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A COMPARATIVE ANALYSIS OF THE PERFORMANCE OF ALTERNATIVE STOCK VALUATION RATIOS USING STOCHASTIC DOMINANCE WITH A RISKLESS ASSET

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and

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Introduction

There has been considerable interest in recent years in stock selection strategies based on various summary valuation ratios. Most of the research in this area has focused on the existence of a low price-earnings ratio (PER) effect. The PER is the most widely used summary measure of the potential performance of a stock. Empirical evidence has consistently shown that diversified portfolios of low PER stocks significantly outperform portfolios of average and above average PER stocks and the overall market.[1]

One way to explain this evidence is in terms of the overreaction hypothesis. The PER may be an effective measure of the degree to which investors overreact to news about a firm's prospects. Since earnings are difficult to predict, a high PER stock is vulnerable to unexpected bad news because the firm's best prospects are already reflected in the multiple. For a low PER stock, just the opposite is true. Because such a stock is not considered attractive, the firm's worst prospects have been impounded in the multiple, making it ready for a strong recovery should unexpected good news be forthcoming. Recent research suggests the overreaction hypothesis is at least plausible.[2]

This study uses the stochastic dominance selection criterion with a riskless asset (SDR) to examine the extent to which the low price-ratio effect extends to other stock valuation ratios and how these alternative investment strategies measure up to investing in low PER stocks. In particular, it evaluates the relative performances of portfolios selected on the basis of the price-book ratio (PBR), the price-cash flow ratio (PCR), the price-dividend ratio (PDR), and the price-sales ratio (PSR) in addition to the PER. It differs from previous studies in that it uses the SDR efficiency criterion as an alternative to the methodologies based on the Capital Asset Pricing Model (CAPM) to systematically compare the performances of these five low price valuation ratio investment strategies. Therefore, it extends previous research on low price ratio effects using a widely known but little used alternative technique for measuring performance.[3]

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The Stock Valuation Ratios

In addition to the low PER, several studies have recently suggested that the low PSR or low PBR screens may also lead to superior performance.[4] The PSR is defined as price per share divided by net sales or revenue per share whereas the PBR represents price per share divided by common stockholders' equity per share. Other stock price ratios that are gaining popularity in the financial community are the PCR and PDR. There are several different definitions of cash flow used by financial analysts. The simplest is net income plus depreciation and amortization. Using this definition, the PCR is computed as current price divided by the most recent annual cash flow per share. Similarly, the PDR is computed as price divided by the most recent annual dividends per share.

While the PER is the most widely disseminated summary measure of a stock's valuation, no one measure, used by itself, is appropriate for all stocks at all times. Each has its own strengths and weaknesses. For instance, the PER is often not meaningful when earnings per share (EPS) are negative or at an unusually high or low level. The PSR, while it may get around the problem of negative EPS, is not as complete a valuation measure as the PER since it ignores operating expenses and interest charges. The PDR is a useful supplement to the PER for dividend paying stocks because dividends per share are more stable than EPS and are not subject to the accounting changes and distortions that can affect the EPS and hence the PER. Furthermore, because capital spending tends to reduce current earnings, it can be argued that it is more appropriate to look at cash flow rather than earnings in order to measure potential performance. Therefore, a more complete picture of a stock's valuation can be obtained by examining different ratios at a given point in time. Since all of these ratios can be useful to the analyst, their effectiveness should be evaluated on a comparative basis.

The SDR Efficiency Criterion

In most instances, past research on portfolio performance has used CAPM-based risk-adjustment measures developed by Treynor, Sharpe and Jensen. These measures have been criticized largely because of the theoretical and empirical problems associated with CAPM.[5] Since the SDR technique is independent of both the statistical and theoretical assumptions underlying the Markowitz mean-variance model and CAPM, it is not subject to the same criticisms. Instead, it requires only a few simple and reasonably realistic assumptions about investor preferences. Consequently, it offers a more direct method of making performance comparisons for selected investment options.

The SDR criterion is a set of distribution-free, optimal investment rules for expected utility maximizers with well-defined preferences. It can be used to evaluate the relative performances of portfolios of stocks selected on the basis of alternative investment strategies. The criterion makes three increasingly restrictive sets of assumptions about the risk-return preferences of investors. Specifically, first degree stochastic dominance (FSDR) assumes only that investors are rational. Second degree stochastic dominance (SSDR) assumes that investors are both rational and risk averse. Third degree stochastic (TSDR) dominance assumes that investor preferences are also characterized by decreasing absolute risk aversion. On the basis of each set of assumptions, the SDR criterion then uses the entire distribution of expected returns to alternative investment options to select the preferred (efficient) set. (See Appendix A for an elaboration of the three SDR rules).

