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***PRICE-RELATED COMMON STOCK ANOMALIES:
CANADIAN EVIDENCE***

By

Bo Li, B.Sc.

**A thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of
the requirement for the degree of
Master of Management Studies**

**School of Business
Carleton University
Ottawa, Canada**

December 15, 1994

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**Price-Related Common Stock Anomalies:
Canadian Evidence**

**submitted by Bo Li, B.Sc.
in partial fulfillment of the requirement for
the degree of Master of Management Studies**

Thesis Supervisor

Director, School of Business

**Carleton University
January 12, 1995**

Abstract

This is an empirical study that examines the relationship between common stock returns and some price-related variables in an attempt to determine whether price-related anomalies exist in the Canadian common stock market, and to evaluate their importance in formulating investment strategies. The individual price-related variables examined in this study include: price per share, price-to-earnings ratio, market capitalization, price-to-book ratio, price-to-cash flows ratio, price-to-adjusted after-tax operating earnings ratio, price-to-sales ratio, and price-to-debt ratio. The study also constructs two composite price-related variables, which are defined as the weighted average of cross-sectional rankings associated with the eight individual price-related variables under study.

The empirical evidence presented in this study suggests that price-related anomalies existed in the Canadian common stock market during the period from January 1986 to December 1993. Portfolio returns exhibited statistically significant inverse relationships with price-related variables. Using active trading strategies based upon some price-related variables, investors could have earned considerably higher returns, compared to passively investing in a broadly-based index fund. Among the eight individual price-related variables under study, stock price and price-to-earnings ratio demonstrated the highest ability to generate abnormal returns, while price-to-cash flows ratio and price-to-adjusted after-tax operating earnings ratio also show an ability to produce superior investment performance. These individual price-related anomalies seem to be consistent over time. This study also provides evidence that investment strategies based on multi-factor composite price-related anomalies tend to dominate strategies based on an individual price-related anomaly alone.

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Chapter 1: Introduction

1.1 Background

The financial theory and practice concerning capital market is traditionally based on two foundations — the efficient market hypothesis (hereafter, EMH) and the single-factor capital asset pricing model (hereafter, CAPM). EMH contends that the price of any capital asset reflects all available information about the asset, and that the systematic departure of a security's price from its equilibrium value disappears once known to rational and well-informed investors. CAPM, given certain assumptions, is used to determine a security's equilibrium price in a perfect capital market. More specifically, CAPM postulates a simple linear relationship between the expected return of a security, or a portfolio of securities, and its market risk.

The EMH and CAPM have some important practical implications. If the EMH and CAPM hold true, there would be no way to “beat the market” in a systematic fashion. A speculative investor could “win” in the short run, but would not be able to sustain the advantage over the long run. Passive investment strategies, such as buying and holding a market index fund, are not only justified, but also desirable.

While the EMH and CAPM have become conventional wisdom on asset pricing theories, and have had a tremendous impact on the thinking of financial practitioners, voluminous research has documented systematic departures from these theories. This valuable body of knowledge is often referred to as “anomaly literature.” In the context of the popular financial literature, an anomaly refers to the persistent departure of security returns from the predictions of the CAPM and EMH.

The existence of these anomalies implies that the capital market is not efficient in the way we have understood it to be, or that the CAPM is false, or both. Therefore, identifying different anomalies would improve our understanding of the behavior of security returns, and enhance our ability to describe, explain and understand the risk-return tradeoffs. More importantly, from a practical point of view, the existence of strong and persistent anomalies may also suggest that investment strategies derived from these anomalies can generate “abnormal” returns. In other words, anomaly study is of great practical significance.

1.2 The scope and purpose of this study

1.2.1 Scope

Since its inception in the late 70s, anomaly research has empirically identified many variables, other than the market beta, that appear to relate systematically to common stock returns. These variables generally fall into four categories: macro-economic variables—factors that affect general business conditions in an economy, such as interest rates; firm-specific variables—factors that characterize specific firms, such as firm size; financial specialist-related variables—factors that depend on investment professionals’ judgment, such as financial analysts’ recommendations; and time-related variables—factors that are associated with time, such as month of the year.¹ This study addresses only a subset of the firm-specific variables, namely those that can be termed as price-related variables.

---

¹For example, see Chen, Roll and Ross (1986) for a description of the relationship between stock returns and some macro-economic variables; see Chan et al. (1991) for anomalies with some firm-specific variables; see Stickel (1985), and Bjerring et al. (1983) for anomalies with some financial specialist-related variables; see Tinic and Barone-Adesi (1988), and Smirlock and Stacks (1986) for anomalies with some time-related variables. For comprehensive reviews on anomalies, see Keim (1988), and Fama (1991). For a review of anomaly studies in the Canadian context, see Jog (1988).

Price-related variable is a generic term that refers to any variable whose construction involves common stock price. Since all variables examined in this study are a function of common stock price, for convenience, these variables are collectively called the “price-related variables.” Two types of price-related variables are considered for the purpose of this study — the “individual price-related variable” and the “composite price-related variable.” An individual price-related variable is a *single-term* price-related variable (for example, price-to-earnings ratio), whereas a composite price-related variable is defined as a *weighted average of cross-sectional rankings* associated with each of the constituent individual price-related variables under study (for computational definitions or construction procedures regarding each of the individual and composite price-related variables examined in this study, see Sections 3.1 and 3.2).

As will be seen in Chapter 2, there are very few anomaly studies which focus on markets outside of the United States. Consequently, we have only a bounded perspective in understanding security returns in a cross-market context. This study extends the anomaly literature in this regard by providing the Canadian evidence of a number of price-related anomalies.

Furthermore, anomaly studies tend to have two interrelated but distinctive focuses. One is primarily geared toward testing and, one hopes, improving asset pricing theory, while the other is more concerned with formulating and evaluating investment strategies using asset pricing theory as a performance benchmark. This study, to a great extent, takes the latter perspective.

1.2.2 Purpose

This study has two purposes. First, it attempts to determine empirically whether price-related anomalies exist in the Canadian equity market. More specifically, this study

examines whether the investment strategies based on price-related variables would produce abnormal returns. Second, given the individual price-related anomalies observed in the Canadian equity market, this study attempts to determine whether investment strategies can be refined based upon *multi-factor* price-related anomalies so as to dominate strategies derived from individual price-related anomalies.²

In summary, this is an empirical study that examines the relationship between common stock returns and some price-related variables in an attempt to determine whether price-related anomalies exist in the Canadian equity market, and to evaluate their importance in formulating investment strategies.

The rest of the thesis is organized as follows. Chapter 2 synthesizes the evidence and theories previously documented in the anomaly literature with respect to the price-related anomalies considered in this study. Chapter 3 defines and constructs the chosen price-related variables under study, and specifies hypotheses in line with the purposes of this study. Chapter 4 describes the sources of data, the sample selection criteria, and the sample size. Chapter 5 addresses issues pertaining to methodological design. Chapter 6 presents and discusses empirical results, based on which conclusions are drawn. Finally, Chapter 7 outlines the benefits and limitations of this study, and makes suggestions for future research.

---

²As will be seen from a literature survey in Chapter 2, there has been no consensus on the interactive nature among individual price-related anomalies. But it seems evident that multiple individual price-related variables jointly possess significantly higher explanatory power than any individual price-related variable alone. It is not the intention of this study to join the debate regarding the interrelationships among individual price-related anomalies. But rather, this study tests the contention that investment strategies based on *multi-factor* price-related anomalies outperform those based on only an individual price-related anomaly, using the Canadian data.

Chapter 2: Evidence and Theories of Price-Related Anomalies

2.1 Evidence of price-related anomalies

A common belief shared by “anomaly researchers” is that systematic risk alone is inadequate to explain the cross-sectional variations in common stock returns, which suggests that other factors must be added into the return generating process in equilibrium. For lack of theoretical guidance in selecting those additional explanatory factors, anomaly researchers generally identify them in *an ad hoc* fashion.

