Global Finance Journal

Global Finance Journal 10:2 (1999) 201–221

Re-examining the small-cap myth: problems in portfolio formation and liquidation

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Abstract

This study investigates the realizable returns on portfolios at the turn-of-the-year. Using an intraday simulation that accounts for the volumes offered or wanted at market bid-ask prices, large-capitalization securities significantly outperform small-capitalization securities by 2.4% and 6.5%, depending on whether the portfolios were formed on the last day of the taxation year or were formed over the last month of the trading year. In no one year could the small-capitalization portfolio be completely divested by the end of the holding period, suggesting that investors are not remunerated for the illiquidity in this portfolio. Results based on returns calculated by using the mean of the bid-ask spread show that the results are not derived solely from transaction costs.

JEL classification: G11; G14

Keywords: Liquidity; Transactions costs; Market depth

". . . small-cap stocks always do better than big company stocks in the long run. Or do they?" (McGough and Lohse, *Wall Street Journal*, 10 February 1997, p. C1).

This study investigates the realizable returns on portfolios at the turn of the year (TOYE). The results suggest that the ability to trade in small-capitalization securities with market orders prior to the year-end differs dramatically from the ability to trade in the same securities after the year-end. This is contrary to the maintained hypothesis that, on average, there are roughly an equal number of buyers and sellers in the market. The study finds that it requires much longer to divest a portfolio than it takes to form it. Given the depth of trading in large-capitalization issues, the standard

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1044-0283/99/$ – see front matter
PII: S1044-0283(99)00017-4

assumption of unlimited instantaneous selling may be appropriate. However, because formation time is a function of liquidity, portfolios constructed with less liquid stocks require much longer to form in the absence of price concessions and commensurately much longer to liquidate. Here, the assumption of unlimited instantaneous selling without price concessions is inappropriate. Thus, the efficient market assumption of symmetry between the numbers of buyers and the numbers of sellers and their related trading volume may, at best, be misleading and may have serious ramifications for the methods by which researchers test hypotheses.

Advocates of investment in small-capitalization securities generally make two points. First, because small firms grow faster than large firms, they are attractive to less-risk-averse investors seeking to increase their wealth. Second, small-capitalization securities have historically appeared to earn returns in excess of theoretical expectations. For example, the most persistent aspect of the capital asset pricing misspecification (CAPM; Reinganum, 1981) was the well-documented empirical finding that small-capitalization securities yield excess returns primarily over the first 4 trading days of the new taxation year[1], although excess returns later in January also have been documented. Small firms also seem to outperform large firms on a risk-adjusted basis in general. Hence, although the turn-of-the-year and the small-firm effect (SFE) are not the same phenomenon, they are also not completely independent.

Many researchers investigating the SFE and TOYE have documented the tendency for prices at the beginning of the year-end period to close at the bid and after the turn-of-the-year to close at the ask. Thus, investment strategies attempting to exploit the short-term price movements at this time must buy at the bid and sell at the ask. Of course, it is not possible to trade at these prices with market orders, and the bid-ask spreads for stocks that exhibit this price pattern are large enough to preclude profitable exploitation (Bhardwaj & Brooks, 1992; Keim, 1989). Nonetheless, this did not prevent individuals from attempting to use derivative instruments to arbitrage the TOYE. Ritter (1996) details both his successful and his unsuccessful attempts at buying Value Line futures and shorting Standard and Poor's 500 futures during the 1980s.

This study revisits the matter because earlier work on this topic revealed serious issues resulting from thin trading in the Canadian market. This issue is nontrivial when examining estimated returns from smaller exchanges in general and, in many cases, returns from international equity markets. Are the estimated returns actually achievable? To illustrate this point, Table 1 reports the market capitalization, the dollar value of traded volume, and the number of issues listed for 23 developed stock markets through the world. On the basis of these data, the Toronto Stock Exchange (TSE) ranks fourth in regard to market capitalization and eighth in regard to traded volume and has the sixth highest number of listed securities. The results indicate that, despite the size of the Canadian market, the problem of small-capitalization portfolio formation and liquidation is far more serious than the belief in the efficient market hypothesis would lead one to believe. It takes approximately from four to five times as long to divest a portfolio than to form it. Further, if there are difficulties in forming and liquidating portfolios on the TSE, one can reasonably expect to find similar problems on other exchanges.

Table 1
Developed equity markets—1995

Country	Principal exchange	Total market capitalization ($ billions)	Trading volume ($ billions)	Total issues listed
Australia	Sydney	434.2	106.8	1,579
Austria	Vienna	30.2	12.7	171
Belgium	Brussels	94.0	1.3	281
Canada	Toronto	728.7	154.6	1,527
Denmark	Copenhagen	64.6	27.7	386
Finland	Helsinki	41.0	18.2	92
France	Paris	488.8	206.4	904
Germany	Frankfurt	544.5	1,168.8	1,818
Hong Kong	Hong Kong	309.2	112.6	553
Italy	Milan	219.3	94.5	316
Japan	Tokyo	3,333.0	770.5	1,793
Luxembourg	Luxembourg	363.6	0.2	327
Malaysia	Kuala Lumpur	232.8	73.6	529
Netherlands	Amsterdam	346.0	241.8	621
New Zealand	Wellington	34.5	9.3	198
Norway	Oslo	48.7	24.6	182
Singapore	Singapore	354.5	63.7	423
South Africa	Johannesburg	255.6	15.8	839
Spain	Madrid	187.3	54.0	366
Sweden	Stockholm	176.0	99.2	236
Switzerland	Zurich	341.7	301.2	530
United Kingdom	London	5,211.8	2,299.4	3,270
United States	New York	6,188.3	3,172.8	3,126

Note: Market capitalizations are for total issues listed as of 31 December 1995 except for Australia where total issued listed is as of 31 December 1994. All amounts are translated into U.S. dollars by using 1996 average exchange rates. Countries chosen are the same as in Ibbotson and Brinson (1993) except for Ireland, which was excluded owing to missing data. All data were obtained from *World Stock Exchange Fact Book* (Meridan Securities Markets, 1997).

