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HOW ARE STOCK PRICES AFFECTED BY THE LOCATION OF TRADE?

Kenneth A. Froot
Emil Dabora

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ABSTRACT

We examine pairs of large, "Siamese twin" companies whose stocks are traded around the world but have different trading and ownership habitats. Twins pool their cashflows so, with integrated markets, twin stocks should move together. In contrast, the relative prices of twin stocks appear correlated with the markets where they are traded most, i.e., a twin's relative price rises when the market on which it is relatively intensively traded rises. We examine several explanations for this phenomenon: discretionary uses of dividend income by parent companies; differences in parent expenditures; voting rights issues; currency fluctuations; ex-dividend-date timing issues; and tax-induced investor heterogeneity. Only that latter hypothesis can explain some (but not all) of the facts. Other possible explanations include: *i*) country-specific sentiment shocks affect share price movements of locally-traded stocks in proportion to their local trading/ownership intensity, and *ii*) investors are rational, but markets are segmented by frictions other than international transactions costs, such as agency problems.

Kenneth A. Froot
Graduate School of Business
Harvard University
Soldiers Field Road
Boston, MA 02163
and NBER
kfroot@hbs.edu

Emil Dabora
Morgan Stanley and Company
1585 Broadway
New York, NY 10036-8200

I. Introduction

The classical finance paradigm predicts that an asset's price is unaffected by the location in which it trades. If international financial markets are perfectly integrated, then the same set of risky cash flows has the same value and risk characteristics when its trade is redistributed across markets and investors.

This paper provides a stark example in which location of trade and ownership appears to influence prices. It shows that the stocks of some of the world's largest and most liquid multinational companies have prices that are strongly influenced by locational factors. The stocks that let us test whether location matters are "Siamese-twin" company stocks. These are corporate pairs with charters that fix the division of current and future equity cash flows to each twin. Each twin retains its own stock with its own distinct trading habitat. We examine three examples of Siamese twins here: 1) Royal Dutch Petroleum and Shell Transport and Trading, plc; 2) Unilever NV and Unilever plc; and 3) SmithKline Beecham. Taken literally, twin charters imply that their stock prices should move in lockstep, in a ratio given by the proportional division of cash flows. However, the stock prices of twins do not behave in this manner. For the first two of these twins, Rosenthal and Young (1990)[1] document persistent and strikingly large deviations of stock prices from the ratio of adjusted cash flows. To this, we add the example of SmithKline Beecham, which exhibits similar types of deviations.

The main contribution of this paper is to show that twin price deviations are highly correlated with relative stock-market indexes in the country where each stock is traded most actively. Thus, for example, when the US market moves up relative to the UK market, the price of Royal Dutch (which trades relatively more in New York) tends to rise relative to that of its twin Shell (which trades relatively more in London). Similarly, when the dollar appreciates against the pound, the price of Royal Dutch tends to increase relative to that of Shell. We consider a number of obvious potential explanations for this behavior, but find that none are able to fully explain it.

A similar sort of behavior occurs with closed-end country funds, which invest in emerging markets but are financed by issuing shares on developed-country markets. It is well-known that the value of these shares differs from the net asset values of the fund portfolios. In particular, it appears that closed-end fund share prices comove more strongly with the stock market on which they trade, while net asset values comove more strongly with their local stock market.[2]

We believe our Siamese-twin stocks provide a more clear-cut example "excess comovement" for several reasons. First, the twins we examine are among the largest and most liquid stocks in the world. By contrast, closed-end funds (and many of the stocks they hold) are relatively illiquid, so their prices are not as clean. Second, our Siamese-twin stocks represent claims on exactly the same underlying cash flows. Closed-end shares, on the other hand, are claims not only to a portfolio of foreign stocks, but also to a dynamic trading strategy determined by fund managers. Differences between fund share prices and

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[1] Rosenthal, and Young (1990).

[2] Hardouvelis, LaPorta, and Wizman (1993) chronicle the behavior of 35 country funds and find that the funds trade on average at a discount and that fund discounts are sensitive to movements in the host country, US and world stock markets. Similarly, Bodurtha, Kim, and Lee (1993) find that the movement of closed-end country funds prices on US markets is correlated with the US market, while the underlying share prices are correlated with the foreign markets on which they trade. These papers build on Lee, Shleifer, and Thaler (1991), who argue that closed-end fund discounts reflect sentiment on small stocks. See also Chen, Kan, and Miller (1993) and Chopra, Lee, Shleifer, and Thaler (1993).

net asset values may be explained by the perceived value of this strategy. Third, arbitrage between closed-end fund shares and net assets is costly or even forbidden.[3] Indeed, because closed-end funds profit by enabling investors to better internationalize their portfolios, funds tend to open where investment barriers are relatively high. By contrast, the stocks of our twins can be easily arbitraged. They trade on major world stock exchanges, so for many investors they can be purchased locally. For example, a US (Dutch) investor can buy Royal Dutch *and* Shell in New York (Amsterdam). As a consequence, the *additional* costs and informational advantages commonly associated with cross-border trading cannot be used to explain our results.[4]

What sources of international segmentation might explain our findings? One hypothesis, which we discuss below, is that of cross-border tax rules. Withholding taxes on dividends differ across countries and investor clienteles. In most instances, however, the withholding taxes for any given investor are the same for the stocks of any pair of twins. Thus, while helpful, tax-driven stories cannot fully account for our findings.

A second possible source of segmentation is that of noise. The story would be that a noise shock hitting, say, US stocks, would disproportionately affect the twin which trades relatively more in New York. That is, stocks which are relatively more actively traded in the local market are more subject to local noise shocks and less subject to foreign noise shocks. If this story is true it has an interesting implication: the component of market movements explained by twin pricing deviations is also likely to be noise. Twin price disparities, which are readily observable, may therefore be informative about market-wide noise shocks, which are not directly observable.

Finally, the comovement patterns may result from institutional frictions involving informational and contractual inefficiencies. Principals may seek to control the agents who invest on their behalf by narrowly defining agents' discretionary authority or by creating contracts which provide incentives for agents to limit discretion. As a result, equity fund managers may be hired with mandates which are restricted to US or international stocks, or they may be benchmarked against a widely-accepted index, such as the S&P500 (which includes Royal Dutch and Unilever NV) or the Financial Times Allshare index (which includes Shell and Unilever plc), even if that index does not exhibit optimal risk / return characteristics. All else equal, these arrangements can create a bias toward certain stocks and away from others by investors from different countries. Such arrangements may be optimal given common information and agency problems in investing.

The rest of this paper is organized as follows. Section II briefly describes the organizational structure of the twins. Section III presents our tests of comovement and cointegration of price twin differentials. Section IV discusses the data. Section V presents our findings on comovement. Section VI discusses several possible explanations for the results. Section VII offers conclusions.

II. Relationships Between Pairs of Twins

A. Royal Dutch Petroleum and Shell Transport and Trading, plc

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[3]Pontiff (1990) shows that the size and persistence of closed-end fund discounts are related cross-sectionally to measures of arbitrage costs between the net asset values and the fund shares.

[4]This argument assumes that the law of one price holds around the world for each stock. Our data support this assumption, as each individual stock trades for approximately the same price in all markets at the same time.

Royal Dutch and Shell are independently incorporated (in the Netherlands and England, respectively). The structure has grown "out of a 1907 alliance between Royal Dutch and Shell Transport by which the two companies agreed to merge their interests on a 60:40 basis while remaining separate and distinct entities."[5] All sets of cash flows, adjusting for corporate tax considerations and control rights, are effectively split in these proportions.[6] Information clarifying the linkages between the two parent companies is widely available.[7] Royal Dutch and Shell trade on nine exchanges in Europe and the US, but Royal Dutch trades primarily in the US and the Netherlands (it is in the S&P 500 and virtually every index of Dutch shares), and Shell trades predominantly in the UK (it is in the Financial Times Allshare Index, or FTSE). Geographical ownership and trading information for Royal Dutch and Shell is shown in Table 1. Log deviations from the expected price ratio are graphed in Figure 1.

B. Unilever NV & Unilever plc

Unilever NV and plc are incorporated in the Netherlands and England, respectively. In 1930, the two companies established an equalization agreement of cash flows. According to it, the two companies act as a single group company and use the same board of directors. In the case of liquidation, all assets are to be pooled and divided evenly among shareholders. The intent of the agreement is to make the shares as similar as possible as if the shareholders in either company held shares in a single company.[8, 9]

Unilever trades on eight exchanges in Europe and the US. NV trades mostly in the Netherlands, then Switzerland and the US (it is in the S&P 500). PLC trades predominantly in the UK (it is in the FTSE). Geographical ownership data are given in Table 1. Deviations from the expected price ratio are graphed in Figure 2.