The assumptions associated with the SDR selection criterion are both realistic and reasonably general. This is particularly true of the asumptions of rationality and risk aversion since they apply to a larger group of investors than the group with preferences described by TSDR. Therefore, if TSDR does not change the SSDR efficient set, the results obtained will be more general.

SDR differs from the traditional stochastic dominance (SD) criterion by the assumption that the individual can invest in some combination of a riskless and a risky asset.[6] The introduction of a riskless asset results in a significant reduction in the size of the efficient sets relative to the size of the sets generated by traditional SD. The reason for this difference is that frequently a portfolio might dominate another except that its lowest return is below the lowest return of the other precluding dominance. The introduction of a riskless asset frequently eliminates this problem by reducing the variance of the returns to one portfolio relative to the other which changes the relative positions of the cumulative distribution functions in probability-return space so that dominance occurs.

SDR does not allow us to make any statements about the magnitude of the difference between the performance of a portfolio which is included in the efficient sets and the performance of a portfolio not included. Nor does it permit the ranking of portfolios included in a given efficient set in terms of their relative performances.[7] Other than the assumptions required by the SDR rules, investor preferences may be sufficiently unique to lead them to make different personal choices from among the options in the efficient set. Finally, the SDR criterion is not an equilibrium theory of security prices like CAPM. Nevertheless, it is similar in effectiveness to the mean-variance criterion without requiring the restrictive assumptions that returns be normally distributed or that the investor's utility function be quadratic.

Methodology

Our sample consists of 543 industrial firms drawn from the Standard and Poor's Compustat Annual Industrial and PDE files over the 15-year period beginning December 31, 1970, and ending December 31, 1985. Financial firms were excluded on the grounds that the PSR would not be meaningful for this group. Utilities were also excluded because of the potential distortions that profit regulation can have on the firm's share price. All five price ratios are calculated for each firm on a trailing basis using closing price (item 24 in the Compustat file) for the 12-month period prior to the period for which returns are computed. The other data used in computing the price ratios are fully diluted EPS before extraordinary items (item 58), tangible common equity (item 11), common shares outstanding (item 25), net sales (item 12), depreciation and amortization (item 14), net income before extraordinary items (item 20), common shares used to calculate EPS (item 54) and ex-date dividends per share (item 26). For consistency in calculating the five ratios, only firms that have December 31 acounting year-ends are used.[8]

For all except the PDR, the firms in each group are sorted into deciles of 50 each on the basis of their respective price valuation ratios. The PDR group was sorted into deciles of 45 firms each. The decile portfolios for all of the price ratio groups except the PDR were formed by skipping from two to five firms between deciles to account for all the firms in the sample. In addition, firms in the PER group are not selected if they have negative earnings on the grounds that a negative PER is not meaningful. Likewise, firms with a negative net worth or a negative cash flow were excluded from the PBR and PCR groups, respectively. However, in each case, firms with negative earnings, negative net worths and negative cash flows were not excluded from the other four price ratio groups. The decile (portfolio) returns are computed on a monthly basis and compounded into annual returns. The mean portfolio returns are determined as the arithmetic average of the 15 annual returns.[9] The monthly return computations were done according to the following formula:

$$R_{it} = [(P_{it} - P_{it-1}) + D_{it}]/P_{it-1}$$

where

R_{it} = holding period return for portfolio i in month t

P_{it} = price of portfolio i at the end of month t

P_{it-1} = price of portfolio i at the end of month t−1

D_{it} = dividends received from portfolio i in month t

In computing the returns, it is assumed that an equal dollar amount is invested in each security. These equal weights are maintained by rebalancing the portfolios monthly. The portfolios are revised annually to insure that the appropriate price ratio values for each security are contained in each decile.

The Wilshire 5000 equal-weighted, total performance equity index is used as a proxy for the market portfolio. In addition, 10 random portfolios of 50 stocks each are included as alternatives to the price ratio selection strategies to determine how the investor might have done if a randomly formed buy-and-hold portfolio had been chosen instead of one of the price ratio deciles. Random portfolios were included in the analysis in order to offer a more realistic alternative to the price ratio decile portfolios than the Wilshire. These portfolios are drawn from the entire sample of firms on the Compustat files.