In particular, this study analyzes the practical implementation problems of portfolio investment and divestment by extending the work of Bhardwaj and Brooks (1992). Their study finds that large-capitalization stocks outperform small-capitalization stocks by using:

1. data from the New York Stock Exchange (NYSE) and the American Stock Exchange (AMEX);
2. estimates of transactions costs; and
3. the implicit assumption that positions of any size can be acquired and liquidated at existing prices on any given day.

By using actual transaction costs and returns based on intraday market prices, this study shows that Bhardwaj and Brooks' third assumption seriously understates the portfolio formation and liquidation problem. The findings suggest that the small-

capitalization portfolio liquidation problem results in the investor being exposed to unexpected holding-period risk.

To keep the issue in an easily understood framework, the TOYE is re-examined but, unlike that of other studies, the purpose is not to exploit the apparent regularity, but rather to highlight the effect that market depth has on portfolio formation, liquidation, and returns. If financial theory is correct, any superior returns to the small-firm portfolio should be eliminated after accounting for transaction costs and should then be indistinguishable from large-firm returns. Although it can be argued that, for illiquid securities with high transactions costs, equilibrium time-horizon investors with much longer expected holding periods than those of investors in liquid securities would exist[2], this paper concentrates on the now infamous TOYE to illustrate the extent of the portfolio formation and liquidation problems.

Theoretically, our study challenges the validity of a maintained hypothesis found in all earlier studies. As stated in Roll (1983b), "After [the turn-of-the-year]. . ., the trading would revert to the normal pattern of a roughly equal number of buyers and sellers and an average transactions price close to the center of the bid-ask spread." The current study addresses several specific questions.

1. What is the nature of available small-capitalization volume prior to the TOYE?
2. What is the nature of available small-capitalization volume during and after the TOYE?
3. Is the nature of volume the same in the two periods?

Simply put, is there any reason to believe Roll's hypothesis? The results provide substantial evidence of an inability to liquidate small-capitalization portfolios in a timely fashion.

The analysis is based on a simulation that acquires positions in both large- and small-capitalization portfolios at the taxation year end. The use of an intraday simulation is crucial to verify the SFE/TOYE existence because the regression analyses are usually based on the last trade of the day, which potentially represents as little as one round lot and thus does not adequately represent the actual intraday volume facing traders. Further, several earlier studies suggested that closing prices are not representative of intraday prices [see, among others, Harris (1986) and Griffiths and White (1993)]. In the empirical tests, the position taken is one of an individual or institution capable of purchasing (selling) the total volume offered (wanted) in small-capitalization securities by using market orders. This assumption is the most reasonable strategy to simulate, because the TOYE is a time-dependent activity; that is, investors need to create a specific portfolio at one particular point and to divest the identical portfolio promptly at a second particular point. For control purposes, these trades are matched with identical simulated dollar-value purchases of securities in the large-capitalization portfolio. Hence, there is a direct examination of whether the small-capitalization portfolio return is equal to the large-capitalization portfolio return. The result is that the large-capitalization portfolio significantly outperforms the small-capitalization portfolio.

Initially, buying on the TSE is deemed to start on the last trading day of the old taxation year, and selling takes place over the first 5 trading days (Keim, 1983) of the

next year. From 1984 through 1993, a small-capitalization portfolio valued in excess of $1 million can be formed only in the last 2 years, despite the assumption of being the sole buyer in the market. Additional volume simply does not exist at market prices. The difficulties with market depth are not limited to portfolio formation; the investment cannot be completely liquidated by the last turn-of-the-year day. If the residual holdings in the portfolios are divested at one tick below the last bid price and brokerage commissions are included, the large-capitalization portfolio dominates the small-capitalization portfolio in every year of the sample period.[3]

The results with the use of the 1993 and 1994 NYSE data are similar. With the assumption again that there is only one purchaser in the market in 1993, only $8.2 million can be invested in the small-capitalization portfolio on the last trading day of the year and 37 issues, representing approximately 9.8% of the original investment remain unsold 5 trading days later. The analysis for the 5-day turn-of-the-year holding period reveals that the large-capitalization portfolio loses approximately 1.3%, whereas the small-capitalization portfolio loses roughly 1.2%.[4] In 1994, although investment to the $10 million limit is possible, approximately 1% remains undivested in the small-capitalization portfolio 5 trading days later. Over this 5-day year-end holding period, the large capitalization portfolio loses 2.2%, whereas the small-capitalization portfolio loses 6.8%.

In an attempt to increase the size of the small-capitalization portfolio and to examine the issue of market depth in greater detail, the simulation was reprogrammed to begin "buying" TSE securities on the first trading day of December. Here, full investment is reached in only 5 of the 10 years in our sample. Even so, in 4 of the years in which $10 million could be invested, it required 12 or 13 trading days to acquire the position. Further, liquidation continues to be a problem. In no one year could divestment be completed by 30 April, despite the assumption that any posted volume at the bid price could be sold without competition. Therefore, in addition to holding-period market risk, there is additional firm-specific risk incurred because of the breakdown in portfolio diversification.

In the next section, previous research on the SFE is summarized. The data and methods are described in Section 2, and our results appear in the third section. The final section comprises a summary and conclusions.

1. Previous research on the small-firm effect

It is generally accepted that a large proportion of the entire year's return for small-capitalization firms is concentrated in the first few days of January (Keim, 1983; Reinganum, 1983) and that the SFE is not an industry-specific phenomenon (Carlton & Lakonishok, 1986). Some of this movement is attributable to tax-loss selling (Griffiths & White, 1993; Jones et al., 1991) in that the marginal investor is selling at the end of December and buying in the first few trading days of January. That is, the majority of trades in December are at the bid prices, and the majority of trades in early January are at the ask prices. Thus, index returns based on closing prices are biased toward positive returns at this time. If, as Haugen and Lakonishok (1987) and

Constantinides (1984) suggest, investors buy in the first half of the year and sell in the last half of the year, then it is not surprising that regression results detect significant effects only at the major turning point.

Bhardwaj and Brooks (1992) estimate that bid-ask bias, caused by the systematic switching of trades from bid to ask prices at the turn of the year, accounts for approximately a 1% overstatement in the estimates of small-capitalization returns during the 1982–1986 period. Keim (1989), using a sample of over-the-counter stocks for the period 1984–1988, reports a bias ranging from 1.5% to 2.5%.

