mean ranges from 15 to 16 days, as one expects for a sample taken fortnightly with occasional gaps for religious holidays. But the variance is especially high for the War of the Austrian Succession and the peacetime between the Seven Years War and the War of American Independence. It is in these periods that three of the six exceptions to random walks occur. This is reassuring for the validity of the remaining (0,0) processes since if a regular time series process exists but is sampled at irregular intervals, the bias will be to find a random walk process. If a

14
random walk exists in a series, on the other hand, but is sampled at irregular intervals, the possibility of finding a deterministic process arises.¹⁸

To reach a preliminary conclusion, efficient markets for the leading British financial securities appear to be in place in both Amsterdam and London after the South Sea Bubble of 1720. Moreover, they seem to have continued to operate efficiently up to the outbreak of the French Revolutionary Wars near the end of the century. Various episodes of market inefficiencies leading to speculative profit possibilities probably did arise at times but they appear to have been confined to the Amsterdam market. These periods merit closer examination, especially in terms of possible differences in the way each market operated.

III

The key to understanding the (0,1) and (1,0) processes found above lies in the finding that the London prices were spot, or money, prices while the Amsterdam prices were forward, or time, prices. The London practice likely arose as a matter of convenience since no fixed settlement days among brokers existed originally and time contracts could vary widely. But in 1734, Barnard's Act (7 Geo. II, cap. 8) forbade all dealings in options and

¹⁸ Time-series purists will object that any irregularity in the timing of the observations violates the assumptions of the statistical technique and so the irregular appearance of the Courant rules it out for time-series analysis. Given the frequency of religious holidays in the eighteenth century even in Protestant Amsterdam and London, however, a case can be made that the irregularities in its appearance reflect precisely irregularities in trading activity on the Effectenbeurs. It is the market activity, after all, that is the underlying process, not the appearance of the newspaper.

future deliveries of stocks, with a fine of 500 pounds to be levied on each person party to such a contract.¹⁹

This latter act was persistently violated in fact, according to Mortimer.²⁰ Dickson, on the other hand, feels that the Act may have been effective in transferring options business to Amsterdam and encouraging London traders to deal on margins.²¹ Castaing's price lists was consistent in showing prices at money although Cope speculates that the curious practice of printing the names of the Bank of England and the East India Company in capital letters may have developed to indicate those securities in which dealings in time may have been possible.²² Since the transfers of stocks for the chartered companies came to be handled through the Bank of England, purchases could in principle be made for a forward date at which the transfer could be made at the Bank. The illegality of dealings in futures and options may not have eliminated the practice in the London market --

¹⁹ Malachy Postlethwayt, "Stock-Jobbing", in *The Universal Dictionary of Trade and Commerce*, 2 vols., 4th edn. (1774), repr. 1971.

²⁰ Thomas Mortimer, *Every Man His Own Broker: Or a Guide to Exchange Alley*, 3rd ed. (1761).

²¹ Dickson (1967), p. 508, quotes a letter by an Amsterdam broker to a Haarlem merchant in 1735 that states "...in London only cash purchases and sales can be made."

²² S. R. Cope, "The Stock Exchange Revisited: A New Look at the Market in Securities in London in the Eighteenth Century," *Economica*, 45 (February 1978), p. 18. On this point it is interesting that Houghton followed the same practice in his early listings of stock but clearly stated that the companies whose names were printed in "Great Letters" were those that had charters while those that had asterisks in front of them were patent monopolies. John Houghton, *A Collection for Improvement of Husbandry and Trade*, 9 vols., London: Randall Taylor et. al., 1692-1703, republished Westmead, Farnborough, Hants.: Gregg, 1969. The list of stocks in no. 106 (Fri., August 10, 1694) has note: "Great Letters by Charter, (*) by Patent."

indeed, the introduction of stiffer bills in the House of Commons in 1745, 1756, 1771, and 1773 may indicate the continued prevalence of futures trading -- but it no doubt was effective in eliminating the printed quotation of future prices for those contracts that were made.