Varying levels of transaction costs are netted out of the return data in each year. The following formula is used to compute the annual post-transaction cost portfolio returns:

$$R_{Tit} = [1 + R_{it}][1 - (T)(a)] - 1$$

where

R_{Tit} = annual post-transaction cost return on portfolio i in period t

R_{it} = annual pre-transaction cost return on portfolio i in period t

a = percent round-trip transaction costs

T = percent of portfolio turned over annually

First, second and third degree SDR rules are applied to the return distributions of each of the deciles for each group of price ratios separately to determine the effect of transaction costs on the performance of the lowest decile price ratio portfolio relative to the highest, the Wilshire, and the random portfolios. The three SDR rules are then applied to all 50 of the price ratio portfolios along with the Wilshire and the 10 random portfolios.

While a study of this nature is subject to a certain degree of post-selection survivor bias, we do not believe that such a bias is particularly important here. The reason is investors employing these price ratio screens would presumably also examine the fundamentals of the low price ratio securities to be considered for the portfolio. They would exclude those firms which have a high potential for failure. Consequently, the firms included in our sample would be similar to those chosen by rational investors to form their low price ratio portfolios.

Analysis of Portfolio Turnover

The portfolio turnover data given in Table 1 indicate a considerable difference in the median turnover rates. For all the ratios, the lowest deciles show

Table 1

Median Turnover Ratios in PBR, PCR, PDR, PER and PSR Deciles (1971-85)*

Decile	PBR	PCR	PDR	PER	PSR
1 (Highest)	31.0%	36.0%	23.0%	52.0%	16.0%
2	53.0	58.0	60.0	65.0	41.0
3	70.0	74.0	76.0	76.0	56.0
4	70.0	73.0	81.0	81.0	61.0
5	74.0	81.0	83.0	82.0	70.0
6	74.0	81.0	82.0	82.0	71.0
7	78.0	84.0	80.0	82.0	71.0
8	72.0	81.0	77.0	80.0	68.0
9	70.0	75.0	69.0	78.0	60.0
10 (Lowest)	63.0	64.0	38.0	70.0	50.0

*Data represents the median percentage of stocks that left each decile and had to be replaced.

higher turnover than the highest with the most turnover occurring in the middle. Turnover is generally greater for the PER and PCR groups and smaller for the PDR and PSR groups. For the lowest deciles, this difference is as high as 32 percentage points between the PER and PDR groups. Thus, the cost of maintaining a low PER portfolio is considerably higher than the cost of maintaining a low PDR portfolio.

Results by Price Ratio Group

Table 2 shows the means and the standard deviations of the portfolios included in the PCR, PDR and PER groups at 0% and 10% transaction costs. (The data for the PBR and PSR groups have not been included because of their similarity to the data shown.) The primary characteristic of this data is that the mean returns of the portfolios increase as we move from the highest to the lowest decile. The difference between the mean returns of adjacent portfolios is, in most cases, greatest for 9 and 10.

Table 3 contains the performances of all the deciles in each price ratio group separately, along with the Wilshire and the random portfolios. A low price ratio effect is evident for all five groups of portfolios. At 0% transaction costs, the SSDR and TSDR efficient sets contain only the one or two lowest price-ratio portfolios. For example, only the lowest decile portfolio is contained in the PCR, PDR and PER efficient sets for SSDR and TSDR while the PBR and PSR groups also contain the ninth decile portfolios in some instances. These results are relatively robust to increasing transaction costs. Only for the PBR and PSR portfolio groups do the Wilshire or the random portfolios enter the SSDR or TSDR efficient sets at transaction costs of 6% or less. In addition, there is almost no change in the composition of the SSDR efficient sets when TSDR is applied to all five groups even at relatively high transaction costs.[10]

The insensitivity of the performance of the low price ratio portfolios to increasing transaction costs, as reflected by the absence of the Wilshire and the random portfolios in the SSDR and TSDR efficient sets, is due primarily to the relatively high levels of returns that the low price ratio portfolios earn. For example, at 0% transaction costs the return on the Wilshire is 24.5% and the highest return on the random portfolios is 21.7%. On the other hand, the lowest return on the lowest price ratio deciles is 26.28% produced by the tenth PBR decile (not shown in Table 2) while the highest return is 31.48% produced by the tenth PER decile. The performance advantage of the low price ratio portfolios cannot be overcome even with the high rates of turnover exhibited by portfolios like the low PER. However, the low PDR portfolio has the added advantage of a low turnover compared to the others. This reduces the impact of increasing levels of transaction costs on the performance of this portfolio.