C. SmithKline Beecham

SmithKline Beckman and Beecham Group merged to form SmithKline Beecham on July 26, 1989. The former holders of Beecham (a UK company) received class A ordinary shares while former holders of SmithKline Beckman (a US corporation) received Equity Units (class E shares) comprised of 5 shares of SmithKline Beecham B ordinary shares and one preferred share of SmithKline Beecham Corporation. The equity units receive their dividends from SB Corp., a wholly-owned American

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[5] Royal Dutch 20F, 1994, p. 1.

[6] "Royal Dutch and Shell Transport shall share in the aggregate net assets and in the net aggregate dividends and interest received from Group companies in the proportion of 60:40. It is further arranged that the burden of all taxes in the nature of or corresponding to an income tax leveeable in respect of such dividends and interest shall fall in the same proportion." Royal Dutch 20-F, 1993, pp. 1-2. See also Rosenthal and Young (1990).

[7] In addition to being explained at the beginning of each Annual Report, the connections are detailed in 20F submissions to the SEC and are the subject of an analyst/investor guide. There is considerable public information about the relative pricing of Royal Dutch and Shell, and "switch" trades are known by traders as those which seek to take advantage of price disparities between Royal Dutch and Shell.

[8] The Equalization Agreement states that distributions are "made on the basis that the sum paid as dividends on every 1 pound nominal amount of plc capital is equal ... to the sum paid as dividends on every 12 fl. nominal amount of ordinary capital of NV". The plc shares are listed as 5 pence per share, and the NV shares are listed at 4 fl per share. Thus earnings per share (expressed in a common currency) are equated by (1 / 5)(plc eps) = (12/4)(NV eps).

[9] The Unilever NV 20F submission to the SEC (1993, p. 2) states: "Since 1930 NV and plc have operated as nearly as is practical as a single entity.... they have agreed to cooperate in every way for the purpose of maintaining a common policy in every field of operations." See also Rosenthal and Young (1990).

subsidiary. The dividends are equalized, so that one class E share provides the same dividend flow as one class A share.[10]

Geographic ownership data are unavailable, so Table 1 lists trading as percentage of yearly trading volume. A shares are traded predominantly in the UK, while H (the ADR on A shares) and E shares are traded in the US. Deviations from parity are graphed in Figure 3.

III. Empirical Hypotheses and Tests

Our null hypothesis is that relative twin prices should be uncorrelated with everything. Our alternative hypothesis is that markets are segmented, so that relative market shocks explain movements in the price differential. Specifically, we hypothesize that those shares which are most intensively traded on a given market will comove excessively with that market and with that market's currency.

To measure the relative comovement, we regress the twin's return differential on contemporaneous US, UK, and Dutch market index returns plus the relevant currency changes:

$$r_{A-B,t} = \alpha + \sum_{i=-1}^{1} \beta_i S\&P_{t+i} + \sum_{j=-1}^{1} \delta_j FTSE_{t+j} + \sum_{k=-1}^{1} \lambda_k DI_{t+k} + \sum_{l=-1}^{1} \gamma_l \$/gl_{t+l} + \sum_{m=-1}^{1} \upsilon_m £/gl_{t+m} + \varepsilon_t \qquad (1)$$

where A and B represent the twin pair. For any return horizon, the null hypothesis is that all of the slope coefficients are zero. Under the alternative hypothesis, the more a stock trades on a given market, the higher its estimated slope. So for example, since Univlever NV trades relatively less intensively in the UK than Unilever plc, the relative return of NV over PLC should exhibit a negative coefficient on the FTSE, and a positive coefficient in the US and Holland (where NV trades relatively more intentsively). Similarly, the NV / PLC differential should exhibit a negative coefficient on the guilder/dollar and guilder/pound exchange rates.

The data in Table 1 suggest that under the alternative, Royal Dutch should have higher correlation with the US and Dutch markets while Shell should have higher correlation with the UK market. The same is true for the Unilever NV / PLC relative return. For SmithKline Beecham, the A (or H) share / E share differential should comove positively with the US market and negatively with the UK market.

We run regressions like equation (1) at return horizons of 1, 2, 5, 15, and 50 days. The lower frequency tests are less impacted by imperfect synchronization of observation of prices (e.g., prices are observed at the close of the New York and European markets, which occurs with a 5-hour lead), staleness, bid/ask bounce, etc. Furthermore, these tests may help choose among underlying causes of segmentation. If, for example, liquidity shocks explain the comovement of local market stocks, they should do so predominantly at higher frequencies.

We also examine the twin price differential for evidence of mean reversion at very low frequencies. Specifically, we test to see whether we can reject the hypothesis that twin price disparities display unit roots:

$$P_{A-B,t} = \alpha + \delta t + \beta P_{A-B,t-1} + \gamma \left(\Delta P_{A,t-1} - \Delta P_{B,t-1}\right) + \varepsilon_t, \qquad (2)$$

[10] "Dividends on Equity Units, which are paid by SmithKline Beecham Corporation ('SB Corp.'), are equivalent to the dividends on the A shares of the Company together with the related tax credit, and include the cumulative preference dividends on the Participating Preferred Shares of SB Corp. up to the date of payment..." (SmithKline Beecham Annual Report and Accounts, 1993).

where $P_{A-B,t}$ is the difference in the logs of twin prices, and Δ is the first-difference operator. The null hypothesis of a unit root in price differentials is given by $\beta = 1$. We also investigate the low-frequency comovement of price disparities and market indexes. That is, we test whether price disparities are cointegrated with some linear combination of stock indexes.

IV. Data

European stock prices for Shell and Unilever plc are from the London Stock Exchange; those for Royal Dutch and Unilever NV are from the Amsterdam Exchange.[11] Royal Dutch, Shell, Unilever plc, and Unilever NV are traded as American Depository Receipts (ADRs) in the US; US return data come from CRSP. Royal Dutch trades in the US markets as a regular security.[12] US returns are from CRSP. The sample period is January 1, 1980 to December 31, 1995. European prices for SmithKline Beecham A shares are for the UK market from IDC.[13] SmithKline Beecham E shares and the ADR of the A shares (H shares) are from CRSP. The sample period follows the merger of SmithKline and Beecham, July 26, 1989 to December 31, 1995.

For US and UK market returns, we use log returns of the S&P500 and FTSE indexes, respectively. The use of these popular indexes creates some ambiguity because Royal Dutch and Unilever NV are in the S&P500 and Shell, Unilever plc, and SmithKline Beecham are in the FTSE. Consequently, the coefficients are slightly biased relative what they would be against indexes which exclude these stocks.

Note, however, that the upward bias in beta is minor, since these stocks comprise only a small part of index capitalization. To see this, one can estimate the approximate bias in the coefficient relative to what it would be in the absence of an own-stock effect. Using data on capitalizations, covariances and variances from 1994, for example, we calculate an upward bias in the coefficient of 0.032 for Shell (which has the largest capitalization of the three stocks in the FTSE).[14] This bias is too small to affect the results presented below.[15]

The own-stock effect is more severe in the case of the Netherlands. Royal Dutch is by far the largest native stock traded on the Amsterdam Exchange. To eliminate any confusion, we remove Royal

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[11]All returns are expressed in log form. Data for Royal Dutch (Amsterdam), Shell (London) and Unilever plc (London) are total returns from Datastream. For Unilever NV(Amsterdam), we used price data from Interactive Data Corporation (IDC), and Datastream total returns (January 1, 1993 to December 31, 1995). Dividend information for Unilever NV is from Rosenthal and Young (January 1, 1980 - May 16, 1986), corporate annual reports (May 17, 1986 to May 4, 1989), and Bloomberg (May 5, 1989 to December 31, 1992).

[12]Shell Oil US handles shareholder servicing responsibilities for Royal Dutch in the US, making ADRs unnecessary.

[13]Dividend data are from Bloomberg Data Services.

[14]This estimate was obtained as follows. The bias in beta is given by:

$$\beta_w - \beta_{w/o} = \left(\frac{Cov(r_{sh}, r_{ftse})}{Var(r_{ftse})}\right) - \left(\frac{Cov(r_{sh}, r) - \alpha Var(r_{sh})}{Var(r_{ftse}) - \alpha^2 Var(r_{sh}) - 2\alpha Cov(r_{sh}, r_{ftse})}\right),$$

where β_w and $\beta_{w/o}$ are regression coefficients with and without Shell included in the FTSE, and α is the fraction of the FTSE's capitalization comprised by Shell (equal to 0.0303 in 1994). Using data from 1994 to estimate the variances and covariances above, β_w and $\beta_{w/o}$ are estimated at 0.9127 and 0.8811, respectively. This suggests that the beta estimate is approximately 0.02 too high.