This section provides a review of the literature on the evidence of price-related anomalies. The magnitude and direction of the previously documented price-related anomalies would help this study hypothesize the relationships between the selected price-related variables and common stock returns. Prior to presenting study results, some commonly used methodologies for anomaly studies are generically described in Section 2.1.1 to assist readers interpret the results. Section 2.1.2 shows the evidence of individual price-related anomalies, and Section 2.1.3 reviews studies that examine interactions among individual price-related anomalies.

2.1.1 Methodologies in brief

Price-related anomaly research can be classified into two broad methodological categories: univariate analysis, and multivariate analysis (referred to under methodology column in Tables 2-1 and 2-2 as U and M, respectively). Univariate analysis observes, *ex post*, if a price-related variable exhibits abilities to create portfolios that systematically produce significant “abnormal” returns relative to an appropriate performance benchmark, either the CAPM or a carefully selected control portfolio. The methodological procedure for these observations starts with portfolio formation. All sample stocks are first ranked by their relative values of the price-related variable under study (e.g., price-to-earnings ratio),

then they are placed into, for example, four portfolios partitioned according to the quartile points from the cross-sectional distribution of the price-related variable.³ These portfolio formation procedures are performed (or portfolios are rebalanced) at the end of every portfolio holding period,⁴ which identifies the stocks within each quartile portfolio for every holding period over a pre-determined investment horizon. A time-series of portfolio returns over the entire investment horizon are then calculated, followed by a comparison of return performance on risk-adjusted basis, typically between each constructed portfolio and the market portfolio, or between two extreme-value quartile portfolios.⁵

The univariate analysis described above can be extended to incorporate multiple price-related variables through "multiple-way portfolio formation procedures."⁶ Following these procedures, the quartile portfolios for the first price-related variable (e.g., price-to-earnings ratio) are first obtained. Then, each of these quartile portfolios are subdivided into four additional portfolios based on the quartile points from the cross-sectional distribution of the second price-related variable (e.g., market capitalization). A third price-related variable (e.g., price-to-book ratio) is then introduced to further sub-divide each of the quartile portfolios obtained from the second step. This process continues until all price-related variables of interest are exhausted, producing 4^n mutually exclusive portfolios of equal size, where n denotes the total number of price-related variables under study. It should be cautioned that as the number of price-related variables increases, the

---

³ Quintile and decile are also frequently adopted.

⁴ Commonly used portfolio holding period include a month, a quarter, or a year.

⁵ A number of statistical procedures can be employed to compare the return performance between portfolios. One commonly used method involves time-series regressions of portfolio excess returns (net of risk-free rate) or portfolio return differentials on the market excess returns. The CAPM predicts that the intercepts of such regressions should be zero. Thus, the existence of the significant intercept terms shows a systematic departure of portfolio returns from the prediction of the CAPM, suggesting that the CAPM may be misspecified. In addition, since portfolios are formed using a price-related variable, abnormal returns are considered to be driven by the price-related variable.

⁶ Some variations of "multi-way portfolio formation procedures" include "independent grouping procedures" and "multiple-way grouping plus randomization procedures." See Cook and Rozeff (1984) for details.

number of stocks within each portfolio diminishes rapidly using the “multiple-way portfolio formation procedures” (for its implication on the methodological design of this study, see Section 7.2).

Multivariate analysis is required for disentangling the interactive impact of various price-related variables on expected stock returns. It can be conducted either on an individual stock basis or at the portfolio level, and usually involves a cross-sectional multivariate regression of stock or portfolio returns on a set of predetermined price-related variables, besides the market beta.⁷ The commonly used multiple regression techniques include “Multivariate Ordinary Least Squares (OLS) model,” “Generalized Least Squares (GLS) model,” and “Seemingly Unrelated Regression (SUR) model.” GLS is considered more appropriate than OLS when the cross-sections of residuals are significantly correlated. SUR has gained popularity recently because it allows researchers to simultaneously adjust for portfolio beta and test for the significance of price-related anomalies, and to increase sample size, among others.

Multivariate analysis generally results in a set of mean regression coefficients associated with the price-related variables under consideration, and the market beta. According to the CAPM, the expected regression coefficient on (or the expected risk premium associated with) any price-related variable should be zero, and the expected regression coefficient on a portfolio’s systematic risk should be positive. The absolute value (sign) of the mean regression coefficient on a price-related variable, therefore, indicates the magnitude (direction) of the anomalous effect pertaining to the price-related variable, and the absolute value (sign) of the mean regression coefficient on the market

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⁷For a good discussion about the methodological designs with multivariate analysis for an anomaly study, see, for example, Chan et al. (1991).

beta measures the magnitude (direction) of the association of stock or portfolio returns with market volatility.

2.1.2 Evidence on individual price-related anomalies

Table 2-1 summarizes the results of some representative studies that document anomalous effects with respect to a number of individual price-related variables. Since the amount of anomaly research on those individual price-related variables is considerable, only those commonly referred-to studies that are recognized as the earliest reports on the corresponding price-related anomalies have been surveyed here.⁸

Table 2-1: Summary of study results on individual price-related anomalies

<i>Author (Year)</i>	<i>Type of Anomaly*</i>	<i>Direction Of Effect</i>	<i>Magnitude** (t-Statistic)</i>	<i>Test Period</i>	<i>Sample Exch. (Size)</i>	<i>Return Interval</i>	<i>Methodology</i>
Blume & Husic (1973)	P	-	0.0204 (4.1)	1932-66	NYSE/AMEX (1829)	Monthly	M
Basu (1977)	PER	-	0.27% (3.73)	1957-71	NYSE (753)	Monthly	U
Banz (1981)	MC	-	1.01% (3.07)	1936-75	NYSE	Monthly	U and M
Rosenberg, Reid, & Lanstein (1985)	PBR	-	0.36% (5.7)	1973-84	NYSE (1400)	Monthly	U
Wilson (1986)	PCR	-	0.230*** (3.87)	1981-82	CRSP (322)	Daily	U
Senchack & Martin (1987)	PSR	-	0.31%	1975-84	NYSE/AMEX (450)	Quarterly	U
Bhandari (1988)	PDR	-	0.0013 (3.84)	1948-79	NYSE	Monthly	M

* Where P = price per share, PER = price-to-earnings ratio, MC = market capitalization, PBR = price-to-book ratio, PCR = price-to-cash flows ratio, PSR = price-to-sales ratio, PDR = price-to-debt ratio. Also note that the original study may define its price-related variable under study as the reciprocal ratio of what is presented here. For example, the original study may use book to price ratio instead of price-to-book ratio (PBR) as the anomalous variable under investigation. Such a change is made to be consistent with the definitions and notations used for this study.

⁸Also note that many early anomaly studies either ignore risk completely or fail to control for it in a reasonably rigorous fashion, so they are not reviewed here. For a good review on early anomaly studies, see Ball (1978).

** Expressed as the monthly *abnormal* return in % term, or the *absolute value* of the monthly mean regression coefficient on the price-related variable under study for the test period specified in the next column, ignoring sub-period results.

*** This is the regression coefficient on cash flows to total book assets ratio over a nine-day interval. The author notes that the regression coefficient on cash flows to price ratio is similar in magnitude.

Blume and Husic (1973) find that price per share (P) of a common stock seems to be inversely related to the stock's subsequent returns, even after controlling for the market risk. They show that high price stocks earn significantly less monthly returns than their low price counterparts. For example, the modified average monthly regression coefficient on P is equal to - 0.0204, with a t-statistic of - 4.1. Blume and Husic also note that although the regression coefficients on the market beta carry the expected positive sign, many are not statistically significant.

Basu (1977) reports that average annual stock abnormal returns are a decreasing function of the stock's price-to-earnings ratio (PER). He demonstrates that investors who follow the strategy of holding only those stocks in his lowest (highest) PER portfolio would have made an average annual market risk-adjusted return of 3.28% (-1.9%), subject to annual rebalancing and differential tax adjustment (but before transaction costs). He adds that the biases caused by differential β or transaction costs can not explain fully the abnormal returns.