Comparative Performance

Table 4 shows the performances of all the price ratio portfolios relative to one another, the Wilshire, and the random portfolios at progressively

Table 2

Portfolio Means And Standard Deviations At 0% And 10% Transaction Costs*

	0%		10%	
	Mean Return	Standard Deviation	Mean Return	Standard Deviation
PCR Portfolio				
1 (Highest)	0.0987	0.2243	0.0565	0.2147
2	0.1381	0.2439	0.0770	0.2361
3	0.1775	0.2409	0.1009	0.2326
4	0.1761	0.2593	0.0969	0.2463
5	0.1604	0.2130	0.0758	0.2046
6	0.1944	0.2460	0.1068	0.2306
7	0.2127	0.2567	0.1202	0.2398
8	0.2027	0.2391	0.1126	0.2228
9	0.2534	0.2530	0.1648	0.2388
10 (Lowest)	0.3020	0.2169	0.2236	0.2090
PDR Portfolio				
1	0.1803	0.2543	0.1571	0.2536
2	0.1731	0.2402	0.1148	0.2340
3	0.1577	0.2280	0.0880	0.2185
4	0.1814	0.1921	0.1016	0.1818
5	0.1734	0.2157	0.0906	0.2052
6	0.1883	0.2331	0.1100	0.2232
7	0.1829	0.2476	0.1040	0.2371
8	0.2191	0.2184	0.1429	0.2090
9	0.2383	0.2407	0.1682	0.2263
10	0.2849	0.2856	0.2447	0.2762
PER Portfolio				
1	0.1078	0.2308	0.0510	0.2180
2	0.1435	0.2217	0.0722	0.2075
3	0.1497	0.2452	0.0695	0.2314
4	0.1843	0.2547	0.0966	0.2401
5	0.1655	0.2174	0.0787	0.2054
6	0.1834	0.2474	0.0939	0.2340
7	0.2191	0.2620	0.1273	0.2465
8	0.2341	0.2380	0.1446	0.2229
9	0.2333	0.2132	0.1451	0.2005
10	0.3148	0.2450	0.2302	0.2301

*The return and standard deviation of the Wilshire 5000 are 0.2451 and 0.2935, respectively.

Table 3

SDR Efficient Sets* At 0% And 10% Transaction Costs

	0%			10%		
	FSDR	SSDR	TSDR	FSDR	SSDR	TSDR
PBR	9 10 1R^	9 10	9 10	9 10 9R W	9 10 3R W	10 3R W
PCR	9 10	10	10	10 7R W	10	10
PDR	4 8 9 10 2R W	10	10	1 10 9R W	10	10
PER	10	10	10	10 7R W	10	10
PSR	2 6 7 8 9 10 8R W	9 10	10	2 8 9 10 10R W	10 2R W	10 2R W

*Riskless rate equals 6%.

^The number followed by the letter "R" denotes the number of random portfolios in the efficient set.

higher levels of transaction costs. Holding turnover constant, higher transaction costs should reduce the ability of the low price ratio portfolios to dominate the random portfolios and the Wilshire. As a result, these portfolios would be expected to appear in the SSDR and TSDR efficient sets. However, the SSDR and TSDR efficient sets do not include the Wilshire or any of the random portfolios until transaction costs reach 12%. Further, the PBR, PER and the PSR portfolios never appear in any sets subsequent to FSDR. At lower levels of transaction costs, the low PCR portfolio is the

Table 4

SDR Results Including All Portfolios

Transaction Costs		Efficient Sets	Total Portfolios
0%	FSDR	9PBR 10PBR 10PCR 10PDR 10PER	5
	SSDR	10PCR	1
	TSDR	10PCR	1
5%	FSDR	9PBR 10PBR 10PCR 10PDR 10PER 10PSR	6
	SSDR	10PCR	1
	TSDR	10PCR	1
10%	FSDR	9PBR 10PBR 10PCR 10PDR 10PER 10PSR W R(6)*	13
	SSDR	10PCR	1
	TSDR	10PCR	1
15%	FSDR	9PBR 10PBR 10PCR 10PDR 10PER 10PSR W R(9)	16
	SSDR	10PCR 10PDR W[A] R(1)	4
	TSDR	10PDR R(1)	2

[A]The Wilshire enters the SSDR efficient set at 12% transaction costs.
*The number in parentheses following "R" denotes the number of random portfolios.

superior performer. At higher levels of transaction costs, however, the PCR loses its performance advantage relative to the PDR due to its significantly higher turnover.