[15]In some tests (not reported), we created our own arithmetic value-weighted UK stock index of the 20 largest UK stocks (as of 1993) excluding Shell, Unilever plc, and SmithKline Beecham. The coefficients against this index were nearly identical to those against the FTSE.

Dutch from the standard CBS Allshare General Price index. Data for this index and all other European indexes and exchange rates are from Datastream.

Next is the issue of where returns are measured. In the tables below, we estimate the relative return on the twins by taking the difference of the twin log returns, *in the market where they trade most actively.* So for example, for Royal Dutch and Shell we use the difference between the returns in Amsterdam and London. The basic results are unaffected if we were to use instead the relative return of Royal Dutch and Shell both observed in, say, New York. In other words, the results we report are not sensitive to geographic deviations in the law of one price for any given stock.

The final issue is the currency denomination of returns. We leave all return variables in local currencies and then add exchange-rate changes as separate independent variables on the right-hand side of the regressions. To the extent that exchange rates and local-currency equity returns are uncorrelated, any error in exchange-rate changes from non-synchroneities will not bias the coefficients.[16]

IV. Results

A. Alternative Specifications

The results from equation (1) are reported in Tables 2-4 for Royal Dutch / Shell, Unilever NV / PLC, and SmithKline Beecham, respectively.[17] Each line in the tables represents a slight variant of the general specification of the regression in equation (1). The first four specifications use one-day return horizons, while specifications 5 through 8 use longer return horizons. Within the one-day returns, specifications 1 and 2 represent slightly different lead/lag variants. In specification 1, the independent variables have one lead and one lag of all right-hand side variables. In specification 2, we restrict the leads and lags to those suggested by the actual market timing differences. For example, in Table 2, the dependent variable, the relative return of Royal Dutch over Shell, is observed daily at the close of European trading. Since the European markets close before the US market, only the earlier day's US market return is included on the right-hand side of Specification 2.

Specifications 3 and 4 are analogous to specifications 1 and 2, except that a lagged dependent variable is added on the right-hand side. This allows us to estimate the short- versus long-run effects of a change in the market indicators on the twin price disparity:[18]

$$r_{A-B,s} = \alpha + \theta\, r_{A-B,s-1} + \beta r_{S\&P,s} + \delta\, r_{FTSE,s} + \lambda r_{DI,s} + \gamma\, \$/gl_s + \upsilon\, £/gl_s + \varepsilon_{A-B,s}. \qquad (3)$$

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[16] Exchange-rate changes and local currency stock returns show little correlation in our data. In an earlier version of this paper (available from the authors), we provide a second method of dealing with currencies. There, we converted all returns into a common currency, and omitted exchange-rate changes from the right-hand side. In principal this method is inferior, because non-synchroneities in currency versus stock prices introduce measurement error into the right-hand side variables. However, in practice the two methodologies yielded very similar results.

[17] In the tables, twin equity returns are observed in the country where each twin is most liquid. We tried using returns from a common market (e.g., Royal Dutch and Shell both measured on the NYSE). See the earlier version of this paper for details. The results were qualitatively similar to those presented here. Small differences in coefficients (particularly in the 1-day regressions) occur, however, due to transient deviations from the law of one price for any given stock.

[18] Leads and lags in equation (3) are identical to those used in equation (1) for all coefficients but the lagged dependent variable. They are omitted to keep the notation simple.

The coefficient β can be interpreted as the short-run response of the return differential to a shock to the S&P 500, and $\beta/(1-\theta)$ can be interpreted as the long-run response. If prices tend to revert toward parity, then we should find that long-run responses are smaller than short-run responses, so that $\theta < 0$.

Specifications 5-8 reports results for return horizons of 2, 5, 15, and 50 days using specification 2. Because low power does not appear to be a problem at these horizons, we take the opportunity to make inferences more reliable by using non-overlapping returns.[19]

B. Estimates

The results in Tables 2-4 strongly reject the perfect-integration hypothesis. The sign of virtually all coefficients line up with our alternative hypotheses, and most are significantly different from zero at the one-percent level.[20] They are also economically large: in Table 2, for example, the one-day Royal Dutch / Shell return differential yields coefficients of about 0.15 on the S&P, -0.50 on the FTSE, and 0.30 on the Dutch index. The coefficients on the exchange rates are also large, at -0.10 and -0.50 for the *gl*/$ and *gl*/£ exchange rates. An one-percent appreciation of the guilder against the dollar and pound increases the relative price of Royal Dutch over Shell by about 10 and 50 basis points, respectively. All the estimates correspond to the *disparity* in the market betas of identical cashflows with different trading and ownership patterns. The R^2s in Table 2 are also surprisingly high, around 20 percent for one-day returns and 50 percent for longer-horizon returns.

The coefficient estimates appear reasonably stable over time. It is interesting that Table 1 shows a large change in Shell ownership in 1985, when US holdings rose to 8 percent from under 1 percent. Table 2 suggests that this change in ownership was associated with a decline in the S&P coefficient, as our alternative hypothesis would predict. Specifications 3 and 4 imply estimates of the lagged-dependent variable coefficient, θ_{AB}, of about -0.2, with strong statistical significance. This implies that the short-horizon beta coefficients are about 20 percent greater than their long-horizon counterparts. While this estimate is not economically small, it suggests nevertheless that the comovements we measure persist as return horizon increases.

Tables 3 and 4 reveal a similar story for Unilever NV and plc and SmithKline Beecham. Once again, we reject the null hypothesis in most cases at the one-percent level of significance.

These results provide evidence of comovement between twin price differentials and market indexes for long as well as short horizons. The data allow us to state this finding more surprisingly: in our sample, there is no statistical evidence that the comovement is at all transient. That is, can we reject the hypotheses that: *i*) the price differentials contain unit roots; and *ii)* the price differentials and linear combinations of stock indexes are cointegrated.

First, we investigated whether the price differentials contain unit roots using the augmented Dickey-Fuller test. The data cannot reject the unit root hypothesis for Royal Dutch / Shell and Unilever NV / Unilever plc. We were, however, able to reject the unit root hypothesis for SmithKline Beecham. Results are reported in Table 5.

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[19] Non-overlapping returns fail to utilize all the information in the data. However, they generate higher quality standard errors because the residuals are serially uncorrelated under the null hypothesis.

[20] The tests of significance are F-tests on the sum of the lead, current, and lag coefficients for each index.

Second, we tested for cointegration between price differentials and arbitrary linear combinations of market indexes. The data are able to reject the null hypothesis of no cointegration for all three sets of twins. This suggests that one would need a longer time series to make even the minimal claim that price differentials do not grow with stock markets differentials over the long run, but instead revert back toward zero

Third, we attempted to determine the number of cointegrating relationships between the price differentials and market indexes using the Johansen test.[21] Our results, reported in Table 5, show that we can reject the null hypothesis of zero cointegrating vectors in favor of the alternative hypotheses of one, two, and three cointegrating vectors. Once again, this suggests that whatever the transient component in price differentials may be, we cannot detect its presence using standard tests.

V. Explaining the Comovement of Relative Prices and Market Indexes

In this section we analyze several potential explanations for the price deviations and comovements with market indexes. In order to conserve space, we focus on the largest twin pair, Royal Dutch / Shell, although similar results obtain for all thee twin pairs. While each explanation may be the source of some slippage between relative prices, it appears none can explain a meaningful fraction of the price differentials or comovement patterns.

A. Preliminary Issue: The Mechanics of Splitting Cashflow

The Royal Dutch / Shell Group splits net income in the proportion 60:40. Included in the group's charter is an arrangement to offset the effects of corporate taxes, so that the 60:40 split applies on an after-corporate-tax basis. This policy became important, when, in 1972, the UK introduced a tax system aimed at eliminating double taxation of dividend income. The Advance Corporation Tax (ACT) provided for an offset against corporate taxes in the year the dividend is paid. Shareholders were to receive their dividend plus a credit from the government. Over time, the credit has varied slightly, but has typically been about 20% of the *gross* dividend (dividend plus credit).