In Amsterdam, by contrast, the practice was always to deal in time contracts since legally binding possession of shares in the Dutch East India Company was not possible until the actual transfer of the share or shares was entered in the Company's books. This was not possible until the books were opened for the payment of dividends. De la Vega's original description of the Amsterdam Beurs in fact describes "putts" and "refuses" in very modern terms for options trading. The extensive trading of dealers with one another on both hedging and speculative contracts in the same stock required regular "rescounter" settlement dates to settle the net differences and straighten out the accounts among the various brokers. These occurred quarterly, on the fifteenth of February, May, August, and November.²³ The quarterly rescouters may have been for the English funds only, since de la Vega reports monthly rescouters, on the 20th of the month for real stock with payment due the 25th, and on the first of the month for "ducaton" shares.²⁴ ["Ducaton" shares were small fractions of actual Dutch East India Company shares that were devised to increase the

²³ Isaac de Pinto, *Traite de la Circulation et du Credit*, (1771), p. 305.

²⁴ de la Vega, introd. by H. Kellenbenz, p. xviii.

possibilities for trading by smaller investors since the cash value of each original share had increased over the decades to very high levels indeed.]

Van Dillen notes the difficulties in deciding whether the figures in the *Amsterdamsche Courant* were cash or time prices:

Until 1747 this is not mentioned, but in comparing them 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 1737 both prices are sometimes mentioned. After this year we find generally the forward rates. From 1759 onwards the quotations are often followed by the name of the next settlement month, e.g., "all of February." The difference between the cash price and the next paying month is, however, not more than a few percent.²⁵

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. Chart 1 illustrates why.²⁶ At regular intervals, dividends are paid on each of our securities. If nothing else happened to disturb the price of the shares from time O to time A on the graph, the nominal value of each share would be fixed until the dividend was paid, at which time the value would rise abruptly. Cash transactions in the shares between time O and time A will take into account the forthcoming dividend payment which the buyer of the share will receive. So the cash prices between time O and time A will show a gradual upward trend along line OB. A contract made at time O for future delivery of the

²⁵ Van Dillen (1931), p. 13.

²⁶ Louis Bachelier, "Theory of Speculation," trans. in Paul Cootner, ed., *The Random Character of Stock Market Prices*, (1964).

share at time A, however, will require the buyer to pay a "contango" to the seller, equal in the absence of disturbances in the price of the share to the dividend. This arises since the seller will hold the share until the delivery date but will then yield possession of the stock, and its dividend, to the buyer who only then will make full payment. This means that the futures price equivalent for the cash price that runs along line OB will be line CB, which always lies above the cash price but gradually converges to it at dividend payment dates.

-- CHART 1 ABOUT HERE --

If Bachelier's exposition explains as well the differences between Amsterdam and London prices, then the Amsterdam prices should be the same as the London prices with only small random disturbances until Barnard's Act in 1734 or until 1737 when Barnard's Act was made a perpetual law. Tables 4 and 5 present regression results for linear regressions of the difference between the Amsterdam and London price at a given date on three variables: 1) DAYSDIVD, the number of days from the date of the observation to payment of the next dividend; 2) PAYTIME, a dummy variable set equal to one during the times London prices were quoted ex dividend; and 3) AMEXPREM, the number of penningen banco the English pound sterling was worth less its mint par ratio. Only the Bank of England and East India Company stocks are analyzed since the South Sea Company stock was essentially dormant for most of the period after 1730.

-- TABLES 4 AND 5 ABOUT HERE --

The variable DAYS DIVD is intended to capture the Le Bachelier effect. Its coefficient should be positive since the dependent variable is the Amsterdam price minus the London price. On average, it should be equal to one-half the annual dividend since dividends were paid semi-annually. For each sub-period, its effect is estimated separately in the third equation. The second equation in each panel adds the effect of AMEXPREM while the first equation has all three explanatory variables. Comparing the third equation in each panel over the two tables, one notices that only in the pre-Barnard Act period does the constant term in the regressions become statistically different from zero, and it does so for both the Bank of England and the East India Company. For the entire period 1738-1794 and for the three peace-time periods within, the constant terms are insignificantly different from zero. This implies both that the contango rate was on average the same as the dividend rate, which we should expect in the absence of persistent expectations for things to improve or to deteriorate, and that no serious barriers existed to equalizing the rate of return on the same financial assets in the two different countries.