A caveat is necessary in drawing generalized conclusions with respect to being able to exploit the TOYE profitably on the basis of these earlier regression-based results. Specifically, these studies concentrate on rates of return or percentage costs or both and draw indirect inferences about economic value. In particular, they generally share two implicit assumptions: (1) returns based on closing prices represent accurately realizable returns, and (2) unlimited volume can be transacted at closing prices. A third issue arising from the use of regression techniques is one of selection bias. In general, securities are chosen on the basis of the existence of daily returns as well as on size characteristics. At the turn-of-the-year, this ex-post selection bias results in retaining successful or frequently traded issues in the sample or both. There may be two reasons for this bias. First, as Ritter (1988) points out, investors may "park-and-ride"; that is, funds from earlier December sales are reinvested over the first few trading days of the new taxation year. Second, as Ferris, Haugen and Makhija (1988) suggest, investors may realize "winners" early but will delay realization of "losers." Thus, securities in demand may be frequently traded and reflect price increases, whereas losers may not trade at all and be eliminated from study samples for lack of returns data. In any case, the maintained hypothesis remains that investors can trade on demand and without any price concessions in identical volume at the bid after the year end as they did at the ask price prior to the year end.

The Knez and Ready (1996) study examines the CAPM that the return to a portfolio of small-capitalization securities is highly correlated with its own previous week's return and with the previous week's return to a portfolio of large-capitalization stocks (Lo & MacKinlay, 1990). Unfortunately, in their analyses of their trading strategies, data limitations precluded them from examining information on quoted depths at the bid and ask prices. Hence, there is no guarantee that the submitted orders would execute at the simulated prices. Nonetheless, they suggest that the transaction costs associated with weekly rebalancing have a negligible effect on the portfolio of large firms but they reduce the annual return to the small-capitalization portfolio from an average annual profit of 14% to an average annual loss of 8%.

This study investigates the assumptions of closing prices being representative of intraday prices and the issue of actual tradable volume. In particular, the role of liquidity and an investor's ability to buy and sell small-capitalization securities at quoted market prices at the turn of the year is examined. With the use of trade-to-trade data, the purchase and sale of securities at the year end can be simulated. That is, the analysis recognizes both the prices and the volumes at which investors would have to trade.

2. Data and methods

Intraday data from the TSE[5] from December 1984 through April 1994 are used in this paper. Data on dividend amounts, split ratios, shares outstanding, and daily closing and opening prices were obtained from the TSE CD-ROM common equity products. The data include all date- and time-stamped bid-ask quotations, transaction prices, and volumes for every security listed on the Toronto Stock Exchange. The analyses are restricted to common equities.

The study also uses the trade and quote (TAQ) database for December 1993 through January 1995. The data, available from the New York Stock Exchange, include observations similar to those available in Canada. Although the data are not as extensive, the observations for NYSE securities are used to demonstrate the generality of the model and findings.

The analyses commence by ensuring that the TOYE continues to appear to exist in Canada. Two daily indices from the TSE-Western Business School Database were obtained. The first is an index of common equities valued at $2 or less, and the second is the TSE300 index, comprising the TSE's 300 largest securities by capitalization. All returns are calculated on the basis of closing prices and are value weighted. Because Canadian tax regulations allow only trades consummated in the current taxation year, the turn-of-the-year in Canada is based on settlement 5 business days after the transaction took place. Hence, the last day of the old taxation year is 6 trading days prior to the calendar year end.

For benchmark comparison purposes, the Griffiths and White (1993) method was replicated, and virtually identical results for the period from December 1977 to January 1989 were obtained, despite their use of individual portfolios. Accordingly, these results are not reported. The analysis was then updated to cover the December 1984 through January 1994 period. The results, generated from estimating Eq. (1) are itemized in Table 2.

$$r_{i,t} = \gamma_0 + \gamma_1 D_{i,t} + \epsilon_{i,t} \tag{1}$$

where:

$r_{i,t}$ = the logarithm of the price relative from $t - 1$ to t.
$D_{i,t}$ = a dummy variable with a value of 1 for each of the trading days from the last trading day of the old taxation year through the fifth trading day of the new taxation year and zero otherwise.
$\epsilon_{i,t}$ = an independently and identically distributed error term.

The findings confirm the appearance of the TOYE in Canada and are highly comparable in size and significance to the earlier Griffiths and White findings. Hence, this sample, which has portfolio sizes similar to those in the earlier paper, demonstrates the same TOYE as that of the index returns.

Five portfolios are then created on the basis of the market value of common equity calculated as the (closing price * number of shares outstanding)[6] as of the last trading day of November for every year in the sample period. On average, this results in approximately 177 securities per portfolio in 1984, to a high of 232 securities per

Table 2
Regression results of daily index returns on Canadian tax year dummy variables

Index	A_{i0}	a_{i1}	Adj. R^2	F statistic	p value
Under $2	−0.0003	0.0137	0.1004	49.439	0.0001
	(−0.357)	(7.031***)			
TSE300	0.0009	0.0015	0.0045	2.960	0.0861
	(2.771***)	(1.720)			

Note: This table follows Griffiths and White (1993) in reporting the OLS regression results for a pooled time series of Canadian index returns. The equation estimated is:

$$R_{it} = \gamma_{i0} + \gamma_{i1}\, DUM + e_{it}$$

where R_{it} is the equally weighted index return on securities prices under $2 or the TSE300 total return index, as indicated. The dummy variable has a value of 1 for each of the 6 trading days commencing 1 day prior to the turn of the tax year, day −6 in Canada. The data were obtained from the TSE-Western Business School database and cover the period December 1984 through January 1994; t-statistics are shown in parentheses.

***Significant at the 1% level.

portfolio in 1988, before declining to 220 securities each in 1993. Table 3 details the average annual market value of capitalization and the average share price for both the large- and small-capitalization portfolios over the sample period.