To neutralize the effects of the ACT, the Group splits the value of the ACT credit in the same 60:40 ratio. Because Royal Dutch shareholders must receive their share of the credit through the company (while Shell shareholders receive it through the UK tax authorities), the Group pays more than 60% to Royal Dutch shareholders. Inclusive of ACT, the precise split is 652:435, where the ACT credit is 0.087 (20% of the Shell gross dividend of $0.435). Of this amount 60% (0.6x0.087 = 0.052) is paid directly to Royal Dutch shareholders. Thus, the Group's direct shareholder payments are split 652:348, and Shell shareholders receive the 0.087 credit to bring their after-tax share to 40%.[22,23]

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[21] For a discussion of the Johansen test, see Chapter 20 of Hamilton (1994).

[22] This split can be obtained as follows. Let a represent the fraction of distributed dividends received by Shell shareholders and b represent the after-tax-credit value per unit of distributed dividends. Royal Dutch shareholders must receive $.6\ b = 1 - a$. Shell shareholders receive b augmented by their tax credit: $b = 1 + a\tau / (1 - \tau)$. If $\tau = 0.20$, then $a = 0.348$.

[23] The 1907 merger agreement anticipated that income taxes paid by parent companies on group dividends would have to be split 60:40. However, taxes on dividends paid by parent company *shareholders* were not included. Because the ACT behaves both as a group tax on dividends and as a Shell shareholder credit, there was a dispute within the group companies as to whether Shell shareholders were entitled, in the spirit of the original merger agreement, to the entire ACT credit or only 40 percent of that credit. From the inception of the ACT in 1972, the group held to a 60:40 split of the ACT credit. In 1977, the group resolved the dispute by deciding that the 60:40

The larger point here is that Royal Dutch / Shell actively maintains its 60:40 policy, even intervening to offset corporate tax asymmetries in the tax regimes of the two countries.

B. Discretion in the Use of Dividend Income

One possible explanation for the price behavior is that the parent companies do not pass dividends directly to shareholders, and that they instead invest independently a portion of the funds. If this were the case, we would expect parent company prices to deviate from the calculated expected price ratio as investment values varied. This does not appear to be the case: the 1907 merger agreement specifies that the parent companies are not to make their own investments, and that they are to pass the dividends received directly along to shareholders.[24]

Note, however, that neither company pays out the all distributed group earnings as shareholder dividends. Both parents maintain a cash reserve account to promote ease in rounding and "to provide a cushion against extreme currency fluctuations."[25,26] The policy is to keep reserves low, but the size of the reserve varies from year to year.[27] To see if the reserve is important, we can cumulate dividends (in a common currency, adjusting for splits and short-term interest rates). This provides us with a crude measure of deviations from a cash-only reserve policy. If reserve funds withheld by the parents were invested only in cash, then the ratio of cumulative dividends would be constant. In fact, the ratio of cumulated dividends did deviate from the 60:40 ratio, but only by a maximum of about 75 basis points. See Figure 4. Such deviations are far too small to explain the magnitude and volatility of the price differentials. Nevertheless, Figure 4 is interesting since it is appears to be correlated with the price differential at low frequencies.

C. Differences Between the Parent Companies' Expenditures

Another potential explanation for the price disparities is that of parent company differences in expenses. If expenses deviated substantially from the 60:40 ratio, the net receipts of parent company shareholders would be affected. However, deviations of expenses from 60:40 are far too small to explain our findings. Differential expenses for 1993, for example, impact each share by approximately 6 basis points. A generous capitalization of these expense differentials would yield share price differentials of only about 1 percent.

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split would continue, but that Shell shareholders were to receive supplementary dividends of 15% of normal dividends for the 1977-1984 period, in consideration of their claims (January 13, 1977 press releases by parent companies).

[24] "Royal Dutch Petroleum has no operations of its own and virtually the whole of its income derives from its 60% interest in the companies collectively known as the Royal Dutch/Shell Group of Companies...." (Royal Dutch 1994 Annual Report) "The Shell Transport and Trading Company, plc has no operations of its own and virtually the whole of its income derives from its 40% interest in the companies collectively known as the Royal Dutch/Shell Group of Companies" (Shell Transport and Trading 1994 Annual Report).

[25] "As the amounts dealt with under the investment reserve have been, or will be, substantially reinvested by the companies concerned, it is not meaningful to provide for taxes on possible future distributions out of earnings retained by those companies; it is furthermore not practicable to estimate the full amount of the tax or the withholding tax element." Royal Dutch, 1994 Annual Report.

[26] From *Guidance Notes For Investors and Analysts: A Technical Guide on the Accounts, Dividends and Shares of Royal Dutch Petroleum Company and the Shell Transport and Trading Company,* June 1994, p. 23.

[27] Annual reports and company interviews suggest that the reserve account is invested either in cash at a bank or in the form of short-term deposits with a duration of less than three months.

D. Voting rights

The issue of control could be used to explain price disparities. Since Royal Dutch has a 60% share in both cash flows as well as voting power, it could then use this power to damage Shell shareholders interests.[28] Fluctuations in value of control would lead to fluctuations in relative prices. The biggest problem with this story is that it fails to explain how Shell can be expensive relative to Royal Dutch, which was the case between 1980 and 1986. Furthermore, a control premium on Royal Dutch would explain the correlation with market indexes only if economy-wide changes in the value of control explain a large fraction of market movements. Finally, there are anti-takeover provisions which make it difficult to accumulate large blocks of control of Royal Dutch or Shell.[29]

E. Dividends and Currencies

Dividends are announced by both parents on the same day. At that time, dividend allocations for Royal Dutch (Shell) are converted into guilders (pounds) at prevailing spot exchange rates. In the time between the announcement and payment dates, fluctuations in the pound/guilder rate change the relative value of the dividend payment to Royal Dutch and Shell shareholders.

These factors can explain only very minor movements in the price differential. Exchange-rate changes can matter only during the window between the announcement and ex-dividend dates, and they can matter only for the value of the current dividend (not the present value of dividends). Given a dividend price ratio of 5%, semi-annual dividends, pound/guilder volatility of 1% per day, and actual payment periods corresponding to those in practice, currency differences in dividend denomination add at most 40 basis points to total return volatility over a year.[30]

F. Ex-Dividend Date Structure

Royal Dutch and Shell shares may go ex-dividend on different dates. This implies that, over some periods, there may a price wedge between the two securities if one security is past its ex-dividend date while the other isn't. This effect is also small. At a dividend/price ratio of 6%, of which approximately 3.6% is the final dividend and 2.4% is the interim dividend, the price differential would be at most a few percent. There is also no reason to think that the ex-dividend patterns are correlated with market movements.[31]

G. Tax-Induced Investor Heterogeneity

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[28]The internal control of the companies is set up as follows. Each parent has its own independent management. The members of the Board of Managers of Royal Dutch and the Managing Directors of Shell are also group Managing Directors. They maintain positions on the boards of the three Group Holding Companies (see figure with company structure). The proportion of members on this Group Board is 60:40.

[29] Ordinary shareholders of Royal Dutch face a cap on the number of shareholder votes at 12,000. This limits attacks on the management board, which can in principle alter the 60:40 relationship.

[30] Note also that we control for currency fluctuations in our regressions. Thus, the comovements with local-currency market indexes cannot under any circumstances be explained by currency fluctuations.

[31]Obviously, any price differential from dividend-date timing persists for only a limited period. For example, during the 1991-93 period, the difference between ex-dividend dates for Royal Dutch and Shell were 13 and 63 days, respectively, for interim and final dividend payments.

Perhaps the most promising explanation of price differentials is that of tax distortions. In the presence of such distortions, country-specific shocks to investor preferences or taxation can lead to correlation between relative twin returns and market indicators. However, for this explanation to work, it is not enough for taxes to segment one country from another. Within each country, taxes would have to segment the twin pair.

To see this, suppose that there are differences in dividend taxation across countries and that, within any given country, dividends on twin stocks are treated identically by the local tax authority. Under these circumstances, a reduction in local dividend taxation might well move the local market up relative to the foreign market. However, there is no reason for the twin log price differential to change, since from any given investor's perspective, there is no change in the after-tax cashflows of one twin *relative* to the other. Thus, to change relative twin prices the tax treatment of the tax treatment of one twin relative to the other would have to be different for at least some investor classes.