Banz (1981) finds that firms with smaller market capitalization (MC), on average, would have made significantly higher risk-adjusted returns than firms with larger market capitalization. He refers to his finding as the "size effect."⁹ Banz illustrates that an investment strategy of holding the portfolio of 50 smallest stocks while short selling the portfolio of 50 largest stocks, rebalancing every month for 5 years, would have earned an abnormal monthly return of 1.01% (or 12.82% on an annualized basis) after adjusting for

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⁹The size effect and the MC effect are used interchangeably throughout this thesis.

beta risk. He also reports that the cross-sectional regression coefficient on the size factor for his sample is -0.00052 that is 2.92 standard deviations away from zero. He further notes that the “size effect” is nonlinear, and unstable over time.

Mindar (1984) reports on an effective security screening device that has contributed to the success of Kenneth Fisher, a San Francisco money manager.¹⁰ Fisher believes that price-to-sales ratio (PSR) conveys more meaningful and reliable information about a stock’s future performance than its counterpart, price-to-earnings ratio (PER). Senchack and Martin (1987) confirmed the statistical merit of the PSR strategy. They show that, on average, the lowest PSR portfolios clearly outperform the highest PSR portfolios either in absolute terms or on risk-adjusted basis. They also show that the lowest (highest) PSR portfolios also tend to outperform (underperform) an equally-weighted market index.

Rosenberg, Reid, and Lanstein (1985) argue that an investment strategy of holding stocks with low price-to-book ratio (PBR) while shorting stocks with high PBR would have generated abnormal returns. They construct a “pure hedge portfolio” whose weights are functions of PBR, among others.¹¹ They then show that the abnormal return on the “pure hedge portfolio” over S&P500 index is significantly positive (36 basis points per month before trading costs with a t-statistic of 5.7). This implies that investors can earn a positive incremental return by simply adjusting the weights of their existing portfolio.

Wilson (1986, 1987) provides evidence that cash flows have incremental explanatory power for the cross-sectional variation in stock returns beyond earnings and

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¹⁰Fisher had earned an average annual return of 27.5% for his clients over the 6 years prior to Minard’s report.

¹¹The “pure hedge portfolio” is constructed conditional to zero wealth change and weights being orthogonal to 11 “risk indices.” Also see footnote 47.

the market risk.¹² Although Wilson only reports the anomaly associated with total book asset-to-cash flows ratio in his paper,¹³ he does note that similar results are obtained for price-to-cash flows ratio (PCR).

Bhandari (1988) shows that price-to-debt ratio (PDR) has a significant negative effect on expected returns, even after controlling for the beta risk and firm size. For example, the average regression coefficient on PDR across all (only manufacturing) firms is -0.13% (-0.18%) per month with a t-statistic of -3.84 (-3.47). The results are shown to be robust across different market proxies, beta estimation techniques, and portfolio formation schemes. The findings are also shown to be insensitive to adjustments for inflation, autocorrelation, and the survivorship bias.¹⁴

In summary, the evidence documented by the studies surveyed above seems to suggest that the joint world of the EMH and CAPM may not capture the essence of the reality, and that price-related variables may help explain some of the stock return anomalies. Stated alternatively, the evidence indicates that the underlying risks priced in the equity market for a stock, or a portfolio of stocks, are multidimensional, and that some price-related variables may serve as good proxies for those risk determinants.

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¹²Wilson (1986, 1987) uses two definitions for cash flows, namely, working capital from operations and cash from operations. Working capital from operations is defined as earnings after extraordinary items plus noncurrent accruals. Cash from operations is defined as working capital from operations plus current accruals. The main effects with both are shown to be similar.

¹³For instance, Wilson (1986) shows that the regression coefficient on the total book asset to cash from operation ratio is -0.230 with a t-statistic of -3.8 after controlling for the market risk and current accruals, while noncurrent accruals exhibit no association with stock returns.

¹⁴For a brief discussion about the survivorship bias, see Section 7.2.

2.1.3 Interactions among individual price-related anomalies

Price-related anomalies, however, appear to be more complex than suggested in the previous sub-section. Keim (1988) argues that since all price-related variables are constructed using a common variable — price per share of common stock, the separate findings of those price-related anomalies should not be entirely independent. He supports his argument by showing a high positive correlation between the PBR values of his sample firms and the corresponding MC, PCR, or P values. Chan et al. (1991) observe a similar pattern between each pair of PBR, PER, PCR and MC in the Japanese market. The significant correlation among price-related variables suggests that changes in some price-related variable(s) may be driven by changes in other price-related variable(s), thus it is highly probable that some price-related anomalies are only proxies for other price-related anomalies. Therefore, a further question would be whether those empirically determined individual price-related anomalies are independent phenomena, hence additive, or mere proxies for one another, or proxies for some other underlying determinants. Answering this question requires an investigation into the interrelationships among those individual price-related variables that univariately seem to account for a significant portion of the cross-sectional variation in stock returns on risk-adjusted basis. This sub-section will review the empirical research in this area.

Table 2-2 presents the conclusions, as well as the sample information, of those studies that examine the interactive effects among individual price-related anomalies.

Table 2-2: Summary of interactions among individual price-related anomalies

<i>Author (year)</i>	<i>Type of Anomaly*</i>	<i>Test Period</i>	<i>Sample Exch. (Size)</i>	<i>Return Interval</i>	<i>Conclusion</i>	<i>Methodology</i>
Reinganum (1981)	MC vs PER	1963-78	NYSE/AMEX (566)	Daily	MC Subsumes PER	U
Basu (1983)	MC vs PER	1963-80	NYSE (900)	Monthly	PER Subsumes MC	U
Cook & Rozeff (1984)	MC vs PER	1964-81	NYSE	Monthly	Neither subsumes the other	U
Banz & Breen (1986)	MC vs PER	1974-81	NYSE/AMEX (>2500)	Monthly	MC Subsumes PER	U
Goodman and Peavy (1986)	MC vs PER	1970-80	125 industrials from S&P 400	Monthly	PER Subsumes MC	U
Senchack & Martin (1987)	PSR vs PER	1975-84	NYSE/AMEX (400-450/quarter)	Quarterly	PER dominates PSR	U
Bhandari (1988)	PDR vs MC	1948-79	NYSE	Monthly	Significant & Independent PDR and MC effects	M
Jacobs & Levy (1988)	25 anomalies incl. MC, PSR, PER, PCR, PBR, & P	1978-86	1500 largest stocks	Monthly	Significant & Independent PER, MC, and PSR effects	M
Jaffe, Keim, & Westerfield (1989)	MC, P, +PER & -PER	1951-86	NYSE/AMEX (352-1309)	Monthly	Neither subsumes the other plus U-shaped PER effect	M
Chan, Hamao, & Lakonishok (1991)	MC, PBR, PER, & PCR	1971-88	Tokyo SE	Monthly	Significant & Independent PBR and PCR effects	U and M
Fama & French (1992)	MC, PBR, PER, & PDR	1963-90	NYSE/AMEX /NASDAQ	Monthly	Significant & Independent PBR and MC effects	M

* Where P = price per share, PER = price-to-earnings ratio, MC = market capitalization, PBR = price-to-book ratio, PCR = price-to-cash flows ratio, PSR = price-to-sales ratio, PDR = price-to-debt ratio. Also note that the original study may define its price-related variable under study as the reciprocal ratio of what is presented here. For example, the original study may use book to price ratio instead of price-to-book ratio (PER) as the anomalous variable under investigation. Such a change is made to be consistent with the definitions and notations used for this study.