The presence of a constant term that is negative and significantly different from zero in the pre-Barnard Act period could imply segmented capital markets or exuberant outlooks by speculators, if in fact the Amsterdam prices were forward prices consistently. Inspecting the pattern of residuals and estimating the regression for subperiods within the period 1723-1738 leads me to believe that this was the case. On average the Amsterdam price was higher than the London price even in the period 1723-

37, although the difference was much less than it became after 1737. This holds for both stocks. If this is true, then the negative constant term implies optimistic expectations by investors during this period. The evidence of the exchange rate variable presented below strengthens this presumption.

There remain differences between the regression estimates for the Bank of England stock and the East India Company stock. On average, the price difference was 1.6 points for Bank stock and 2.5 points for East India stock. This reflects the generally higher dividend rates paid by the East Company stock. In sum, these regression results, combined with the evidence of extremely tight market integration presented in the introduction, demonstrate that what small, but persistent differences in prices remained between the Amsterdam and London markets for the British securities were due to the London prices being cash, or spot, prices while the Amsterdam prices were forward prices.

When the semi-annual dividend payment dates approached, the transfer books for the particular stock would be closed so that the sums due to each owner could be calculated and made ready. During this period which usually lasted two weeks, the stock would be quoted ex dividend. Any deliveries of stock taking place during that period, then, would not include the dividend about to be paid since the clerks would be in the process of making the payment ready for the currently registered owner. So the variable `DAYSDIVD` was calculated as the number of days from the

given date to the day the first ex dividend quote appeared in the Course of the Exchange. In Amsterdam, on the other hand, it appears that the quoted price was always with dividend. In the printed form shown by Dickson for sales of stock made in Amsterdam for delivery (and payment) in London, explicit provision is made that if the receiver of the stock does not get the current dividend, then he deducts that dividend from the stated price he has agreed to pay. This is stated clearly in a contract dated 4 April 1730 between Jacob Reynst and David Leeuw, both of Amsterdam, that Dickson translates as follows:

I the undersigned acknowledge to have Bought from *Heer David Leeuw One Thousand Pounds Sterling Capital Shares of the Bank of England at London, at a price of a Hundred and Forty Five and a Quarter per Cent* remaining after the Dividend paid last October, for settlement on next *15 May*, the which *11000* I oblige myself to receive in London at the stated Price. And in case in the interim any Dividend is paid, it shall be to my profit and to reduction of the above Price. Contrarywise all supplementations and Calls shall be at my expense, in the usual way. All done in good faith at Amsterdam the *Fourth April* Seventeen hundred and *thirty*.²⁷

To capture this difference in practice in quoting prices during the period dividends were being calculated, a dummy variable was created, PAYTIME, which was set to a value of one for the first observation after the ex dividend quotes began in London. It proves to be positive, as expected, and usually significant, especially in the earlier years. It also has the felicitous effect of reducing substantially the serial correlation in the regressions.

²⁷ Dickson, (1967), p. 335. This was a pre-printed form except for those items shown in italics, which were entered by hand.

Since transfers of stock had to take place in London; where the actual stock had to be paid for in pounds sterling, we should expect some effect in the Amsterdam market from fluctuations in the exchange rate with London. Taking deviations in the observed sight rate from the mint par ratio as the measure of changes in the exchange rate (AMEXPREM), what effect should one expect on the Amsterdam price of an English stock (in English pounds sterling) of, say, an increase in the value of the English pound relative to the Dutch guilder? Recognizing that any effect will be merely transitory until prices are equalized on the basis of the new exchange rate, one might expect the demand for English stock in Amsterdam to be shifted downward (any given price in pounds sterling is now felt to be more expensive by a Dutch purchaser) while the supply of the English stock in Amsterdam would be shifted outward (any given price in pounds sterling is now more attractive to a Dutch supplier). The effect of these shifts in both demand and supply is to reduce the price of the English stock in Amsterdam relative to its price in London. Since the dependent variable in the regressions is the Amsterdam price minus the London price while the independent variable for the effect of the exchange rate is the price of the pound sterling in terms of Dutch bank money less the mint par ratio, the expected sign on the exchange rate variable is negative. That is, the higher the value of the pound on the foreign exchanges, the lower we expect the price of a British security to be in Amsterdam relative to London.