To address this issue we examine the tax burdens borne by specific investor groups in the US, UK, and Netherlands. Taxation of international dividends is clearly a complex area. For example, a US shareholder of a UK security may pay withholding tax, receive the ACT tax credit, and receive a credit from the US Treasury on the withholding tax.[32] And the actual rates paid may be altered through financial contracting or institutional restructuring. In spite of this, the tax laws are generally clear on how dividends ought to be treated for investor classes in different countries. Table 6, therefore, shows dividend withholding tax rates inclusive of ACT for shareholders by country (UK; US; and Netherlands) and by investor class (private investors; companies and investment trusts; and pension funds).

The table shows that that private investors in any country should be indifferent between investing in Royal Dutch and Shell.[33,34] Companies and investment trusts in the Netherlands and US should also be indifferent between Royal Dutch and Shell, while UK companies and investment trusts should slightly prefer holding Shell. The major differences are with pension funds. UK pension (or "gross") funds pay no taxes on Shell, but face net 15% withholding taxes on Royal Dutch dividends; [35] Netherlands pension funds face no taxation on Royal Dutch but pay 15% withholding taxes on Shell. By contrast, prior to January 1, 1994, US pensions were indifferent to holding Royal Dutch and Shell, as the withholding tax faced by US pensions was 15% on both stocks.[36]

There are several implications of these facts. First, there is at least one group of investors in each country that is indifferent to the tax effect. This group could act as the marginal investor to qualize

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[32]This ignores taxes which affect both twins identically (e.g., personal income taxes).

[33]When holding Royal Dutch, UK residents pay a 25% withholding tax, but 10% is reclaimable under the UK/Netherlands double taxation agreement. The UK also levees a supplemental 5% dividend tax, bringing the total tax to 20%. The Shell shareholder also pays a net tax of 20% on dividends, so that the taxation on Royal Dutch and Shell are the same.

[34] Netherlands investors are subject to a 25% withholding tax on Royal Dutch dividends, which is creditable against their Netherlands income tax liability on the dividends. Shell shareholders that invest through a UK nominee company receive the full UK tax credit, but then must pay a 15% UK withholding tax. The withholding tax is creditable against Netherlands income taxes, so that the effective tax rates are equal on both sources of dividend income.

[35] Under UK law, tax-exempt investors are entitled to a full credit against ACT. This includes UK, US, and Netherlands pensions.

[36] At the time of writing, US pension funds have a preference for Royal Dutch. However, this is true only since the Double Taxation Treaty between the US and the Netherlands became effective on January 1, 1994.

price. For example, we would expect private investors and companies in the Netherlands to hold shares in Shell when it is cheap relative to Royal Dutch. However, no discernible increase in the net holdings of Shell in the Netherlands appears during these periods.

Second, during all but the last two years of the sample period, *all* US investors were faced indifferent to Royal Dutch versus Shell on a tax basis. Thus, we would expect to see holding patterns in the US move toward the cheaper security. For example, Shell is the relatively cheap security from 1985 to 1992. Nevertheless, very few Shell shares are held in the US during this period, yet at the same time, US Royal Dutch holdings are large and increasing. Furthermore, the tax indifference makes it difficult to explain the correlation of relative prices with either US market movements or with the US dollar.

Third, even though some investors may have had tax-induced differences in reservation prices, it is not clear that these differences would be enough to explain price deviations of 30% or more. Thus, this analysis suggests that tax issues, while helpful, are unlikely to explain all of the components of the price deviations.

III. Conclusions

This paper presents evidence that stock prices are affected by the location of trade. It shows that twin stocks, which have nearly identical cashflows, move more like the markets where they trade most intensively. The comovements are present at long as well as short horizons. Location of trade therefore appears to matter for pricing.

As to the underlying sources of segmentation, three possibilities emerge from our study. First is the tax-induced investor heterogeneity explanation. This explanation seems incomplete. It does not explain correlations with the US market, since during the bulk of our sample all major US investor groups faced equivalent tax treatment on twin stocks. It also does not explain why US holdings of the cheap stock did not grow while those of the expensive stock did not shrink.

The second possible source of segmentation is that of noise. Market-wide noise shocks from irrational traders which infect locally traded stocks more than foreign traded stocks can explain the comovement. Indeed, this story suggests that the portion of market movements that is correlated with fluctuations in twin relative prices is attributable to noise. The main problem with this story – generally – is that it is hard to identify the source of noise or persistent irrationality.

Third, institutional inefficiencies might explain comovements. By virtue of higher liquidity or inclusion in domestic-market indexes, one twin may be classified as a "domestic" stock. (Note that causality here could easily run the other way, suggesting the possibility of multiple equilibria.) Classification as "domestic" and "foreign" appear to be important in practice and may help resolve informational asymmetries and agency problems in the investment process.

Finally, there is the question of how arbitrage can discipline the price gap. In a frictionless world, it is clear that arbitrage would occur – any single investor could finance sufficiently large long positions in the cheap twin with short positions in the expensive one to drive prices to parity.[37] But frictions – i.e., lack of discipline – should not be construed as a satisfactory explanation for twin price behavior. By analogy, we have laws that require parents to protect their offspring, but we would not want to accept the inability to invoke such laws as the reason that offspring are at times abandoned.

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[37] Specific data on transactions costs and strategies are explored in Froot and Perold (1996).

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Figure 1
Log Deviations from Royal Dutch / Shell Parity