A review of these chronologically ordered studies indicates that the main empirical issue concerning the interactions among price-related variables in the earlier years has been whether the PER effect subsumes the size (MC) effect, or vice-versa, or whether there are two separate effects. Reinganum (1981) questions the merit of the PER effect being an independent phenomenon. He shows that a significant size effect still emerges after controlling for the PER effect, but a separate PER effect disappears after controlling for the size effect. He then asserts that the size effect largely subsumes the PER effect.

In response to the claim by Reinganum (1981), Basu (1983) re-examines the relationship between the PER effect, and the size effect, using a slightly different sample period and stocks. Based on his findings, Basu takes the opposite stand. He shows that after controlling for firm size with random assignments of stocks, low PER firms still seem to have earned, on average, higher risk-adjusted returns than high PER firms; when risks and PER are accounted for, however, the size effect becomes virtually negligible. Basu implies that Reinganum's conclusions may be misled by the biases introduced by a less appropriate methodology "which does not control for the effect of risk—either systematic or total—on returns."

Cook and Rozeff (1984) attempt to solve the dispute between Reinganum (1981) and Basu (1983) by checking the robustness of Reinganum's and Basu's results. They employ nine different methods for estimating abnormal returns, three different portfolio formation methods, and a variety of statistical testing methods (ANOVA, Hotelling T^2 test, etc.). They show that Reinganum's results are marginally held but only with his methodology, and Basu's finding is sample-specific. In other words, the evidence of Cook and Rozeff supports neither Basu's nor Reinganum's, but rather seems to suggest that both size and PER effects are at work, or alternatively, both effects may measure separate aspects of a single underlying effect. However, Cook and Rozeff's results are not supported by two later studies conducted by Goodman and Peavy (1986), and Banz and Breen (1986) for the same purpose. The findings of Goodman and Peavy (1986) support those of Basu (1983), whereas the results of Banz and Breen (1986) are consistent with those of Reinganum (1981).

Jaffe, Keim, and Westerfield (1989), after having identified the shortcomings of previous studies,¹⁵ re-examine the issue of PER and MC interaction in a broader context. They use a more sophisticated data analysis tool, Seemingly Unrelated Regression (SUR), extend the sample period, and include a new variable, P, into the analysis. They demonstrate that no single factor among PER, MC, and P subsumes any other factor, which seems to be an expanded conclusion of Cook and Rozeff (1984). Jaffe et al. (1989) also conduct SUR analyses over the periods sampled by Basu (1983), Banz and Breen (1986), Cook and Rozeff (1984), and Reinganum (1981). They show that the findings of those studies happen to be period-specific, thus the conflicting conclusions drawn from those studies may well be expected. In the same study, Jaffe et al. document a unique phenomenon that portfolios with negative earnings consistently outperform many portfolios with positive earnings, suggesting a U-shaped relationship between PER and stock returns.

While the debate over the interactive nature between PER and firm size continues, anomaly research on the interrelationships among other price-related variables are moving forward. Senchack and Martin (1987) conduct a descriptive evaluation on investment strategies based on price-to-sales ratio (PSR), and price-to-earnings ratio (PER). Their study indicates that low PER strategy dominates low PSR strategy in generating abnormal returns. More specifically, low PER strategy outperformed an equally-weighted market index 81% of quarters during the test period, whereas low PSR strategy maintained such "superior" performance only 58% of the time. Low PER strategy achieved a total return of 563.9% over the ten year test period as compared to 470% for low PSR strategy, and 355.1% for the market index. Finally, low PER strategy outperformed low PSR strategy for 68% of quarters evaluated. Senchack and Martin's analysis also reveals that variables

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¹⁵Including relatively short sample period for analysis, limited power of data analysis technique, and failure to correlate PER and size effect with other factors, such as price level, etc.

like PSR, PER, MC, P, and shares outstanding (S) are systematically related. There is a monotonically increasing relation between values of PSR and those of PER, MC, P and S; PER appears to have U-shaped relationship with MC, P, and S. These observations seem to suggest that low PSR effect might be, to some extent, a proxy for small size effect or low price effect.

Jacobs and Levy (1988) attempt a truly multi-dimensional experiment. They believe that the inability of previous anomaly studies to yield conclusive results is because those studies consider only a few explanatory variables at a time. They argue that a complete set of anomalous variables has to be examined jointly in one multiple regression equation so that the effect with each variable can be "purified." Consistent with their line of thought, Jacobs and Levy (1988) select twenty-five different anomalous variables identified by previous anomaly researchers, then run a set of GLS regressions of abnormal stock returns on all twenty-five variables simultaneously. Of those twenty-five variables, six are price-related variables examined in this study, including PER, MC, P, PBR, PSR, and PCR. For those six price-related variables, the "pure" effects are shown to be:

- (1) Both PER effect and size effect are evident and statistically significant at 0.01 level. The monthly abnormal payoffs amount to 0.46% (t-statistic = 4.7) for PER effect and 0.12% (t-statistic = 2.7) for size effect, respectively. However, both PER and size effect appear to be nonstationary;
- (2) PSR exhibits a highly significant explanatory power. Its monthly abnormal return attribution averages 0.17%, which is 3.7 standard deviations away from zero;
- (3) There are no statistically significant anomalous effects associated with P, PCR, and PBR for the sample period and stocks studied, although the regression coefficients of these attributes show the expected signs. According to the authors, disappearance of P effect is just a recent phenomenon, PBR effect is absorbed by PSR effect, and PCR effect may just be a proxy for PER effect.

A more recent study by Fama and French (1992) provides more insights into our understanding of the interrelationships among individual price-related variables. The authors test jointly the effects of market beta (β), firm size (MC), price-to-book ratio (PBR), price-to-earnings ratio (PER), market leverage (A/MC), and book leverage (A/BE) on the cross-section of average stock returns.¹⁶ They find that: (1) after isolating the effect of the market beta from that of firm size, the market beta does not show significant explanatory power for the cross-section of average stock returns, even considered alone (with an unimpressive t-statistic of 0.46); (2) when examined separately, PER has a U-shaped relation with average stock returns as observed by Jaffe et al. (1989) and Chan et al. (1991), but adding firm size into the analysis eliminates the explanatory power of the negative PER. Further, when considering firm size, PBR and PER together, once significant positive PER effect declines to an insignificant level.¹⁷ Therefore, PER effect seems to be just a mimic of the size and PBR effect; (3) in the univariate context, both the market leverage (A/MC) and the book leverage (A/BE) are significantly related to average stock returns with similar magnitudes, but in opposite directions. However, the joint effect of A/BE and A/MC appears to correspond to PBR effect both in magnitude and direction.¹⁸ This seems to suggest that PBR captures the joint effect of A/MC and A/BE.¹⁹ Overall, Fama and French (1992) show that firm size (MC) and price-to-book ratio (PBR) are two independent and reliable variables that explain almost all cross-sectional variation in average stock returns associated with, besides market beta, five variables: MC, PBR, PER, A/MC, and A/BE. The evidence presented by Fama and French (1992), therefore, confirms the suspicion of Keim (1988) that some price-related variables may be redundant in explaining the cross-section of average stock returns. More

¹⁶A denotes total book asset; BE represents book value of common equity.

¹⁷t-statistic drops from 3.04 for univariate test to 1.23 when conducting the multivariate test.

¹⁸For example, when regression coefficients on A/BE and A/MC are 0.32 and -0.46, respectively, coefficient on PBR is -0.13.

¹⁹Not incidentally, BE/ME is equal to the difference between A/ME and A/BE in logarithmic form.

importantly, the finding that the market beta does not have significant relation with the cross-section of average stock returns, but firm size and PBR do, casts a serious doubt on the validity of the CAPM.

The observation that stock returns are related to some price-related variables is not confined just to the US stock market. Chan, Hamao, and Lakonishok (1991) rigorously investigate the relationship between stock returns and four price-related variables, MC, PER, PCR, and PBR, for the Japanese stock market. Their univariate analyses confirm the existence of similar “size effect,” “PER effect,” “PCR effect,” and “PBR effect” in the Japanese market to those in the US market. Through their multivariate tests, they observe that: (1) PBR and PCR exhibit significant and reliable negative association with the cross-section of expected stock returns, and these two effects appear to be independent of each other; (2) the size effect seems to emerge, but its statistical significance is highly sensitive to model specifications and sample periods; (3) after controlling for PBR or PCR, the existence of PER effect becomes questionable.