In fact, the estimated coefficient for the exchange rate variable does not prove to be statistically different from zero in the earliest period and when it does become significant it has a positive sign! After mid-century, however, it always has the expected sign and is often significantly different from zero as well, especially in the regressions from which outliers have been removed. The anomaly that needs to be explained then is the positive sign and significant effect before 1750, especially during the War of the Austrian Succession. The most likely explanation stems from the fact that the period from 1723 to 1750 was precisely the period when the Dutch built up their holdings in the English joint stock companies and long term government debt most rapidly. Dickson found that Dutch holdings of Bank of England stock rose from 10.5% of the total capital in 1723-4 to 30.3% in 1750 while their share of East India Company stock rose from 13.4% to 21.4% over the same period.²⁸ It would appear, then, that in this period the massive inflows of Dutch capital to the English long-term securities market were sufficient to drive up the value of the English pound whenever surges of Dutch demand lifted the Amsterdam price above its predicted level, based on the purely technical factors embodied in our variables PAYTIME and DAYSDIVD.

The final step taken in the regression analysis was to remove outliers. Analyzed the graphs of predicted vs. actual values of the Amsterdam-London price differences revealed a very close clustering of the actual

²⁸ Dickson, (1967). Calculated from Tables 47 and 48, pp. 312-13 for 1723-4 and from Tables 50 and 51, p. 321 and p. 324, for 1750.

values to the regression plane with a few (less than 2%) of the observations causing much of the unexplained variance. Setting these equal to the predicted value (or the actual value in the few cases where it turned out that an error had been made in the data entry), improved the goodness-of-fit greatly, without altering the size or significance of the estimated coefficients. (An exception is the AMEXPREM variable which did prove responsive in some time periods to the removal of outliers.) Some of the outliers may be due to errors of transcription in the original data source. Some of the numbers in Van Dillen's table, for example, appear to be in error -- two digits are reversed or two columns are reversed. But most of the anomalies in Van Dillen appear to occur in the Amsterdamsche Courant as well.²⁹

This leads us to confront the second source of transcription error -- that from the original source on the actual trading day in London or Amsterdam to the printed source used now by historians. This must remain a matter of speculation, but extensive use of the Course of the Exchange by the author has not revealed other examples of typographical errors -- e.g., inconsistencies in the date headings which had to be altered with each issue or reversal of data entries. But it is true these would be easier to pick up by the original typesetters as well.

²⁹ The ten most dubious numbers in Van Dillen were checked against xerox copies of the Amsterdamsche Courant obtained from the New York Public Library. Only three, those for East India stock on November 16, 1733 and April 3, 1789 and that for South Sea stock on November 25, 1793 proved to be Van Dillen's mistake in transcribing.

Studying the pattern of residuals for the period 1763-1778, when the largest number of outliers occurred, suggests another explanation. The outliers in this period appeared as a result of sharp movements of very short duration on the London Stock Exchange. If one had taken the observation for London of three days previous, for example, in most cases the difference from the Amsterdam quote would have been largely eliminated. If the next observation was also an outlier, it was nearly always of opposite sign. This suggests that information of great influence on the price of English stocks was reaching one market well before it reached the other. Since our observations are taken from the same day in both markets, ephemeral information of the kind associated with panics (the panics of 1763 and 1772 occur in this period) that reaches one market before the other will not be reflected in the price difference. In anything other than panic situations, this is not a problem since the Amsterdam prices are taken only every two weeks and most of the information flow that has occurred in that time interval will also have reached the London market. It is not surprising then that the worst goodness-of-fit occurs in the period 1763-1778 and again in the period 1790-1794.

IV

In sum, the regression results strengthen the conclusion that these two markets were efficient and well-integrated from the second quarter of the eighteenth century on. The spot prices quoted in the London market

followed a random walk process consistent with efficient markets. The forward prices in the Amsterdam market were highly correlated with them. The semi-annual dividend payments in London then produced regular patterns in the Amsterdam prices both from the Le Bachelier effect and the practice of London quoting prices ex dividend during the preparation of dividend payments while Amsterdam quoted them with dividend. These regular patterns, however, were sometimes masked by unusual expectations (e.g., during the War of the Austrian Succession), fluctuations in exchange rates, or panics. In those periods we find random walks in general, although the War of the Austrian Succession remains an anomaly.