In each year of the 10-year sample period, there are approximately 211 issues in each of the large- and small-capitalization portfolios. In the small-capitalization portfolio, an average of 53% (112 issues) trade daily in December; this percentage ranges from a low of 39% in 1990 to a high of 65% in 1993. In contrast, 85% of the large-capitalization issues trade daily in December, ranging from a low of 79% in 1990 to a high of 92% in 1993. Further, the average small-capitalization issues trade only an average of five times a day—roughly, once every 1.5 hours—whereas a large-capitalization issue trades almost eight times as frequently.

To ascertain which securities to purchase, a time series is created for all securities in each quintile ordered by the time-stamped quotes and transactions. The objective is to ensure that quantities included in the simulation represent actual quantities available at the turn of the year; that is, it would have been possible to purchase these quantities at the quoted price. Hence, the simulation deems purchases of available securities according to the shares-offered order flow, and it will not acquire more shares than were offered at that time. The investment is restricted to less than a controlling position and therefore limits the equity position in any issue to a maximum of 10% of the shares outstanding. The dollar amount invested is then tracked to compute the holding-period return. This arbitrary restriction was employed to emphasize the acquisitive nature of the transactions and to avoid any confounding criticisms related to takeover and acquisition issues. Additionally, because the analysis relies on the small-capitalization order flow, it was important to ensure adequate diversification by avoiding concentration in a single issue. Empirically, the restriction has no effect.

On the appropriate day of every year, the program commences “buying” securities

Table 3
Summary statistics for the Canadian small- and large-capitalization portfolios

Year	Number of issues	Average price ($)	Average capital ($)	Average number of issues traded (Dec)	Average number of trades daily (Dec)	Average daily volume (Dec)	Average number of issues traded (Jan)	Average number of trades daily (Jan)	Average daily volume (Jan)
A. Small-capitalization portfolio:									
1984	177	0.65	1,793,297	115	4	7,520	83	3	7,409
1985	180	0.79	2,283,472	108	6	16,798	103	6	22,219
1986	203	0.88	2,572,441	118	5	13,066	127	7	20,013
1987	231	1.12	3,308,805	128	4	9,046	126	5	10,246
1988	232	0.59	2,599,802	120	4	15,053	121	5	14,873
1989	230	0.47	2,062,481	114	3	22,012	104	4	15,599
1990	219	0.30	1,280,999	86	4	20,569	63	3	17,271
1991	207	0.34	1,478,941	87	4	22,351	74	5	28,481
1992	206	0.40	1,821,248	105	9	45,651	97	16	67,515
1993	220	0.87	5,500,720	142	8	37,520	145	13	56,644
B. Large-capitalization portfolio:									
1984	177	25.44	1,902,366,050	154	25	24,674	158	37	40,610
1985	180	28.46	2,199,383,952	164	40	46,187	165	45	56,603
1986	203	25.49	2,174,096,132	183	32	41,747	188	56	92,995
1987	231	20.18	2,084,658,194	200	38	60,940	202	43	57,778
1988	232	22.25	2,328,883,293	189	34	60,563	200	62	95,383
1989	230	24.60	2,836,830,431	191	39	65,499	190	50	92,542
1990	219	18.94	2,547,392,060	174	36	62,584	174	39	68,243
1991	207	20.49	2,480,709,438	172	40	67,138	179	52	89,773
1992	206	19.78	2,255,261,858	172	41	84,971	173	48	105,004
1993	220	23.82	2,576,803,711	202	58	131,615	202	75	187,372

Note: Portfolio size was determined as of the last trading day in November in the relevant year. The data were obtained from the TSE-Western Business School database and cover the period 30 November 1984 through 30 April 1994. Results in this table cover the period November 1984 through December 1994. Where appropriate, amounts are in Canadian dollars.

in the smallest quintile to a maximum of $10 million or 10% of the total market capitalization of a given issue.[7] According to the order flow, the total or fractional round lot volume (as appropriate) offered at the ask prices is deemed to be purchased. To ensure the accuracy of the simulation, in regard to the number of shares available, the following decision rule [Eq. (2)] is used to guarantee that the shares posted at successive market quotes are not double counted.[8]

Volume at successive quotes is assumed to represent the same shares unless an intervening buy or sell transaction takes place. If an increase in the volume quoted at the bid (ask) occurs, it represents an increase in available shares that can be used in the simulation.[9] The direction of the intervening transaction is determined by identifying the initiator of the trade. For Canadian securities, the modified tick test is used, whereas the standard tick test is used for the U.S. data owing to the differences in the minimum spread. See, Griffiths and White (1993) for a discussion of the merits of these tests.

New volume at either the bid or the ask is defined as:

$$\Delta V_t = V_t + T_t - V_{t-1} \tag{2}$$

where:

V_t = quoted volume at time t.
T_t = transaction volume between $t - 1$ and t, provided $T_t \leqslant V_{t-1}$.
V_{t-1} = quoted volume at time $t - 1$.

Hence, any changes in volume at the bid (ask) is determined by taking the current volume quoted (V_t), subtracting the volume stated in the preceding quote (V_{t-1}), and adding any intervening shares transacted. If $T_t > V_{t-1}$, then the quoted volume at V_t is deemed to be new supply.[10]

For control purposes, every small-capitalization purchase is matched with an equal dollar-value purchase of the next available large-capitalization security according to the order-flow time line. Given the liquidity of the securities in the large-capitalization portfolio, the potential price effect of any timing lag is negligible. Although purchases are simulated in round lots only in the small-capitalization portfolio, for dollar-matching purposes, we must allow the purchase of fractional lots in the large-capitalization portfolio. Liquidations of securities are handled in the same fashion as purchases but based on the order flow of volumes at the bid in each of the portfolios; that is, the liquidation of the large-capitalization portfolio is not dependent on the small-capitalization order flow. Funds arising from liquidations are deemed to be held at the call-loan rate (the Canadian overnight interbank loan rate) until the end of the holding period.

Because the method depends on order flow, the simulation does not buy an equal-dollar value of shares of each security in the portfolio. Requiring an equally weighted small-capitalization portfolio would increase both the portfolio formation and liquidation time, as well as decrease the total amount invested. Any excess cash is assumed to earn the call-loan rate. All cash dividends earned during the holding period are reinvested in the appropriate portfolio at the earliest possible opportunity. Stock

dividends increase the total number of shares held. If a security is delisted in the holding period, the portfolio sells backward to liquidate 100% of its holding by the delisting date, and the cash is assumed to be held at the call-loan rate.