Based on the evidence cited in this sub-section, it is evident that research on the interactive relationship among individual price-related variables is still far from conclusive. Results seem to vary with sample stocks and periods, and sometimes even with the analytical methodologies employed. It is suspected that there may never be a consensus regarding the true nature of the interaction among price-related variables. Nevertheless, from a practical point of view, the evidence does seem to reveal that anomalous stock return behavior is explained much better when taking into account multiple individual price-related variables jointly, instead of only one. This suggests that an investment strategy may be further improved based on *multi-factor* price-related anomalies so as to dominate a strategy derived from a *single-factor* individual price-related anomalies alone.

2.2 Rationale for price-related anomalies

Before proceeding to the empirical design for this study, a few words on the rationale behind price-related anomalies are in order.²⁰ There are three plausible arguments advanced to explain the observed price-related anomalies. Based on an extensive survey of anomaly literature up to 1977, Ball (1978) argues that the CAPM, when applied to a portfolio of common stocks, misspecifies the stock return generating process in equilibrium; and that price-to-earnings ratio (PER) correlates with, thereby acts as a proxy for all underlying risk determinants omitted by the misspecified CAPM or all spurious variables resulting from an imperfect measure of the true market portfolio.²¹ Ball's proxy argument makes sense because PERs does seem to be associated with priced risk factors, whatever they are. Conventionally, it is assumed that rational investors always demand higher returns for the higher risk they bear. Hence the prices of higher risk stocks are most likely to be penalized (by a higher cost of capital) in a capital market dominated by rational investors. It is also known that current earnings are often being used by investors to proxy for future earnings. It follows, therefore, that higher risk stocks, on average, must have higher earnings relative to their market prices, or lower PER values. Fama and French (1992) pointed out, however, that Ball's proxy argument does not explain the negative PER effect of Jaffe et al. (1989).

Chan and Chen (1991) argue that it is not the size, per se, but the "marginal firm characteristics" that differentiate the stock return performances between small size and

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²⁰This section is included to further help hypothesize the expected direction of each individual price-related anomaly shown in Exhibit 3-1 of Section 3.3.1.

²¹Ball (1978) also concluded that the arguments based on systematic experimental errors (including look-ahead bias, the "Fisher effect" of securities being traded discontinuously in time, shifts in securities' relative risks due to their correlation with PER, etc., error in estimating securities' true β s due to an inappropriate proxy for the true market portfolio, and revision of earnings after their preliminary announcement) or costs of trading and information processing can at best explain the direction, but not the magnitude of the observed anomalies.

large size portfolios. Marginal firms are poor performers. They tend to have lower operating efficiency²² and a higher level of financial distress.²³ Their stock prices are more likely to have declined recently, and are more sensitive to changes in business conditions. Such firms tend to be judged by the market to have poorer relative prospects, and higher relative risks. Chan and Chen (1991) show that the “marginal firm characteristics” are more often associated with the small firm portfolios. Therefore, it is the underlying risks mimicked by “marginal firm characteristics” that are compensated in the stock market, rather than the firm size taken at face value. Notably, the negative PER effect of Jaffe et al. (1989) can be explained within the framework of Chan and Chen (1991). Negative PER is an indication of poor relative prospects or high relative distress. Stocks with negative PER values should, therefore, be priced at a level that would make up for the additional risk investors bear.

Fama and French (1992) generalize the proxy argument of Ball (1978) for the PER effect, and the relative distress argument of Chan and Chen (1991) for the size effect, to explain some other price-related anomalies. They argue that since all price-related variables are scaled versions of a common factor — stock price — they represent different ways to extract the information about risk and expected returns contained in stock prices. On the other hand, the level of PER, PCR, PSR, or PDR could, like size, serve as a signal to the market about the degree of relative operating efficiency and relative financial distress of a firm.

Fama and French (1992) also add an “irrational” dimension into the possible explanation for price-related anomalies. They suspect that market “overreaction” to the

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²²e.g., lower accounting returns on assets.

²³e.g., lower interest coverage ratios, higher debt to equity ratios, and more often with high dividend cut backs.

relative prospects of firms may have something to do with the cross-section of price-to-book ratios (PBR), or firm size (MC), which, in turn, influences the cross-section of expected stock returns. Since all equilibrium asset pricing models assume rational behavior from all market participants, it is, therefore, reasonable to expect that stock return patterns inconsistent with an equilibrium asset pricing model may result from some irrational forces. While the “overreaction” theory seems logically sound, Fama and French did not find any evidence supporting it.

2.3 Remarks

Without question, the theory and evidence of price-related anomalies have greatly enhanced our understanding about the cross-sectional behavior of stock returns. But a casual glance at the anomaly literature on price-related anomalies reveals an apparent shortfall. Most of the studies on price-related anomalies are confined to the US stock market. There is little published empirical research available on price-related anomalies for different markets. This is particularly true for the Canadian market.²⁴ As a result, there is very limited knowledge of price-related anomalies in a cross-market context, and few insights have been offered to financial practitioners pursuing global investment opportunities. As globalization has become the rule rather than exception in the investment world today, it is important to provide an empirical perspective on markets outside the United States. By presenting the Canadian evidence of price-related anomalies, this study,

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²⁴It seems that firm size (MC) is the only price-related variable within the scope of this study that has been touched upon by previous anomaly studies for the Canadian equity market. Indeed, as a side product of testing the CAPM, Tinic and Adesi (1988) present some empirical results regarding the size effect in Canada. Their results indicate that the size effect is not prevailing in the Canadian equity market over 1969-83, and that the regression coefficients on firm size are highly sensitive to the choice of proxy for the market portfolio, as well as to the month of the year. Berges, McConnell, and Schlarbaum (1984) show a “size effect” consistent with Banz (1981) for the Canadian market over 1951-72 and 1973-80, but their comparisons of performance between different size portfolios are not adjusted for risk.

one hopes, improves our knowledge of stock returns across markets, and provide some valuable insights to market participants.

Chapter 3: Price-Related Variables and Hypotheses

3.1 Definitions of individual price-related variables

This section defines the eight individual price-related variables that are included in this study. Because there has not yet been any theory developed to guide the selection or construction of anomalous variables, the choice of these individual price-related variables for study is directed by the existing evidence in the US market (see Section 2.1), and is influenced by their popularity among practitioners in "attribute investing."²⁵

As mentioned in Section 1.2.1, an individual price-related variable is a *single-term* variable constructed with common stock price. Table 3-1 below lists the eight individual price-related variables examined in this study, and provides the notation and computational definition for each.

Table 3-1: Individual price-related variables and their computational definitions

<i>Individual Price-Related Variable</i>	<i>Notation</i>	<i>Computational Definition*</i>
Stock price level	P	The closing common stock market price per share at a fiscal year-end
Firm size (Market capitalization)	MC	The closing common stock market price per share at a fiscal year-end × The average number of shares outstanding during the fiscal year
Price-to-sales ratio	PSR	The closing common stock market price per share at a fiscal year-end ÷ Total revenue per share during the fiscal year

²⁵"The purpose of 'attribute investing' is to select stocks that exhibit one or more characteristics that have been indicators of superior investment performance." See Senchack and Martin (1987): p.46

Price-to-earnings ratio	PER	The closing common stock market price per share at a fiscal year-end $\div$ Earnings per share during the fiscal year before extraordinary items, discontinued operations, and minority interest, fully diluted, net of preferred dividend per share
Price-to-adjusted after-tax operating earnings ratio	POER	The closing common stock market price per share at a fiscal year-end $\div$ Adjusted after-tax operating earnings per share during the fiscal year, where: Adjusted after-tax operating earnings = Pre-tax earnings – Income tax + After-tax interest expense ²⁶ + Unusual item ²⁷
Price-to-cash flows ratio	PCR	The closing common stock market price per share at a fiscal year-end $\div$ After-tax operating cash flows per share during the fiscal year, where: After-tax operating cash flows ²⁸ = Pre-tax earnings – Income tax + After-tax interest expense + Unusual item + R&D adjustment ²⁹ + Changes in deferred credit ³⁰
Price-to-book ratio	PBR	The closing common stock market price per share at a fiscal year-end $\div$ Total <i>common</i> equity per share at the fiscal year-end

²⁶Which is equal to interest expenses times one minus income tax rate. After-tax interest expenses are added back to separate business decisions of a firm from its financing decisions. POER can be seen as an indicator of performance with respect to a firm's business operation or an all-equity firm.