The significance of these findings will be seen differently by economists and historians. For historians, they will simply confirm in large part the authoritative work of P.G.M. Dickson on the operation of the London capital markets in this period and his perceptive comments on the Dutch influence. Dickson's work, in turn, relied heavily on the earlier work done by Carter, van Dillen and Wilson.³⁰ All are agreed on the importance and effectiveness of the integration of these two capital markets at the dawn of modern capitalism. After all, even Karl Marx raged at the

³⁰ Alice Carter, "Dutch Foreign Investment, 1738-1800," *Economica*, 20 (1953), pp. 322-340; "Dutch Foreign Investment, 1738-1800, in the Light of the Amsterdam 'Collateral Succession' Inventories," *Tijdschrift voor Geschiedenis*, (1953), pp. 27-38; and "The Huguenot Contribution to the Early Years of the Funded Debt, 1694-1714," *Proceedings of the Huguenot Society of London*, 19 (1955), p. 21. All these are reprinted and summarized in her book, *Getting, Spending and Investing in Early Modern Times* (1975). Cf. Charles Wilson, *Anglo-Dutch Commerce and Finance in the Eighteenth Century*, Cambridge: University Press, 1941, and his "Dutch Investment in Eighteenth Century England," *Economic History Review*, 2nd series, 12 (1959), 434-439. Van Dillen's works have been cited above.

establishment of the National Debt in England as the single most effective device in the "primitive accumulation of capital".³¹

For economists, the quantitative results should strengthen their confidence in doing analytical work on the financial relations between London and Amsterdam.³² The pioneer work in this regard was done by Eagly and Smith who used interest rate and foreign exchange rate data in the framework of an interest rate arbitrage model. Their results, according to them, "support the general hypothesis of a trend towards increased integration among money markets during the course of the century, but at the same time they show that during individual sub-periods there was considerable variation in this trend."³³ This could as well be the conclusion from the results above but my emphasis would be on the high level of integration that existed at the beginning of the second quarter of the eighteenth century and the continued efficiency of the operations of both stock markets rather than a trend toward improved integration.

³¹ Karl Marx, *Capital*, London: Lawrence & Wishart, 1970, v. I, Ch. 31, pp. 754-6.

³² Two works should be mentioned. Brian Parsons, "The Behavior of Prices on the London Stock Market in the Early Eighteenth Century," unpublished Ph.D. dissertation, University of Chicago, 1974 concentrates on the daily course of prices during the South Sea Bubble and finds the market operated efficiently although he finds unexplained differences in the price quotes from different sources. Philip Mirowski, "The Rise (and Retreat) of a Market: English Joint Stock Shares in the Eighteenth Century," *Journal of Economic History*, 41 (September 1981), 559-577, compares internal accounts of profitability for several joint stock companies with the pricing of their equity on the stock market. He finds increasing discrepancies in the latter part of the century.

³³ Robert Eagly and V. Kerry Smith, "Domestic and International Integration of the London Money Market, 1731-1789," *Journal of Economic History*, 36 (March 1976), p. 210.

True, these operations were disturbed by repeated wars -- each fought with different financial techniques and consequences, by trade disturbances, and by occasional financial panics. Nevertheless, it must be emphasized that these disturbances never changed the fundamental economic characteristics of the two markets in the way that modern policy measures of sovereign nation states manage to do. There were no attempts at independent national monetary policy by either country in the period 1723-1794 -- i.e., no controls on capital movements, no withholding taxes on dividend or interest payments to foreigners, no changes in monetary standards, no managed exchange rates, and no attempts to regulate M1, M2, or M3. There was an absence, therefore, of the modern impediments to efficient operation of multiple listing markets. (Witness the current difficulties in expanding multiple listings of stocks among the members of the European Community.) In other words, a remarkably modern pair of capital markets were permitted to interact in an unfettered (and hence unmodern) fashion. This may be why economic integration occurred first in these capital markets well before comparable degrees of integration could be achieved in goods markets, much less in labor markets.

Table 1.