After the relevant buying period, the program simulates the sale of the securities, beginning on the first trading day of the new tax year. Sales are made as they take place, based on the aforementioned criteria, until the entire portfolio is liquidated, with the cash being invested at the appropriate call-loan rate.

To account appropriately for transaction costs, the program utilizes the Green Line Investors Services Direct Trading Commission Schedule (available on request) posted on their World Wide Web page on 18 April 1996. Green Line is a major Canadian discount broker. For completeness, the Green Line commission rates were compared with the Charles Schwab rates posted on the same day and were found to be very similar. The assumption that the commissions listed prevailed throughout the sample period was arbitrarily made. Because these rates are current minimum rates, they bias the results in favor of finding a small-capitalization premium.

For the purposes of this study, a minor adjustment was made to the algorithm determining the transaction costs of the large-capitalization purchases. Because purchases are matched on the basis of the small-capitalization securities' order flow, the result will be an unrealistically high transaction cost for large-capitalization stocks because the simulation will generally be acquiring partial lots. Accordingly, at the end of each formation period, the purchases of large-capitalization securities are re-examined, and transactions costs are re-calculated on the basis of likely purchases. For example, the purchase of four partial lots might be combined into two round lots and one partial fill. This adjustment to fixed transaction costs only has no effect on the relative performance of the large- and small-capitalization portfolios. The adjustment is performed only to provide a more realistic measure of the benchmark return.

3. Results

3.1. The 5 turn-of-the-year days

To begin, the optimal investment strategy in the Canadian market is examined;—that is, buying on day −6 and selling on days −5 through −1. As Table 4 shows, more than $1 million can be invested in the small-capitalization portfolio in only the last 2 years of the sample period. Surprisingly, in 3 years, the simulation was unable to invest more than $475,000, despite the assumption of being the only buyer in the market. Although this may appear somewhat unusual because the TSE is North America's second-largest centralized exchange, the results are consistent with the reported findings of Griffiths and White (1993) on Canadian year-end trading activity.

Although, on average, the investment per issue is [1/N*100]% of the small-capitalization portfolio, some individual securities actually constitute from 4.5% to 22% of the total investment. In only 3 years is the 10% (of total shares outstanding) investment limit reached (for one issue in each case). Nonetheless, the mean weight per security

Table 4
Summary statistics for the Canadian small-capitalization portfolios

Year	Number of issues qualified for inclusion	Number of issues purchased	Total amount invested ($)	Average % of port holding per issue (VW)	Median % of port holding per issue (VW)	Minimum % of port holding per issue (VW)	Maximum % of port holding per issue (VW)	Number of issues at 10% limit
1984	177	147	402,843	0.68	0.20	0.01	18.77	0
1985	180	146	663,137	0.69	0.14	0.01	15.25	0
1986	203	159	939,759	0.63	0.26	0.01	4.65	0
1987	231	155	862,568	0.65	0.22	0.01	12.52	0
1988	232	138	656,475	0.73	0.30	0.01	16.26	1
1989	230	159	611,087	0.63	0.26	0.01	13.38	0
1990	219	132	423,407	0.76	0.23	0.01	12.15	0
1991	207	133	466,487	0.75	0.33	0.01	7.68	0
1992	206	144	2,517,254	0.69	0.13	0.00	21.85	1
1993	220	192	4,569,558	0.52	0.14	0.00	9.63	1

Note: Portfolio size was determined as of the last trading day in November in the relevant year. All simulated purchases are made on trading day −6 relative to the calendar year end. Simulated sales begin on day −5 and continue through day −1. The data were obtained from the TSE-Western Business School database and cover the period 30 November 1984 through 30 April 1994. Where appropriate, amounts are in Canadian dollars.

is significantly greater than the median weight. In contrast, in every year, some issues constitute less than 0.01% of the total portfolio value. This type of portfolio weighting is consistent with securities being purchased on the basis of order flow, rather than on a diversification strategy. Note that the weighting of the individual securities is contrary to efficient market expectations and contrary to the equally weighted method with which researchers generally form portfolios for hypothesis-testing purposes.

Table 5 presents summary holding-period results for the trading strategy. In no one year could the portfolio purchased on day −6 be liquidated over the next 5 trading days; sufficient volume at the ask prices simply did not exist. The unsold securities represent from 4% to 31% of the original portfolio on the basis of the average cost but are worth approximately 23% less on the basis of the last bid price; the unsold share values range from $53,043 to $426,147. The shares are valued at total average cost, because the undivested securities are sold from "inventory" without regard to price or time of purchase.

In every year in the sample period, the return to the small-capitalization portfolio is negative and is dominated by the return to the large-capitalization portfolio. In fact, over the entire sample period, the large-capitalization portfolio outperforms the small-capitalization portfolio by 2.4% on an average 5-day holding period arithmetic-mean basis.[11] The hypothesis of equal mean returns is easily rejected at the 1% level (t-statistic = 4.47), although this may arise from several factors.

First, returns are now measured from ask prices to bid prices. Because small-

Table 5
Summary holding period results for the Canadian small-capitalization portfolio

Year	Number of transactions	Number of issues not sold by day −1	Total average cost of unsold issues ($)	Total value of unsold shares at last bid ($)	Total average cost as % of original investment	Total small portfolio holding period return (%)	Total large portfolio holding period return (%)
1984	748	30	73,356	57,425	18.2	−1.0	0.3
1985	868	22	158,069	126,345	23.8	−1.9	0.1
1986	965	29	150,274	126,408	16.0	−2.4	−0.1
1987	797	21	110,055	89,962	12.8	−1.8	−0.1
1988	692	34	201,874	165,681	30.8	−2.6	0.0
1989	697	36	142,292	101,225	23.3	−2.6	0.1
1990	594	28	107,533	80,884	25.4	−1.4	0.2
1991	605	30	79,042	53,043	16.9	−1.6	0.0
1992	1,636	19	95,539	72,480	3.8	−1.1	−0.5
1993	2,297	22	450,324	426,147	9.8	−8.5	−1.0