²⁷Unusual item can be expense or income. It includes such things as non-recurring expenses or earnings, restructuring expenses, write-offs, and other miscellaneous items that are not expected to occur frequently. Unusual item does not represent a firm's regular business activities, so it is added back to offset its deduction in calculating pre-tax earnings.

²⁸Assuming that incremental depreciation is equal to incremental capital investment in any given year of interest.

²⁹Contrary to conventional accounting practice, the R&D expenses are treated here as an investment that is expected to generate future cash flows. For computational purpose, we assume that the current year R&D expenses will be amortized evenly over the next five year period. Therefore, the R&D expenses deductible in the current year equals to one-fifth of the total R&D expenses over the past five year period including the current year. It should also be noted that due to limitations of data, R&D adjustments can not be made for fiscal year 1986 through 1989.

³⁰Deferred credits mainly includes deferred taxes, but may also include provisions for pension costs, deferred income or other credits not currently payable or receivable.

Price-to-debt ratio	PDR	The closing common stock market price per share at a fiscal year-end ÷ (Total book assets per share – Total <i>common</i> equity per share, at the fiscal year-end)

*Defined for any given fiscal year under consideration during an investment period.

3.2 Constructions of composite price-related variables

As defined earlier in Section 1.2.1, a composite price-related variable for the purpose of this study is a *weighted average of cross-sectional rankings* associated with the eight individual price-related variables defined in Table 3-1. It can be thought of as a rating scale along which a firm's eight rankings on the individual price-related variables are combined into an aggregate ranking. A composite price-related variable, therefore, provides an aggregate rating index measuring the overall ranking of a firm's relative standing with respect to different individual price-related variables of interest.

The procedures for constructing a composite price-related variable for a sample firm, in any given year under consideration, are as follows:

- (1) Calculate the values of the eight individual price-related variables for every sample firm according to the computational definitions specified in Table 3-1;
- (2) Rank cross-sectionally the computed values of each individual price-related variable in ascending order (i.e., the lowest value for every individual price-related variable is ranked #1; the next lowest value is ranked #2, and so on). Upon completion of this step, every sample firm is assigned eight cross-sectional ranks corresponding to the relative values of its eight individual price-related variables.
- (3) Compute a weighted average of the eight ranks assigned to each firm in step (2) to obtain the value of a composite price-related variable pertaining to each firm:

$$CV_{iy} = \sum_{v=1}^8 W_v \times RK_{iyv} \quad (3.1)$$

where:

CV_{iy} = the value of a composite price-related variable pertaining to firm i in year y ;

v = any one of the eight individual price-related variables;

RK_{iyv} = the rank assigned to firm i in year y with the individual price-related variable v ;

W_v = the weight coefficient attached to the individual price-related variable v .

According to the construction procedures specified above, once the rankings for each sample firm with the eight individual price-related variables are known, it is the weighting scheme (W_v) that determines the value of a composite price-related variable. Two types of W_v are designed for this study. One uses equal weights. The value of the equally-weighted composite price-related variable for a sample firm is equal to the arithmetic average of the ranks assigned to that firm with the eight individual price-related variables. In mathematical terms,

$$EWCV_{iy} = \frac{1}{8} \sum_{v=1}^8 RK_{iyv} \quad (3.2)$$

where:

$EWCV_{iy}$ = the value of the equally-weighted composite price-related variable pertaining to firm i in year y ;

Other terms are as previously defined.

The other weighting scheme designed for this study depends on the magnitude of the anomalous effect identified with each of the individual price-related variables during a test period.³¹ Let SH_v denote the Sharpe performance score associated with the best performing portfolio for individual price-related variable v during a test period,³² then

³¹For specification of the test periods for this study, see Section 5.2.

³²For a description of the Sharpe performance measure, see Section 5.6.1

$$AWCV_{iy} = \sum_{v=1}^8 \frac{SH_v}{\sum_{v=1}^8 SH_v} \times RK_{iyv} \quad (3.3)$$

where:

$AWCV_{iy}$ = the value of the anomaly-weighted composite price-related variable pertaining to firm i in year y ;

Other terms are as previously defined.

It is obvious that the anomaly weighting scheme gives more weight to the ranking associated with a stronger anomalous variable in calculating a firm's composite ranking.

3.3 Hypotheses

3.3.1 Hypothesized relationships between returns and price-related variables

Based on the theories and evidence of price-related anomalies reviewed in Chapter 2, Exhibit 3-1 depicts the hypothesized relations between risk-adjusted portfolio returns and each of the eight individual and two composite price-related variables under study.

Exhibit 3-1: Hypothesized Relations between returns and price-related variables

As shown in Exhibit 3-1, risk-adjusted portfolio returns are hypothesized to be inversely related to all individual price-related variables considered in this study. In other words, the portfolio that is ranked the *lowest* on any of these eight individual price-related variables is expected, on average, to outperform the portfolio that is rated the *highest* on the respective individual price-related variable.

Exhibit 3-1 further hypothesizes that the composite price-related anomalies, EWCV and AWCV, are also negatively related to risk-adjusted portfolio returns, but they are stronger in magnitude when compared to *most* of the individual price-related

anomalies.³³ The composite price-related anomalies are expected to exhibit the same direction as that of the individual price-related anomalies, because all of the eight individual price-related variables are expected to exhibit anomalies in the same direction, and the weighting coefficient attached to every individual price-related variable is expected to be always positive. The composite price-related anomalies are expected to be stronger in magnitude when compared to most of the individual price-related anomalies, because it has been documented that some individual price-related anomalies are additive to one another in the sense that an *incremental* abnormal return can still be earned with an individual price-related variable after controlling for other individual price-related variables. Therefore, as suggested by Exhibit 3-1, the *lowest* ranked portfolio constructed with either composite price-related variable should outperform the *lowest* ranked portfolios constructed with most of the individual price-related variables.

3.3.2 Null hypotheses

Following the hypothesized relationships between risk-adjusted portfolio returns and price-related variables illustrated in Exhibit 3-1, Table 3-2 specifies twelve null hypotheses that are designed to accomplish the purposes of this study. The null hypotheses 1 through 10 test whether price-related anomalies exist in the Canadian equity market; and the null hypotheses 11 and 12 test whether anomalies derived from *multi-factor* composite price-related variables dominate anomalies derived from a *single-factor* individual price-related variable alone.

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³³It is acknowledged that when some individual price-related anomalies actually show the direction opposite to what is expected, a composite price-related anomaly defined here may be less strong than some individual price-related anomalies. However, composite price-related anomalies are still expected to be comparable in magnitude with the strongest individual price-related anomaly, hence it should dominate most of the constituent individual price-related anomalies.