Correlation Coefficients between London and Amsterdam Prices for Stock of Bank of England, South Sea, and East India Company for 1723-1794 and Various Sub-periods of War and Peace. (levels and first differences of actual prices)

Period	Bank of England	East India	South Sea
1723-1794	0.994	0.993	0.989
(changes)	0.589	0.624	0.394
Peace			
8/09/23 - 10/19/39	0.978	0.990	0.951
(changes)	0.381	0.544	0.505
11/11/48 - 7/14/56	0.983	0.988	0.983
(changes)	0.327	0.370	0.361
2/18/63 - 3/04/78	0.993	0.997	0.974
(changes)	0.656	0.716	0.389
12/06/82 - 9/22/90	0.996	0.988	0.969
(changes)	0.570	0.578	0.153
War			
10/21/39 - 10/23/48	0.988	0.977	0.954
(changes)	0.536	0.593	0.305
8/04/56 - 2/05/63	0.976	0.963	0.979
(changes)	0.655	0.610	0.408
3/02/78 - 11/20/82	0.823	0.943	0.907
(changes)	0.465	0.536	-0.004
10/08/90 - 12/19/94	0.988	0.984	0.986
(changes)	0.803	0.644	0.664

Table 2.

ESTIMATED ARMA MODELS FOR BANK OF ENGLAND AND EAST
INDIA COMPANY STOCK PRICE CHANGES IN LONDON AND
AMSTERDAM

Time Period	London		Amsterdam	
	H-R	B-J	H-R	B-J
Bank of England				
Entire Period				
1723-1794	0,0	0,0	0,0	0,0
Pre- and Post-Barnard				
1723-1737	0,0	0,0	0,0	0,0
1738-1794	0,0	0,0	0,0	0,0
Peace Periods				
1748-1756	0,5	0,0	0,1	0,1
1763-1778	2,0	2,0	0,0	0,0
1782-1792	0,0	0,0	0,0	0,0
War Periods				
1739-1748	3,0	3,0	0,0	0,0
1756-1763	0,0	0,0	0,0	0,0
1778-1782	0,0	0,0	0,1	1,0

Table 2 (cont.)

East India Company

Time Period	London		Amsterdam	
	H-R	B-J	H-R	B-J
Entire Period				
1723-1794	0,0	0,0	0,3	0,3
Pre- and Post-Barnard				
1723-1737	0,0	0,0	2,0	0,0
1738-1794	0,0	0,0	3,0	3,0
Peace Periods				
1748-1756	0,0	0,0	0,0	0,0
1763-1778	0,0	0,0	0,0	0,0
1782-1792	0,0	0,0	0,0	0,1
War Periods				
1739-1748	0,0	0,0	0,3	0,3
1756-1763	0,0	0,0	0,0	0,0
1778-1782	0,0	0,0	0,1	0,1

Table 3.

Regularity of Observations from
the Amsterdamsche Courant,
Sub-Periods of Peace and War, 1723-1792.

Period	Mean	Variance	No. of obs.
1723-39	15.1	28.55	391
1739-48	16.01	43.87	207
1748-56	15.35	19.05	185
1756-63	15.72	25.90	153
1763-78	15.94	97.34	357
1778-82	14.98	10.16	115
1782-92	15.17	21.94	189

Table 4.

Summary of Regression Results for the Bank of England, 1723-1794; Amsterdam-London Price Differences Explained with:

- 1: Days to Next Dividend Payment (DAYSDIVD);
 - 2: Changes in the Exchange Rate (AMEXPREM); and
 - 3: Whether the London Price was with or
ex dividend (PAYTIME).
- [Outliers removed and set to regression plane.]

Subperiods:

1723-1739	[Peace, Pre-Barnard]
1739-1748	[War of Austrian Succession]
1748-1756	[Peace, no financial crises]
1756-1763	[Seven Years' War]
1763-1778	[Peace, Panics of 1763 and 1772]
1778-1783	[War of American Independence]
1783-1790	[Peace]
1790-1794	[French Revolution, start of war]

(A-L) DIF DAYSDIVD AMEXPREM PAYTIME CONST R2 DW

PANEL A: 1723-1739

OLS	.005	.002	1.999	-.140	.30	1.78
(4.365)	(.241)	(8.839)	(-.520)	(1.083)		387
OLS	.010	.003		-.397	.16	1.63
	(8.772)	(.308)		(-1.348)		388
OLS	.009			-.480	.16	1.63
	(8.780)			(-4.006)		389

Panel B: 1739-1748

OLS	.009	.056	1.141	1.284	.31	1.55
	(5.343)	(4.952)	(3.549)	(4.016)		203
OLS	.012	.056		1.118	.28	1.40
	(7.862)	(4.843)		(3.436)		204
OLS	.011			-.233	.20	1.25
	(7.164)			(-1.32)		205

[T-statistics are in parentheses under respective coefficients]

Table 4. (cont.)