Note: Portfolio size was determined as of the last trading day of November in the relevant year. All simulated small-capitalization portfolio purchases (number of transactions) are made on trading day −6 relative to the calendar year end. Simulated sales begin on day −5 and continue through day −1. Five-day holding-period returns include transaction costs, interest on univested cash, and unsold small-capitalization shares liquidated at one tick below the last bid price, as described in Section 3. The data were obtained from the TSE-Western Business School database and cover the period 30 November 1984 through 30 April 1994. Where appropriate, amounts are in Canadian dollars. All columns refer to the small-capitalization portfolio unless otherwise indicated.

capitalization securities have larger relative bid-ask spreads, one would expect this result just as regression results may capture an apparent excess return owing to closing prices shifting systematically from bid prices to ask prices at the year end. Second, the difference may result partly from the use of simulated market orders. That is, to the extent that price improvement through negotiation with dealers is possible and more likely for small-capitalization securities, our estimate of the mean difference in returns is overstated. Both of these arguments are contradicted by analyses using the mean of the bid-ask spread, which were performed to address directly the issue of whether the dominant performance of the large-capitalization portfolio is attributable to their small relative bid-ask spreads.

With the use of mean spread returns (not presented in the interest of brevity but available upon request), the large capitalization portfolio continues to dominate in 9 of the 10 years in the sample. Only in 1992 does the small-capitalization portfolio outperform the large by earning 2.5% to the latter's 0.3%. However, 1992 is also the only year in which the small-capitalization return is positive. Excluding 1992, the small-capitalization portfolio ranges from a low of −3.7% (1993) to a high of −0.4% (1984, 1991). The large capitalization portfolio return is positive in every year and significantly outperforms the small-firm portfolio by 1.12% (arithmetic mean) over the 5-day holding period. Hence, (1) transaction costs alone do not explain the SFE

and TOYE, and (2) the pretransaction costs excess returns to the small-capitalization portfolio are insufficient to offset the consequences of the inability to trade.

Note also that the value of the unsold securities at the last bid price is always less than their value at total average cost. Thus, the overall value of these issues is declining over the turn of the year. The existence of these unsold securities is evidence that the nature of trading in these issues after the year end is different from the nature of trading prior to the year end. This result is strong support for the Roll (1983a) arguments on the biases inherent in daily rebalanced portfolios (indexes) and lends support to other findings that closing transactions may not be representative of intraday prices.

Table 6 presents the results from analyzing the 2 years of NYSE data available.[12] Here, simulated purchases take place on the last trading day of the calendar year. Table 6A shows that, in 1993, there were deemed purchases of 211 large-capitalization issues but only 180 small-capitalization issues. This result is considerably different from the 1994 year-end results where there are deemed purchases of 38 large-capitalization issues and 249 small-capitalization issues. These results stem from the timing of purchases being based on the small-capitalization order flow. Further, although \$8,312,454 of the \$10 million assumed to be available could be invested and no issue hit the 10% maximum holding limit in 1993, the portfolio was fully invested in 1994. The results are highly comparable to the Canadian results and support the rejection of the maintained hypothesis. Without adjusting for currency differences, in 1993, the U.S. firms are much larger than their Canadian counterparts. The NYSE small-capitalization firms are considerably higher priced than the Canadian small-capitalization securities (\$7.56 vs. \$0.87), although the NYSE large-capitalization firms are only slightly more than twice the price of the comparable Canadian firms (\$55.56 vs \$23.82).

Ibbotson Associates (1994, p. 85) report that the 1993 annualized small-firm premium was 9.9%. If this premium is assumed to have been earned exclusively over the 5 turn-of-the-year trading days, the small capitalization portfolio would have earned 0.13%. The analysis of the 5-day year-end holding period in Table 6B indicates that the U.S. large-capitalization portfolio lost 1.3% in 1993 and 2.2% in 1994, whereas the small-capitalization portfolio lost 1.2% and 6.8%, respectively, over the two year ends on an aftertransactions costs basis.

Returning to the 1993 U.S. results, we find that 9.8% (\$810,978) of the small-capitalization holdings remained undivested on the fifth trading day of the new year and thus were valued at one tick (\$837,136) below the last bid price. Although this represents a higher valuation in 1993, in the next year, \$102,111 (\$56,664) in securities at average cost (one tick below the last bid) remains undivested. All holdings in the large-capitalization portfolio were liquidated by 11:35 A.M. on the first trading day of 1994. The analysis indicates that 34.3%, 19.1%, 15.1%, 13.5%, and 9.2% (respectively) of the small-capitalization portfolio was liquidated per day over the first 5 trading days of the new year.

Hence, on the basis of the empirical results, the holding-period and firm-specific risks attributable to the small-capitalization portfolio at the year end appear to be considerable. Additionally, one can conclude that the traditional method of determining turn-of-the-year returns without consideration of the volumes, bid-ask spreads, and brokerage commissions, especially for small-capitalization portfolios, is flawed.

Table 6
Summary statistics for portfolios and 5-day holding-period returns

Year	Portfolio	Average price ($)	Average market capitalization ($)	Total amount invested ($)	Number of issues purchased	Average % of port holding per issue (VW)	Minimum % of port holding per issue (VW)	Maximum % of port holding per issue (VW)	Number of issues at 10% limit
A. Summary statistics									
1993	Large	53.56	12,930,550,225	8,312,454	211	0.39	<0.01	4.32	0
1993	Small	7.56	35,719,737	8,312,454	180	0.46	<0.01	7.26	0
1994	Large	41.83	12,072,455,550	9,999,994	38	2.63	0.08	22.04	0
1994	Small	8.62	33,771,786	9,999,994	249	0.40	<0.01	7.75	0

Year	Portfolio	Number of issues not sold by day +5	Total average cost of unsold issues ($)	Total value of unsold shares at last bid ($)	% of original investment	Total portfolio holding period return (%)
B. Five-trading-day return results						
1993	Large	0	0	n.a.	0%	−1.3%
1993	Small	37	810,978	837,136	9.8%	−1.2%
1994	Large	0	0	n.a.	0%	−2.2%
1994	Small	5	102,111	56,644	1.0%	−6.8%

Note: (A) Summary statistics for the large- and small-capitalization portfolios drawn from the TAQ database. Portfolio size was determined as of the last trading day of November of the year indicated. All simulated purchases are made on trading day −1 relative to the calendar year end. Simulated sales begin on day +1 and continue through day +5 (B) Five-day holding-period returns include transactions costs, interest on univested cash, and unsold small-capitalization shares liquidated at one tick below the last bid price, as described in Section 3. The data were obtained from the NYSE and cover the period December 1993 through January 1995. Where appropriate, amounts are in U.S. dollars.