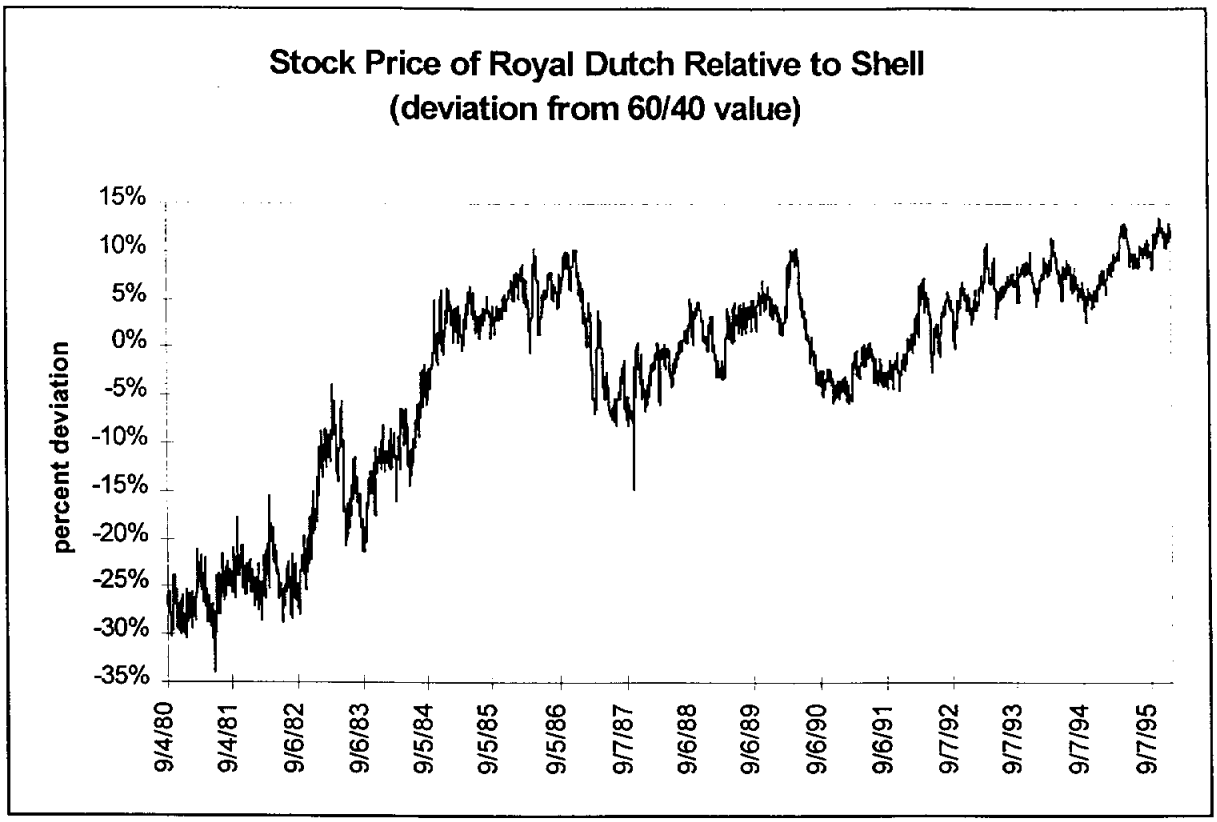


Figure 2
Log Deviations from Unilever NV / Unilever plc Parity

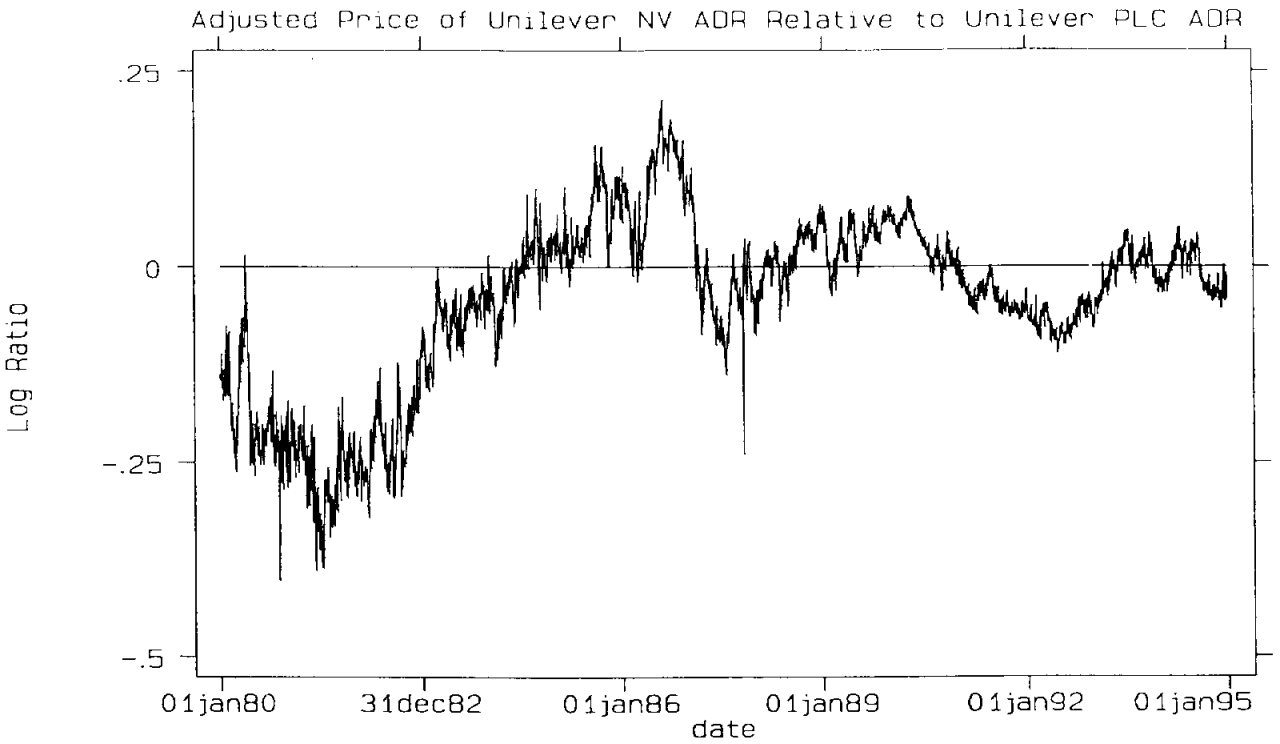


Figure 3
Log Deviations from SmithKline Beecham Parity

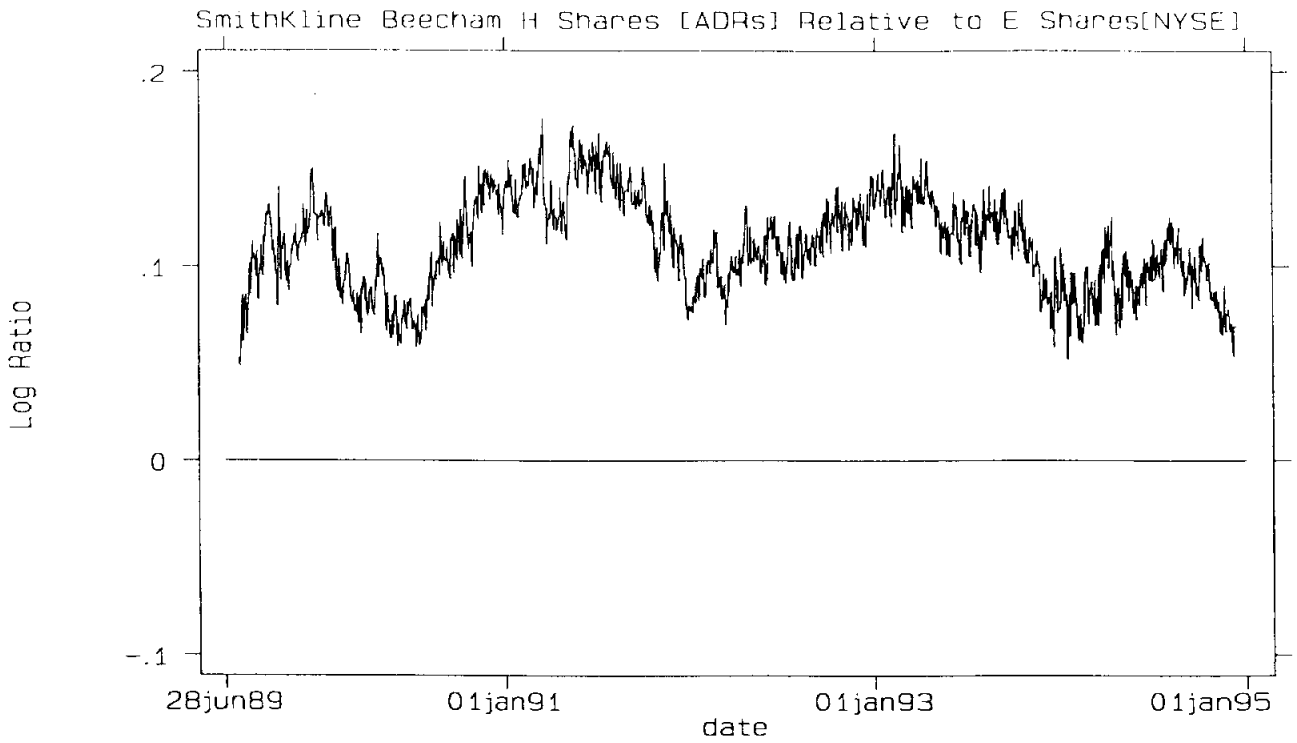


Table 1
Distribution of Share Ownership Across Markets

(average 1980 - 1992)

Company	Percent owned in		
	US	UK	Netherlands
Royal Dutch	33%	4%	34%
Shell	3%	96%	<1%
Unilever NV	16%	10%	46%
Unilever PLC	<1%	99%	<1%

(average 1991-95)

Company	Percent of average daily volume traded in		
	US	UK	Netherlands
Royal Dutch	70%	NA	30%
Shell	32% (ADR)	68%	NA
SmithKline	83%	17%	NA

Sources: Royal Dutch and Shell 20-F statements, 1980-1992; Unilever NV, 20-F, 1980-1983; a booklet published by Unilever NV entitled "Charts 1984 - 1994"; Trading volume data are from the NYSE and London Stock Exchange.

Table 2
Regression Output For Royal Dutch / Shell Transport & Trading

Regressions are of the equation:

$$r_{RD-SH,t} = \alpha + \sum_{i=-1}^{1} \beta_i S\&P_{t+i} + \sum_{j=-1}^{1} \delta_j FTSE_{t+j} + \sum_{k=-1}^{1} \lambda_k DI_{t+k} + \sum_{l=-1}^{1} \gamma_l gl/\$_{t+l} + \sum_{m=-1}^{1} \upsilon_m gl/£_{t+m} + \varepsilon_t$$

where $r_{RD-SH,t}$ is the difference between the log returns of Royal Dutch (Amsterdam) and Shell (London); *S&P*, *FTSE*, and *DI* are returns on the S&P, Financial Times Allshare index, and Dutch stock indexes, respectively, expressed in their native currencies; and *gl/*$ and *gl/*£, represent log changes in the dollar- and pound-to-guilder exchange rates. Specification 1 includes leads and lags (shown) to allow for nonsynchronous trading. Specification 2 employs a more restricted set of leads and lags (based on actual time differentials). Specifications 3 and 4 are the same as Specifications 1 and 2, but include a lagged dependent variable on the right-hand side. Durbin's Alternate H (DAH) is reported in place of the Durbin-Watson (DW) statistic for Specifications 3 and 4. Specifications 5, 6, 7, 8 employ 2-, 5-, 15-, and 50-day returns. For these specifications, leads and lags of independent variables are dropped. All regressions are OLS, with standard errors that allow for serial correlation and heteroskedasticity. One, two, and three asterisks represent statistical significance at the 10%, 5%, and 1% levels, respectively. Tests statistics are F-tests against zero on the sum of each index's coefficients.