Table 3-2: Null Hypotheses

	Anomaly	Null Hypotheses
H₀₁	P	The portfolio of the <i>lowest</i> P common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> P common stocks, and the market portfolio;
H₀₂	MC	The portfolio of the <i>smallest</i> MC common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>largest</i> MC common stocks, and the market portfolio;
H₀₃	PSR	The portfolio of the <i>lowest</i> PSR common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> PSR common stocks, and the market portfolio;
H₀₄	PER	The portfolio of the <i>lowest</i> PER common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> PER common stocks, and the market portfolio;
H₀₅	POER	The portfolio of the <i>lowest</i> POER common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> POER common stocks, and the market portfolio;
H₀₆	PCR	The portfolio of the <i>lowest</i> PCR common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> PCR common stocks, and the market portfolio;
H₀₇	PBR	The portfolio of the <i>lowest</i> PBR common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> PBR common stocks, and the market portfolio;
H₀₈	PDR	The portfolio of the <i>lowest</i> PDR common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> PDR common stocks, and the market portfolio;

H₀₉	EWCV	The portfolio of the <i>lowest</i> EWCV common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> EWCV common stocks, and the market portfolio;
H₀₁₀	AWCV	The portfolio of the <i>lowest</i> AWCV common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>highest</i> AWCV common stocks, and the market portfolio;
H₀₁₁	EWCV	The portfolio of the <i>lowest</i> EWCV common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>lowest</i> P (or MC, or PSR, or PER, or POER, or PCR, or PBR, or PDR) common stocks;
H₀₁₂	AWCV	The portfolio of the <i>lowest</i> AWCV common stocks produces, on average, the same risk-adjusted rate of returns as those produced by the portfolio of the <i>lowest</i> P (or MC, or PSR, or PER, or POER, or PCR, or PBR, or PDR) common stocks;

Chapter 4: Data and Sample

4.1 Sources of data

The primary data for this study is gathered directly from two existing databases. The price-related variables are computed through version 4.6 of the StockGuide database updated as of July 23, 1994 by StockGuide Publications Inc. The monthly rates of return for all sample stocks, for the Canadian government 90 day treasury bills, and for the market indices are drawn from the monthly return and index files of the TSE/Western database. Version 4.6 of the StockGuide database contains historical corporate income statements and balance sheets, as well as many pre-calculated financial ratios for 1,014 companies listed on the Toronto Stock Exchange or the Montreal Stock Exchange from 1985 to 1993. The monthly return files of the TSE/Western database contain the historical monthly rates of return for most of the securities listed on the Toronto Stock Exchange plus a modest number of securities listed on the Montreal or Vancouver Exchanges over the period from 1950.1 to date. The monthly index file of the TSE/Western database contains the historical monthly rates of return for the Canadian government 90 day treasury bills, and two market indices—the TSE300 index and the value-weighted TSE/Western index over the period from 1956.1 to date. These two databases are selected because they are the most comprehensive financial databases available to this study, and they are well suited for the purposes of this study. In addition, the Consumer Price Indices (CPI) are collected from the *Bank of Canada Review*.

4.2 Sample selection criteria

To qualify for inclusion in the sample of this study for any given year under consideration during a test period, a firm must meet the following requirements:

- (1) The firm must belong to an industry group other than the industries of “Gold and Precious Metal,” “Mining exploration without production,” “Utilities,” and “Financial services including insurance;”³⁴
- (2) The firm’s common stock must be traded at yearly closing price equal to or above \$1.50 in 1985 constant dollars;³⁵
- (3) The firm must have a total annual revenue equal to or higher than \$1.5 million in 1985 constant dollars;
- (4) The firm must have a year-end total asset base equal to or larger than \$3 million in 1985 constant dollars;
- (5) The firm must have total annual revenue, year-end price, year-end total asset, and other relevant data available in the StockGuide database for running the sample selection screens as per criteria (2), (3), and (4) above, and for calculating the price-related variables under study;³⁶
- (6) The firm must be listed on the Toronto Stock Exchange; and,
- (7) The firm must have monthly return data available for the given year under consideration in the TSE/Western database.

Criterion 1 excludes firms in those industry groups whose price-related variables may not be easy to interpret in a cross-sectional study. For example, financial service firms tend to have higher degree of debt financing than non-financial service firms. While a high degree of financial leverage may normally suggest a high degree of financial distress for non-financial service firms, it is hardly the case for financial service firms. In addition,

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³⁴That is, the firm must not belong to group #13, 14, 77, 79, 90, 92, 95, 96, and 97 classified by the StockGuide database. For industry classifications for the StockGuide database and this study, see Appendix A.

³⁵The \$ signs throughout this thesis refer to Canadian dollars.

³⁶The data of a firm are undefined in the StockGuide database mostly for the reason that the firm’s market price is not available, or the firm is trading preferred shares only.

utility industries are highly regulated, thus, the risk-return profiles of firms in utility industries may be highly predictable.

It should be noted that Criterion 1 excludes, by design, all firms belonging to four industry groups. Since this may also exclude some firms belonging to the TSE300 index, an argument can be made to question the appropriateness for using the TSE300 index as a performance bench mark for this study. Instead, one may suggest to create a pseudo-TSE300 index which also excludes firms in those four industry groups. Such exclusion, however, is not possible due to the changes made to the weights and the composition of the TSE300 index. Moreover, given that the TSE300 index is a well-known and popular bench mark among anomaly researchers, the choice of it would allow a easy comparison of the research findings. Also, as will be seen in Chapter 6, the results of this study are of such magnitude that the choice of bench mark cannot be considered as the most important issue that would have a significantly impact on the conclusions of this study.

Criteria 2, 3, and 4 impose a size constraint on sample firms. These size screens ensure that the selected sample firms are large enough to be frequently researched and considered by investment professionals. More directly related to the research design, these size screens serve as a way to control some of the potential biases, such as the survivorship bias, the infrequent trading bias, and the contaminating effect of outliers, that tend to characterize very small firm stocks. Furthermore, since the rate of inflation was fairly high, and varied considerably over the period of 1986–93, the size thresholds are adjusted for the change in the Consumer Price Index through the period to obtain a consistent size scale. Criteria 5, 6, and 7 ensure that meaningful data are available for the analysis of this study. Although sample size is reduced by executing the sample selection screens listed above, the net benefits gained from these screens are considerable.

4.3 Sample size

Table 4-1 presents the detailed procedures used in the sample selection process for this study, and the sample size after each sub-screening for every year from 1986 to 1993.³⁷ The total number of firms which pass all of the sample selection screens are shown in the last row of the table. For each year under consideration, Table 4-1 also gives the number of firms deleted through each screen, and three inflation adjusted size thresholds. As shown, after running all of the sample selection screens, the sample size of this study ranges from 218 firms for 1986 to 386 firms for 1993.

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³⁷Note that sample selection procedures are performed at the beginning of every year from 1986 to 1993, using the StockGuide data of the previous year, i.e., 1985 to 1992, respectively.

Table 4-1: Sample selection procedures and sample size (1986-93)

	1986	1987	1988	1989	1990	1991	1992	1993
Total number of firms in the StockGuide*:	353	463	572	594	620	591	607	667
<i>Industry Screening:</i>								
Less: Gold & Precious Metal firms:	21	28	37	43	45	32	33	36
Less: Exploration firms without production:	6	10	11	6	4	1	0	4
Less: Utility firms:	19	20	21	22	22	23	24	30
Less: Financial Service firms:	39	59	68	73	74	75	74	79
Sample size after the industry screens:	268	346	435	450	475	460	476	518
<i>Exchange Screening:</i>								
Less: Firms not on the Toronto Stock Exchange:	11	29	55	62	57	51	50	55
Sample size after the exchange screen:	257	317	380	388	418	409	426	463
<i>Size Screening:</i>								
Consumer Price Index:	100.0	104.2	108.8	113.1	118.8	124.5	131.5	133.4
Total revenue threshold**:	\$1,500	\$1,563	\$1,632	\$1,697	\$1,782	\$1,868	\$1,973	\$2,001
Total assets threshold**:	\$3,000	\$3,126	\$3,264	\$3,393	\$3,564	\$3,735	\$3,945	\$4,002
Price threshold:	\$1.50	\$1.56	\$1.63	\$1.70	\$1.78	\$1.87	\$1.97	\$2.00
Less: Total revenue < Total revenue threshold:	10	13	17	14	12	9	13	15
Less: Total assets < Total assets threshold:	0	1	0	1	1	0	3	2
Less: Price < Price threshold:	7	14	27	35	37	49	49	56
Sample size after the size screens:	240	289	336	338	368	351	361	390
<i>TSE/Western Screening:</i>								
Less: Firms unavailable in the TSE/Western database:	22	29	30	25	26	15	6	4
Sample size of this study:	218	260	306	313	342	336	355	386

* that have stock prices available and total assets greater than zero.