Table 7
Summary statistics for the Canadian small-capitalization portfolios

Year	Number of Transactions	Number of issues not sold by 4/30	Total average cost of unsold securities ($)	Total value of unsold shares at last bid ($)	Total small-capitalization portfolio holding-period return ($)	Total large-capitalization portfolio holding-period return (%)
1984	7,806	4	58,348	26,656	3.4	3.6
1985	11,013	5	39,308	11,986	−2.8	3.0
1986	10,547	2	34,920	795	−1.7	−0.1
1987	10,067	2	6,967	780	−3.7	5.8
1988	11,148	6	94,378	52,826	−3.4	4.2
1989	8,602	11	142,726	80,636	−10.6	3.1
1990	6,937	9	359,250	150,686	−11.3	3.9
1991	7,510	9	117,824	59,357	−18.6	−0.2
1992	10,643	6	264,298	243,768	12.0	−0.3
1993	5,169	1	19,826	0	−6.2	−1.3

Note: Portfolio size was determined as of the last trading day in November in the relevant year. All simulated purchases begin on the first trading day of December and continue through day −6 relative to the calendar year end. Simulated sales begin on day −5 and continue through the last trading day in April of the next year. Five-day holding-period returns include transaction costs, interest on uninvested cash, and unsold small-capitalization shares liquidated at one tick below the last bid price, as described in Section 3. The data were obtained from the TSE-Western Business School database and cover the period 30 November 1984 through 30 April 1994. Where appropriate, amounts are in Canadian dollars.

3.2. Expanding the portfolio formation period

Because an investment of less than $10 million in the TSE small-capitalization portfolio took place on day −6, a second strategy was considered, assuming (arbitrarily) that the purchases for the small-capitalization portfolio began on the first trading day of December in each year. This analysis is restricted to TSE securities. In this simulation, the portfolio is not fully invested in 5 of the 10 years in the sample. With the exception of 1992, when the $10 million could be invested in 2 trading days, it generally requires 12 or 13 trading days before sufficient quoted volume exists at the ask prices to acquire the desired position. In contrast, on the basis of the order flow in the large-capitalization portfolio, the buying strategy would require less than one-half of 1 trading day to become fully invested. Sufficient volume at bid prices after the turn of the year again did not exist in any year to permit total liquidation of the small-capitalization portfolio by 30 April.

Table 7 presents the results for the expanded turn-of-the-year holding period. Over the 5-month turn-of-the-year period, the large-capitalization portfolio outperformed the small-capitalization portfolio by 6.46% on an arithmetic-mean basis.[13] Again, the hypothesis of equal mean returns (t-statistic = 5.90) is rejected. And, again, a part of the superior performance in the large-capitalization portfolio may be attributable to several factors (discussed in Section 3.1), including the fact that the undivested small-capitalization securities, after 4 months, have declined substantially. Recall that

these securities were generally purchased over a minimum 12-day period. Compare the value of the unsold securities at the average cost with the value at the last bid (columns 4 and 5) in Table 7. The evidence suggests that the investor is not compensated for the risk arising from the inability to trade in the small-capitalization securities.

Only in 1992 does the small-capitalization portfolio outperform the large-capitalization portfolio, although it does so dramatically by earning 12% over the 5-month holding period, whereas the large-capitalization portfolio loses 0.3%. Recall, however, that the assumption of being able to liquidate at one tick below the last bid biases in favor of finding a small-capitalization liquidity premium. In 1992, approximately 2.5% of the original investment remains undivested 4 months later, and the actual probability of putting this position to the market at this price is unknown. Nevertheless, because this occurrence is considerably less than what would be expected by random chance, we continue to conclude that, in general, the large-capitalization portfolio outperforms the small-capitalization portfolio.

4. Summary and conclusions

This study investigates the realizable returns on portfolios at the turn of the year. The results suggest that the ability to trade with market orders in small-capitalization securities prior to the year end differs dramatically from the ability to trade in the same securities after the year end. This suggestion is contrary to the maintained hypothesis that, on average, roughly an equal number of buyers and sellers should exist in each security in an efficient market. Over the time period studied, the results suggest that investors are insufficiently remunerated for the illiquidity in the small-capitalization portfolio. It is possible, however, that equilibrium time-horizon investors as in Amihud and Mendelson (1986) exist and are appropriately remunerated over a much longer holding period.

Portfolio liquidation takes much longer than portfolio formation. Given the depth of trading in large-capitalization issues, the standard assumption of unlimited instantaneous selling may be appropriate. However, because formation time is a function of liquidity, portfolios constructed with less liquid stocks require much longer to form in the absence of price concessions and, commensurately, much longer to liquidate. Here, the assumption of unlimited instantaneous selling at current prices is inappropriate. This finding suggests that the efficient market assumptions of symmetry between buyers and sellers and their related volume may, at best, be misleading and may have serious ramifications for the methods by which researchers test hypotheses.

The large-capitalization securities in the sample outperform the small-capitalization securities by 2.4% and 6.5%, depending on whether the portfolios were formed on the last day of the taxation year or were formed over the last month of the trading year, respectively. In contrast, regression results suggest that the small-capitalization portfolio outperforms the large-capitalization portfolio by roughly 1.4% per day over the 5-day turn-of-the-year period.