Specification	Return Horizon	R^2	DW or DAH	DOF	Lagged Dep Var	S&P	FTSE	Dutch Index	*gl/*$	*gl/*£
1, 1980-1995	1 day	0.247	2.37	4155		0.207***	-0.428***	0.150***	-0.102***	-0.345***
2, 1980-1995	1 day	0.218	2.35	4164		0.135***	-0.516***	0.365***	-0.123***	-0.612***
3, 1980-1995	1 day	0.271	-0.39***	4154	-0.174***	0.205***	-0.516***	0.213***	-0.113***	-0.439***
4, 1980-1995	1 day	0.262	0.19	4164	-0.209***	0.146***	-0.536***	0.359***	-0.121***	-0.612***
5, 1980-1995	2 day	0.204	2.42	1950		0.064**	-0.451***	0.292***	-0.041*	-0.502***
6, 1980-1995	5 day	0.244	2.29	776		0.087**	-0.409***	0.246***	-0.068*	-0.440***
7, 1980-1995	15 day	0.233	2.49	254		0.116***	-0.370***	0.213***	-0.126**	-0.287***
8, 1980-1995	50 day	0.521	2.35	71		0.184***	-0.489***	0.285***	-0.170***	-0.385***
2, 1980	1 day	0.187	2.40	250		0.074	-0.636***	0.450***	-0.114	-0.629***
2, 1981	1 day	0.274	2.33	253		0.483**	-0.882***	0.817***	-0.449**	0.885***
2, 1982	1 day	0.188	2.29	253		0.186	-0.540***	0.356***	-0.152	-0.846***
2, 1983	1 day	0.265	2.05	253		0.291***	-0.500***	0.141*	-0.065	-0.779***
2, 1984	1 day	0.305	2.19	253		0.206	-0.556***	0.364***	0.024	-0.752***
2, 1985	1 day	0.158	2.39	253		-0.036	-0.307***	0.158**	-0.050	-0.562***
2, 1986	1 day	0.295	2.02	253		0.131***	-0.323***	0.198***	-0.067	-0.564***
2, 1987	1 day	0.293	2.38	253		0.048***	-0.496***	0.484***	0.212	-0.656***
2, 1988	1 day	0.270	2.69	253		0.084**	-0.630***	0.437***	-0.178	-0.583***
2, 1989	1 day	0.362	2.16	253		0.069	-0.722***	0.464***	-0.177**	-0.345***
2, 1990	1 day	0.256	2.43	253		0.091**	-0.306***	0.247***	-0.182	-0.695***
2, 1991	1 day	0.189	2.09	253		0.033	-0.562***	0.499***	-0.005	-0.328*
2, 1992	1 day	0.242	2.23	253		0.151	-0.428***	0.289***	-0.187**	-0.430***
2, 1993	1 day	0.323	2.27	253		-0.097	-0.475***	0.266***	-0.009	-0.659***
2, 1994	1 day	0.376	2.45	253		0.224***	-0.698***	0.388***	0.260***	-0.556***
2, 1995	1 day	0.183	2.65	252		0.059	-0.270***	0.186**	-0.169**	-0.357***

Table 3
Regression Output For Unilever NV / Unilever PLC

Regressions are of the equation:

$$r_{NV-PLC,t} = \alpha + \sum_{i=-1}^{1} \beta_i S\&P_{t+i} + \sum_{j=-1}^{1} \delta_j FTSE_{t+j} + \sum_{k=-1}^{1} \lambda_k DI_{t+k} + \sum_{l=-1}^{1} \gamma_l gl/\$_{t+l} + \sum_{m=-1}^{1} \upsilon_m gl/£_{t+m} + \varepsilon_t$$

where $r_{NV-PLC,t}$ is the difference between the log returns of Unilever NV (Amsterdam) and PLC (London); *S&P*, *FTSE*, and *DI* are returns on the S&P, Financial Times Allshare index, and Dutch stock indexes, respectively, expressed in their native currencies; and *gl*/$ and *gl*/£, represent log changes in the dollar- and pound-to-guilder exchange rates. Specification 1 includes leads and lags (shown above) to allow for nonsynchronous trading. Specification 2 employs a more restricted set of leads and lags (based on actual time differentials). Specifications 3 and 4 are the same as Specifications 1 and 2, but include a lagged dependent variable on the right-hand side. Durbin's Alternate H (DAH) is reported in place of the Durbin-Watson (DW) statistic for Specifications 3 and 4. Specifications 5, 6, 7, 8 employ 2-, 5-, 15-, and 50-day returns. For these specifications, leads and lags of independent variables are dropped. All regressions are OLS, with standard errors that allow for serial correlation and heteroskedasticity. One, two, and three asterisks represent statistical significance at the 10%, 5%, and 1% levels, respectively. Tests statistics are F-tests against zero on the sum of each index's coefficients.

Specification	Return Horizon	R^2	DW or DAH	DOF	Lagged Dep Var	S&P	FTSE	Dutch Index	*gl*/$	*gl*/£
1, 1980-1995	1 day	0.290	2.27	4124		0.098***	-0.490***	0.328***	-0.138***	-0.463***
2, 1980-1995	1 day	0.259	2.25	4133		0.046***	-0.624***	0.556***	-0.125***	-0.658***
3, 1980-1995	1 day	0.298	-0.30**	4091	-0.131***	0.098***	-0.571***	0.394***	-0.157***	-0.552***
4, 1980-1995	1 day	0.287	0.13***	4101	-0.182***	0.085***	-0.640***	0.544***	-0.667***	-0.132***
5, 1980-1995	2 day	0.258	2.26	1950		0.041**	-0.550***	0.467***	-0.090***	-0.565***
6, 1980-1995	5 day	0.244	2.26	776		0.034	-0.470***	0.341***	-0.123***	-0.374***
7, 1980-1995	15 day	0.239	2.44	254		0.095**	-0.436***	0.253***	-0.146**	-0.291***
8, 1980-1995	50 day	0.352	2.16	71		0.017	-0.376***	0.274***	-0.090*	-0.255***
2, 1980	1 day	0.300	2.06	247		0.073	-0.596***	0.847***	-0.401	-0.862***
2, 1981	1 day	0.313	2.18	250		0.014	-0.752***	0.760***	0.009	-0.705***
2, 1982	1 day	0.331	2.03	250		-0.092	-0.687***	0.725***	-0.145	-0.777***
2, 1983	1 day	0.163	2.32	250		0.166	-0.392***	0.247***	-0.070	-0.468***
2, 1984	1 day	0.355	2.29	250		-0.007	-0.546***	0.547***	-0.120	-0.755***
2, 1985	1 day	0.235	1.73	251		0.074	-0.506***	0.390***	0.064	-0.799***
2, 1986	1 day	0.355	2.05	251		-0.010	-0.442***	0.512***	-0.417***	-0.940***
2, 1987	1 day	0.291	2.34	251		-0.060	-0.744***	0.695***	-0.093	-0.886***
2, 1988	1 day	0.395	2.45	252		0.167***	-0.778***	0.715***	0.101	-0.510***
2, 1989	1 day	0.469	2.00	252		0.040**	-0.696***	0.688***	-0.214*	-0.838***
2, 1990	1 day	0.346	2.21	250		0.188*	-0.629***	0.548***	-0.106	-0.454***
2, 1991	1 day	0.256	2.16	250		0.080*	-0.635***	0.502***	-0.116	-0.432**
2, 1992	1 day	0.220	2.21	251		0.199	-0.369***	0.309***	-0.127	-0.450***
2, 1993	1 day	0.176	2.58	253		0.002**	-0.493***	0.202*	-0.069	-0.688***
2, 1994	1 day	0.200	2.59	253		0.513***	-0.775***	0.199	-0.668***	-0.845***
2, 1995	1 day	0.160	2.67	252		0.015**	-0.456***	0.230**	-0.213	-0.464**

Table 4
Regression Output For SmithKline Beecham

Regressions are of the equation:

$$r_{SKA-SKB,t} = \alpha + \sum_{i=-1}^{1} \beta_i S\&P_{t+i} + \sum_{j=-1}^{1} \delta_j FTSE_{t+j} + \sum_{l=-1}^{1} \gamma_l \$/£_{t+l} + \varepsilon_t$$

where $r_{SKA-SKB,t}$ is the difference between the log returns of SmithKline Beecham A shares (London) and E shares (New York); S&P and FTSE, are returns on the S&P and Financial Times Allshare index, respectively, expressed in their native currencies; and \$/£ represents log changes in the pound-to-dollar exchange rate. Specification 1 includes leads and lags (shown above) to allow for nonsynchronous trading. Specification 2 employs a more restricted set of leads and lags (based on actual time differentials). Specifications 3 and 4 are the same as Specifications 1 and 2, but include a lagged dependent variable on the right-hand side. Durbin's Alternate H (DAH) is reported in place of the Durbin-Watson (DW) statistic for Specifications 3 and 4. Specifications 5, 6, 7, 8 employ 2-, 5-, 15-, and 50-day returns. For these specifications, leads and lags of independent variables are dropped. All regressions are OLS, with standard errors that allow for serial correlation and heteroskedasticity. One, two, and three asterisks represent statistical significance at the 10%, 5%, and 1% levels, respectively. Tests statistics are F-tests against zero on the sum of each index's coefficients.