Comparative Performance Excluding the PCR

Because of the superior performance of the low PCR portfolio, it would be appropriate to view the relative performances of the price ratio portfolios excluding the PCR. These results, which appear in Table 5, indicate that the low PER is the dominant performer up to 5% transaction costs. At 10% the SSDR and TSDR efficient sets also include the low PDR portfolio. The low PER loses its performance advantage relative to the PDR at transaction costs of 15% due to its comparatively high turnover.

Conclusions

Within the framework of investor preferences required by the SDR selection criterion, the low PCR, PDR and PER portfolios exhibited superior post-transaction cost performance relative to the other valuation ratios and the market over the sample period. While low PBR and low PSR portfolios perform better than high PBR and PSR portfolios, these two ratios appear to be the least effective. Furthermore, these results were obtained without applying TSDR. Thus, investors with preferences characterized only by rationality and risk aversion would prefer low PCR and PER portfolios to any of the alternatives examined here at reasonable levels of transaction costs.

Table 5

SDR Results Excluding PCR Portfolios

Transaction Costs		Efficient Sets		Total Portfolios
0%	FSDR	9PBR 10PBR 10PDR 10PER		4
	SSDR	10PER		1
	TSDR	10PER		1
5%	FSDR	9PBR 10PBR 10PDR 10PER 10PSR	R(2)*	7
	SSDR	10PER		1
	TSDR	10PER		1
10%	FSDR	9PBR 10PBR 10PDR 10PER 10PSR	W R(7)	13
	SSDR	10PDR 10PER		2
	TSDR	10PDR 10PER		2
15%	FSDR	9PBR 10PBR 10PDR 10PER 10PSR	W R(9)	15
	SSDR	10PDR	W^ R(1)	3
	TSDR	10PDR	R(1)	2

^The Wilshire enters the SSDR efficient set at 12% transaction costs.
*The number in parentheses following "R" denotes the number of random portfolios.

To the extent that a low price ratio effect exists for each of the five ratios, the analyst should consider other price ratios along with the PER and, in particular, the PCR. Just as no one financial ratio is adequate for an analysis of a company's financial statements, no one price ratio can be adequate for a complete analysis of its market valuation.

Appendix

It is assumed that the investor has a choice between two risky investment alternatives A and B. Let F_a and F_b be the cumulative distribution functions associated with A and B and let $Q_a(p)$ and $Q_b(p)$ be the inverses of these distribution functions where p represents the probability of obtaining values lower than or equal to $Q_{(*)}(p)$. In addition, let U(R) be the investor's expected utility function and R be the return on his investment.

FIRST DEGREE STOCHASTIC DOMINANCE (FSDR): Investors are assumed to be rational since they prefer a higher return to a lower one so that $U' > 0$. In this event, A will dominate (be preferred to) B if and only if $Q_a(p) \geqslant Q_b(p)$ for all p with the strong equality holding for at least one value of p.

SECOND DEGREE STOCHASTIC DOMINANCE (SSDR): Investors are assumed to be both rational and risk averse. Therefore, $U' > 0$ and $U'' < 0$. Risk aversion implies that the loss of utility an investor would experience if he lost a fair bet would exceed the gain in utility if he won. In this case A will dominate B if and only if:

$$\int_0^p Q_a(x)dx \geqslant \int_0^p Q_b(x)dx$$

with the strict inequality holding for at least one value of p.

THIRD DEGREE STOCHASTIC DOMINANCE (TSDR): This rule adds the further restriction that the investor's utility function is characterized by decreasing absolute risk aversion. As the investor's wealth increases, he becomes more willing to undertake a fair gamble costing the same absolute amount. Therefore, $U' > 0$, $U'' < 0$, and $U''' > 0$. In this case A will dominate B if and only if:

$$\int_0^p \int_0^t Q_a(x)dxdt \geqslant \int_0^p \int_0^t Q_b(x)dxdt$$

with the strict inequality holding for at least one value of R and

$$E(R_a) \geqslant E(R_b)$$

where $E(R_a)$ is the expected return to A and $E(R_b)$ is the expected return to B.