There are several possible explanations for the differences between the regression

and simulation results. First, the simulation avoids the ex-post selection bias, which excludes from regression analysis issues that trade when the portfolio is being formed but do not trade later in the study period. Hence, regression analysis considers securities that are more likely to be in demand and increasing in price. Second, returns are now measured from ask prices to bid prices and, because small-capitalization securities have larger relative bid-ask spreads, one might expect to find lower relative returns, just as regression results may capture an apparent excess return owing to closing prices shifting systematically from bid prices to ask prices at the year end. The analysis using bid-ask means invalidates this argument. Third, the simulation does not account for any price improvement through nonmarket orders that may be proxied by closing returns and would result in an underestimate of the simulated return on the small-capitalization portfolio. Recall, however, that earlier studies showed closing prices at the turn of the year to be nonrepresentative of intraday activity. Fourth, because the simulation considers all trades and not just closing transactions, it more accurately imitates the realizable prices facing investors. Finally, the simulation computes specific holding-period returns and not daily compounded returns derived from the implicit rebalancing strategy inherent in regression analysis of portfolio returns.

The large difference in holding-period performance between the large-capitalization and small-capitalization portfolios in the simulation may be attributable to the length of the holding period and the nature of liquidation. In a flat or declining market, the small capitalization portfolio's return is biased downward relative to the large-capitalization portfolio's return because the large-capitalization portfolio liquidates on the first day of the new taxation year and the cash is then deemed to be held at the call-loan rate. The undivested small-capitalization shares are liquidated at one tick below the last bid price at the end of the holding period. However, this point actually highlights the significant difference in liquidity between the two portfolios. Replication of the analysis of the 1993 and 1994 year ends with the use of NYSE data yields results consistent with the Canadian findings; the characteristics of the two markets are similar in regard to the formation and liquidation of the small-capitalization portfolio.

This study identifies three main issues. First, considerably more transactions are required to form and liquidate the small- versus the large-capitalization portfolio. Second, the small-capitalization portfolio cannot be liquidated by the end of any turn-of-the-year period without price concessions. Finally, the liquidation time required for the small-capitalization portfolio increases both the market holding-period risk and the firm-specific risk, owing to the reduction in diversification. A serious implication of the study is that estimated returns with the use of daily closing prices and regression techniques may not be achievable, especially for smaller, thinly traded exchanges, as is the case with many international equity markets.

The results show that small-capitalization firms do not earn adequate returns after transaction costs during the period covered by this study to offset the consequences arising from the inability to trade. However, exploitation of the apparent turn-of-the-year anomaly may be possible by derivative securities, mutual funds, or index funds (or all three) that value positions on the basis of closing prices.

Acknowledgments

The authors would like to thank the Toronto Stock Exchange for allowing access to the data used in this study. We would also like to thank Andrew Karolyi, Richard Kish, Greg Kuhlemeyer, John Polonchek, Brian Smith, Geraldo Vasconcellos, Drew Winters, and an anonymous referee for their valuable suggestions and comments.

Notes

1. These abnormal returns were first documented in such studies as Banz (1981), Basu (1983), and Reinganum (1981). See Schwert (1983) or Fama (1991) for a summary of empirical regularities. Griffiths and White (1993) show that the turn-of-the-year effect appears to be tax induced.
2. Amihud and Mendelson (1986); the authors thank an anonymous referee for identifying this point.
3. Because all wanted market volume has been taken, a price concession is necessary to liquidate the remaining shares. The minimum concession possible is one tick. This assumption also biases in favor of a small-capitalization liquidity premium because whether complete divestiture is possible at this new price is uncertain.
4. All return calculations are reported on an after-transactions cost basis.
5. At the time of the study, the Toronto Stock Exchange was one of the three largest centralized exchanges in North America. The 1993 equity trading volume (US) was $2,283,389.6MM, $110,643.3MM, and $56,736.6MM for the New York, Toronto, and AMEX exchanges, respectively; see the Toronto Stock Exchange (1994) and the American Stock Exchange, Inc. (1994). The AMEX and NASDAQ have since merged.
6. To obtain as accurate a measure of total common equity as possible, aggregation across various share classes was performed where appropriate. Only the largest and smallest capitalization portfolios are examined in this study.
7. The profitability of any trading strategy is a function of the execution prices and the size of the transaction. Thus, it is necessary to specify the size of the investment as well as the trades that will be made. Potentially high returns on a small investment are uninteresting to most traders. Because the simulation assumes the role of the only investor, setting a high initial investment allows one to identify the upper bound of the trading strategy on an annual basis should it be impossible to invest the arbitrarily chosen initial investment. Knez and Ready (1996) assume an initial investment of $5 million.
8. The study also makes the assumption that taking all the volume at market prices does not result in subsequent changes in prices and volumes.
9. In the TAQ database, a code exists to represent “volume behind” at current quoted prices. The NYSE system can identify only as many as 999 round lots; hence it is possible to understate volumes in certain cases. The volume behind need not be at the same price. A review of the codes revealed that there were

no quotes of interest to this study that had volume behind at either the relevant bid or ask prices. Thus, there is no possibility of misrepresentation from this source.

10. For example, assume that the bid $V_t = V_{t-1} = 100$; if a buy order of $T_t = 0$ occurs, then there has been no change in the number of shares available for the simulation. Only 100 shares can be "bought." If a buy order of $T_t = 20$ occurs, then there has been an increase of 20 shares available [100 + 20 − 100]. The book now indicates a new order of 20 shares replacing those sold. If a buy order of $T_t = 200$ occurs, then there has been an increase of 100 (V_t) shares available, because all available shares at the bid were eliminated by the trade.
11. Throughout this paper, returns are expressed on the basis of prices adjusted for splits, dividends, interest, and transactions costs over the stated holding period. The returns are neither annualized nor normalized to a daily rate.
12. Two adjustments were made to the analytical method when processing the U.S. data. First, to maintain comparability in portfolio size, deciles instead of quintiles were used. Second, excess cash was deemed to be reinvested at the overnight government general-collateral repo rate. These repo data are drawn from those used in Griffiths and Winters (1997).
13. The adjustments made to the fixed transaction costs for the large-capitalization portfolio saves between 130 and 190 basis points. In no case did they change the relative ranking of the portfolios' performances. Detailed results available on request.

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