Specification	Return Horizon	R^2	DW or DAH	DOF	Lagged Dep Var	S&P	FTSE	\$/£
1, 7/89-12/95	1 day	0.221	2.70	1665		-0.270***	0.291***	0.119***
2, 7/89-12/95	1 day	0.216	2.69	1668		-0.390***	0.390***	0.215***
3, 7/89-12/95	1 day	0.311	-0.54***	1665	-0.335***	-0.508***	0.458***	0.212***
4, 7/89-12/95	1 day	0.307	-0.43***	1667	-0.318***	-0.541***	0.365***	0.214***
5, 7/89-12/95	2 day	0.118	2.70	834		-0.466***	0.409***	0.184***
6, 7/89-12/95	5 day	0.167	2.68	330		-0.460***	0.380***	0.136***
7, 7/89-12/95	15 day	0.112	2.57	106		-0.275***	0.216***	0.092*
8, 7/89-12/95	50 day	0.217	1.98	28		-0.299**	0.120*	-0.057
2, 7/89-7/90	1 day	0.450	2.35	253		-0.713***	0.629***	0.309***
2, 7/90-7/91	1 day	0.302	2.57	256		-0.400**	0.242***	0.331**
2, 7/91-7/92	1 day	0.282	2.50	256		-0.167***	0.213***	0.232***
2, 7/92-7/93	1 day	0.214	2.88	256		-0.278***	0.544***	0.237
2, 7/93-7/94	1 day	0.122	2.85	256		-0.235***	0.382***	-0.137*
2, 7/94-7/95	1 day	0.113	2.57	256		-0.060***	0.154***	0.104***
2, 7/95-2/95	1 day	0.143	2.41	107		-0.457***	0.285*	0.035***

Table 5
Cointegration and Unit Root Tests

Augmented Dickey-Fuller Tests of Log Price Differentials and Log Prices

Variable	Coefficient	P-Value	Results
$P_{RD,t} - P_{Shell,t}$	-0.0034	-0.0034	Fail to Reject Unit Root
$P_{UNV,t} - P_{Uplc,t}$	-0.0042	-0.0042	Fail to Reject Unit Root
$P_{SKA,t} - P_{SKE,t}$	-0.0052	-0.0052	Fail to Reject Unit Root
Dutch Index	-0.0002	-0.0002	Fail to Reject Unit Root
FTSE Index	-0.0006	-0.0006	Fail to Reject Unit Root
S&P Index	-0.0007	-0.0007	Fail to Reject Unit Root

Tests for Cointegration Between Price Differentials and Market Indices

Variable	Coefficient	P-Value	Results
$P_{RD,t} - P_{Shell,t}$	-0.0249	0.00000	Reject Unit Root
$P_{UNV,t} - P_{Uplc,t}$	-0.0129	0.00057	Reject Unit Root
$P_{SKA,t} - P_{SKE,t}$	-0.0253	0.00366	Reject Unit Root

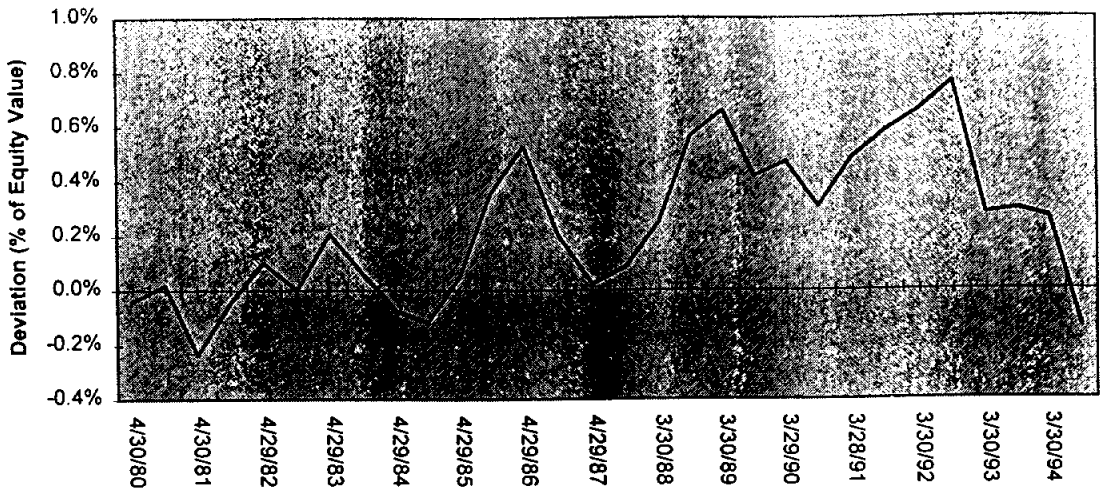
Johansen Test for the Number of Cointegrating Vectors (h) Among Price Differentials and Market Indices

Hypothesis for $P_{RD,t} - P_{Shell,t}$	Likelihood Ratio	Test Statistic, p = 0.05	Result
Test null h=4 vs h=0	79.68	47.18	Reject Null
Test null h=1 vs h=0	31.66	27.17	Reject Null

Hypothesis for $P_{UNV,t} - P_{Uplc,t}$	Likelihood Ratio	Test Statistic, p = 0.05	Result
Test null h=4 vs h=0	73.98	47.18	Reject Null
Test null h=1 vs h=0	33.77	27.17	Reject Null

Hypothesis for $P_{SKA,t} - P_{SKE,t}$	Likelihood Ratio	Test Statistic, p = 0.05	Result
Test null h=3 vs h=0	24.93	29.51	Fail to Reject Null
Test null h=1 vs h=0	16.79	20.78	Fail to Reject Null

Figure 4
Cumulative Present Value of Dividends on Royal Dutch Shares Relative to those of Shell



Dividends of Royal Dutch and Shell are converted into a common currency and cumulated (from the date on the horizontal axis to the end of the sample) using short-term interest rates. Each point on the graph shows the relative value of cumulated dividends.

Table 6
Taxation of Different Investor Classes in Different Countries, 1993[a]

Country	Investor Class	Tax Rate on Royal Dutch Dividends	Tax Rate on Shell Dividends	Preference	Difference in Annual Return from Tax Differential[b]
U.K.	Private Investors	20%	20%	Indifferent	-
	Companies	33%	20%	Shell	-0.64%
	Pension Funds	15%	-	Shell	-0.74%
Netherlands	Private Investors	25%	25%	Indifferent	-
	Companies	25%	25%	Indifferent	-
	Pension Funds	-	25%	Royal Dutch	1.23%
Us[c]	Private Investors	15%	15%	Indifferent	-
	Companies	15%	15%	Indifferent	-
	Pension Funds[d]	15%	15%	Indifferent	-

[a] Taxes represented: withholding tax, dividend tax, and ACT. Tax treatment of capital gains on Royal Dutch and Shell were equivalent for all shareholder groups, and are therefore not reported.
[b] Average of Royal Dutch and Shell dividend/price ratios (4.92% in 1993) times the difference between Shell and Royal Dutch rates of dividend taxation.
[c] In the United States, withholding taxes were reclaimable from income tax for corporations and individuals. Withholding taxes on foreign securities could either be deducted against U.S. personal or corporate income taxes, or, under current tax treaties, refunded directly from the United Kingdom and Netherlands tax authorities.
[d] Historically, US pension and endowment funds were not able to deduct foreign taxes paid against U.S. tax obligations. Following January 1, 1994, U.S. pension funds were able to obtain withholding-tax refunds on Netherlands stocks, such as Royal Dutch, reducing the effective tax rate to zero.