(A-L) DIF	DAYS DIVD	AMEXP REM	PAYTIME	CONST	R ²	DW
Panel C: 1748-1756						
OLS	.010 (7.15)	.003 (.245)	.758 (2.728)	-.137 (-.468)	.34	1.51 181
OLS	.012 (9.39)	.002 (.159)		-.275 (-.936)	.32	1.32 182
OLS	.012 (9.42)			-.316 (-2.18)	.32	1.32 183
Panel D: 1756-1763						
OLS	.011 (4.69)	-.014 (-1.078)	.515 (1.139)	-.193 (-.495)	.19	1.40 149
OLS	.012 (5.95)	-.013 (-1.02)		-.250 (-.646)	.19	1.38 150
OLS	.012 (5.99)			.071 (.317)	.19	1.36 151
Panel E: 1763-1778						
OLS	.016 (10.95)	-.008 (-1.206)	.243 (.869)	-.537 (-2.30)	.32	1.44 353
OLS	.017 (13.04)	-.009 (-1.222)		-.577 (-2.52)	.32	1.42 354
OLS	.017 (13.07)			-.353 (-2.555)	.32	1.42 355

Table 4. (cont.)

(A-L) DIF	DAYS DIVD	AMEXP REM	PAYTIME	CONST	R2	DW
Panel F: 1778-1782						
OLS	.010 (3.79)	-.025 (-2.683)	.567 (1.102)	-.14 (-.428)	.21	1.60 111
OLS	.011 (4.95)	-.025 (-2.67)		-.223 (-.676)	.21	1.53 112
OLS	.011 (4.82)			.364 (1.442)	.16	1.42 113
Panel G: 1782-1790						
OLS	.017 (7.56)	-.033 (-4.31)	.492 (1.105)	-.122 (-.520)	.35	1.72 185
OLS	.018 (9.08)	-.032 (-4.280)		-.196 (-.870)	.35	1.70 186
OLS	.019 (8.90)			-.166 (-.706)	.29	1.55 187
Panel H: 1790-1794						
OLS	.009 (2.21)	-.002 (-.179)	1.761 (2.462)	.568 (1.14)	.20	1.58 75
OLS	.015 (3.90)	-.002 (-.165)		.253 (.509)	.15	1.44 76
OLS	.015 (3.93)			.207 (.504)	.16	1.44 77

TABLE 5.
Summary of Regression Results for the East India Company explaining Amsterdam-London price differences (A-LDIF) with:
1: Day to next dividend payment (DAYSDIVD);
2: Changes in the exchange rate (AMEXPREM); and
3: Whether the London price was with or ex dividend (PAYTIME).
[Outliers removed and set to regression plane.]

Subperiods:
1723-1739 [Peace, pre-Barnard]
1739-1748 [War of Austrian Succession]
1748-1756 [Peace, no financial crises]
1756-1763 [Seven Years War]
1763-1778 [Peace, panics of 1763 and 1772]
1778-1783 [War of American Independence]
1783-1790 [Peace]
1790-1794 [French Revolution, start of war]

(A-L) DIF DAYSDIVD AMEXPREM PAYTIME CONST R2 DW

PANEL A: 1723-1739

OLS	.006 (3.214)	-.001 (-.106)	2.884 (7.930)	-.477 (-1.07)	.24	1.90 387
OLS	.012 (7.28)	-.005 (-.342)		-1.00 (-2.102)	.12	1.69 388
OLS	.012 (7.29)			-.851 (-4.43)	.12	1.69 389

Panel B: 1739-1748

OLS	.015 (5.74)	.068 (3.95)	1.383 (2.751)	1.251 (2.52)	.29	1.54 203
OLS	.018 (7.93)	.069 (3.945)		1.072 (2.14)	.27	1.38 204
OLS	.018 (7.61)			-.633 (-2.44)	.22	1.28 205