Footnotes

1. See Sanjoy Basu, "The Relationship between Earnings' Yield, Market Value and Return for NYSE Common Stocks: Further Evidence," **Journal of Financial Economics**, June 1983, pp. 129-156, and "Investment Performance of Common Stocks in Relation to their Price Earnings Ratios: A Test of the Efficient Market Hypothesis," **The Journal of Finance**, June 1977, pp. 663-682, David Goodman and John Peavy, III, "Industry Relative Price-Earnings Ratios as Indicators of Investment Returns," **Financial Analysts Journal**, July/August 1983, pp. 60-66, and John Peavy, III and David Goodman, "The Significance of PEs for Portfolio Returns," **The Journal of Portfolio Management**, Winter 1983, pp. 43-47. See also Thomas Cook and Michael S. Rozeff, "Size and Earnings/Price Ratio Anomalies: One Effect or Two?," **Journal of Financial and Quantitative Analysis**, December 1984, pp. 449-446.
2. See Werner F.M. De Bondt and Richard H. Thaler, "Does the Stock Market Overreact?," **The Journal of Finance**, July 1985, pp. 793-805, and "Further Evidence on Investor Overreaction and Stock Market Seasonality," **The Journal of Finance**, July 1987, pp. 557-582. See also John S. Howe, "Evidence on Stock Market Overreaction," **Financial Analysts Journal**, July/August 1986, pp. 74-77.
3. The only other paper employing SDR to evaluate the performance of a low price valuation investment strategy was that of Haim Levy and Zvi Lerman. However, they confined their study to the PER. See "Testing P/E Ratio Filters with Stochastic Dominance," **The Journal of Portfolio Management**, Winter 1985, pp. 31-40. A.J. Senchak, Jr. and John D. Martin, "The Relative Performance of the PSR and PER Invest-

ment Strategies," **Financial Analysts Journal**, March/April 1987, pp. 46-56, did examine the performance of the PSR relative to the PER but their study neglected to consider transaction costs. They also used a CAPM-based methodology. To our knowledge there has been no academic research done on the performances of low PCR and the low PDR investment strategies.

4. For example, see B. Rosenberg, K. Reid and R. Lanstein, "Persuasive Evidence of Market Inefficiency," **The Journal of Portfolio Management**, Spring 1986, pp. 9-16 and A.J. Senchak, Jr. and John D. Martin, **op. cit.**

5. Roll has demonstrated that a correct test of CAPM cannot use a proxy for the market portfolio since different proxies can generate different results. Therefore, lacking an index that reflects the performance of the "true" market portfolio, we cannot accurately test the validity of the CAPM or performance measures based on it. This suggests that an alternative method of measuring performance may be justified. See Richard Roll, "A Critique of the Asset Pricing Theory's Tests; Part I: On Past and Potential Testability of the Theory," **Journal of Financial Economics**, 4, 1977, pp. 129-176.

6. For a discussion of this topic see Haim Levy and Yoram Kroll, "Stochastic Dominance with Riskless Assets," **Journal of Financial and Quantitative Analysis**, December 1976 and Yoram Kroll and Haim Levy, "Stochastic Dominance: A Review and Some New Evidence," **Research in Finance**, 2, 1980, pp. 188-202.

7. The SDR technique does not consider statistical tests of significance such as tests of the differences between the mean risk-adjusted returns to the options in the efficient set. This may be viewed as a strength of the technique since it does not require the restrictive assumptions on the data that are frequently required for statistical hypothesis testing.

8. The empirical evidence suggests that even though the annual report does not appear until several months after the end of the year, investors have anticipated the information it contains. See Haim Levy and Zvi Lerman, **op. cit.**, p. 33 and G. Foster, "Quarterly Accounting Data: Time-Series Properties and Predictive-Ability Results," **Accounting Review**, January 1977, pp. 1-21.

9. The use of arithmetic average returns was necessitated by the nature of the SDR selection technique which utilizes the cumulative distribution function of returns to each portfolio as the primary input to determine dominance.

10. The results of this study are somewhat different from those of Levy and Lerman (LL) **op. cit.** with regard to the PER, even though the methodologies are similar. These differences are the result of several factors. First, the sample of firms they used is different and the sam-

ple period used here is considerably more recent. LL covered the period from 1960 to 1978. Second, the returns for our study are both much higher and less volatile on a relative basis. This is especially true for the lowest price ratio portfolios. As a result, we find that it takes considerably higher transaction costs to eliminate the low PER portfolio from the efficient sets.

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