[T-statistics are in parentheses under respective coefficients]

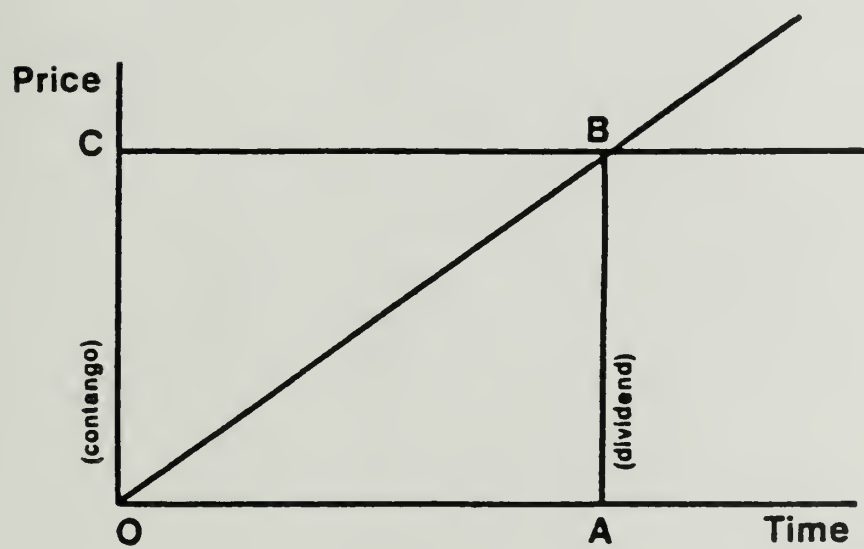
Table 5. (cont.)

(A-L)DIF	DAYSDIVD	AMEXPREM	PAYTIME	CONST	R2	DW
Panel C: 1748-1756						
OLS	.016 (7.05)	.028 (1.40)	2.032 (4.51)	.427 (.927)	.41	1.69 181
OLS	.016 (7.07)		2.024 (4.48)	-.137 (-.62)	.41	1.68 182
OLS	.021 (9.91)			-.416 (-1.85)	.35	1.40 183
Panel D: 1756-1763						
OLS	.013 (5.15)	-.044 (-2.99)	.872 (1.72)	-.800 (-1.78)	.27	1.43 149
OLS	.015 (6.69)	-.046 (-3.07)		-.959 (-2.16)	.26	1.38 150
OLS	.015 (6.56)			.156 (.599)	.22	1.29 151
Panel E: 1763-1778						
OLS	.021 (6.57)	-.063 (-3.828)	.835 (1.35)	-1.42 (-2.75)	.19	1.56 353
OLS	.023 (8.17)	-.063 (-3.84)		-1.55 (-3.03)	.19	1.55 354
OLS	.023 (8.15)			.016 (.053)	.16	1.49 355

Table 5. (cont.)

(A-L) DIF	DAYS DIVD	AMEXPREM	PAYTIME	CONST	R2	DW
Panel F: 1778-1783						
OLS	.028 (7.16)	-.036 (-2.71)	.684 (.913)	-1.40 (-2.83)	.41	1.93 111
OLS	.029 (8.64)	-.036 (-2.755)		-1.51 (-3.177)	.41	1.91 112
OLS	.029 (8.38)			-.66 (-1.78)	.38	1.77 113
Panel G: 1782-1790						
OLS	.020 (7.33)	-.028 (-2.987)	.839 (1.552)	.359 (1.34)	.33	1.79 185
OLS	.022 (9.15)	-.028 (-3.005)		.244 (.942)	.32	1.73 186
OLS	.022 (8.90)			.320 (1.215)	.29	1.65 187
Panel H: 1790-1794						
OLS	.016 (2.82)	-.010 (-.501)	1.776 (0.707)	.709 (1.11)	.19	1.69 75
OLS	.021 (4.24)	-.012 (-.600)		.495 (.779)	.17	1.66 76
OLS	.021 (4.265)			.267 (.527)	.18	1.65 77

Chart 1
Equivalent Prices of Spot and Future Deliveries



UNIVERSITY OF ILLINOIS-URBANA



3 0112 037627640