** in thousands of Canadian dollars.

Chapter 5: Methodological Design

5.1 Portfolio formation procedures and portfolio size

5.1.1 Portfolio formation procedures

Since this study attempts to evaluate investment strategies, the analysis is conducted at the portfolio level. Although portfolios for this study are created using each of the eight individual and two composite price-related variables independently, the portfolio formation procedures are identical for any of these price-related variables. Thus, it is sufficient to describe the portfolio formation procedures with only one price-related variable, say PER. To construct portfolios with a price-related variable other than PER, the procedures are simply replicated by replacing PER with the price-related variable under investigation.

The portfolio formation procedures with PER for a given year during a test period are as follows:

- (1) Compute PER for every sample firm as per the computational definition in Table 3-1;
- (2) Sort the computed PER values in ascending order;
- (3) Group all firms with *negative* PER values into one portfolio, denoted as PER0;³⁸
- (4) Identify the quartile points from the cross-sectional distribution of the *positive* PER values so that the cut-off points for four quartile portfolios are established;
- (5) Assign every *positive* PER firm into one of the four quartile portfolios according to the PER value associated with the firm. Portfolio 1 (denoted as PER1) includes all firms whose PER values are within the lowest PER quartile; Portfolio 2 (denoted as

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³⁸Jaffe et al. (1989), among others, observe that negative value PER portfolio seems to consistently outperform many positive value PER portfolios, suggesting a U-shaped relationship between PER and stock returns. This step is to obtain the negative value PER portfolio so that the observation of Jaffe et al. (1989) can be verified in the Canadian context. Similarly, the same procedures are performed for PCR and POER to form their negative value portfolios.

PER2) is composed of all firms whose PER values are within the next lowest PER quartile; and so on.

Through portfolio formation procedures (1) to (5), five PER portfolios (a negative value PER portfolio, PER0, and four positive value quartile portfolios, PER1 through PER4) are created for the given year under consideration.

The above procedures are repeated for all other years during a pre-specified test period, resulting in five PER portfolios for each of those years. In other words, this study uses annual portfolio rebalancing. It should be noted that the composition of the five PER portfolios, as well as the number of firms in each of those five portfolios may vary across years. Firms may drop out of or enter the sample due to, for example, mergers and acquisitions, bankruptcies, data availability, and the sample selection screens.

To understand the portfolio construction procedures outlined above, we may view each of the five PER portfolios as a mutual fund. The fund identifies and acquires all the stocks in a given PER class at the beginning of a pre-determined investment period (or investment horizon), say the beginning of 1986 fiscal year, holds them for a year, and then reinvests all proceeds from the disposition of the fund in the same PER class at the beginning of the second year of the investment period, i.e., the beginning of 1987 fiscal year. This invest-hold-dispose-reinvest cycle continues year after year until the disposition of the fund at the end of the last year of the investment period, say at the end of 1993.

5.1.2 Portfolio size

Table 5-1 presents the number of firms (portfolio size) for each of the five portfolios constructed with each of the eight individual and two composite price-related

variables for each year from 1986 to 1993. For each of the ten price-related variables, Table 5-1 also presents two average portfolio sizes. One is averaged *across four positive-value quartile portfolios* in each year, and the other is averaged *across the time period* for the negative-value and four positive-value quartile portfolios. As shown in Table 5-1, the cross-sectional average *positive-value quartile* portfolio size ranges from 43.8 for EWCV or AWCV in 1986 to 96.5 for P, MC, PSR, and PDR in 1993. The time-series average *positive-value quartile* portfolio size varies from 59 for EWCV2 to 82.3 for PSR4. The time-series average *negative-value* portfolios for PER, POER, and PCR are 71.3, 33.3, and 30.9, respectively. Table 5-1 indicates that the portfolio size of this study is sufficiently large to emulate the number of stocks held by an actual investment fund.

Table 5-1: Size of portfolios constructed with price-related variables (1986-93)

	<i>Portfolio</i>	<i>1986</i>	<i>1987</i>	<i>1988</i>	<i>1989</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>Average**</i>
Panel A:										
Price Level	P0	0	0	0	0	0	0	0	0	0.0
	P1	53	60	74	73	82	82	89	98	76.4
	P2	57	68	79	84	88	84	90	96	80.8
	P3	54	68	77	80	88	90	90	97	80.5
	P4	54	64	76	76	84	80	86	95	76.9
	Sample Size:	218	260	306	313	342	336	355	386	314.5
	Average*	54.5	65.0	76.5	78.3	85.5	84.0	88.8	96.5	78.6
Panel B:										
Market Capitalization	MC0	0	0	0	0	0	0	0	0	0.0
	MC1	49	58	72	74	82	86	89	96	75.8
	MC2	57	70	79	82	89	81	90	97	80.6
	MC3	56	64	73	76	84	87	89	98	78.4
	MC4	56	68	82	81	87	82	87	95	79.8
	Sample Size:	218	260	306	313	342	336	355	386	314.5
	Average*	54.5	65.0	76.5	78.3	85.5	84.0	88.8	96.5	78.6
Panel C:										
Price to Sales Ratio	PSR0	0	0	0	0	0	0	0	0	0.0
	PSR1	53	65	76	78	85	83	88	95	77.9
	PSR2	54	65	76	78	86	84	89	97	78.1
	PSR3	52	59	73	74	80	82	89	97	75.8
	PSR4	59	71	81	83	91	87	89	97	82.3
	Sample Size:	218	260	306	313	342	336	355	386	314.5
	Average*	54.5	65.0	76.5	78.3	85.5	84.0	88.8	96.5	78.6
Panel D:										
Price to Earnings Ratio	PER0	34	40	32	39	67	83	151	124	71.3
	PER1	47	51	68	72	71	64	51	66	61.3
	PER2	46	56	68	69	65	62	51	65	60.3
	PER3	49	55	71	66	68	63	51	65	61.0
	PER4	42	58	67	67	71	64	51	66	60.8
	Sample Size:	218	260	306	313	342	336	355	386	314.5
	Average*	46.0	55.0	68.5	68.5	68.8	63.3	51.0	65.5	60.8
Panel E:										
Price to After Tax Operating Earnings Ratio	POER0	18	18	17	16	31	35	69	62	33.3
	POER1	45	53	70	71	80	74	72	81	68.3
	POER2	51	62	67	73	74	72	71	79	68.6
	POER3	54	62	76	73	75	78	71	79	71.0
	POER4	50	65	76	80	82	77	72	85	73.4
	Sample Size:	218	260	306	313	342	336	355	386	314.5
	Average*	50.0	60.5	72.3	74.3	77.8	75.3	71.5	81.0	70.3
Panel F:										
Price to Cashflows Ratio	PCR0	18	17	17	16	28	33	62	56	30.9
	PCR1	45	57	67	68	81	73	72	81	68.0
	PCR2	51	59	70	73	70	75	73	83	69.3
	PCR3	54	67	76	76	79	78	74	82	73.3
	PCR4	50	60	76	80	84	77	74	84	73.1
	Sample Size:	218	260	306	313	342	336	355	386	314.5
	Average*	50.0	60.8	72.3	74.3	78.5	75.8	73.3	82.5	70.9

	<i>Portfolio</i>	<i>1986</i>	<i>1987</i>	<i>1988</i>	<i>1989</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>Average**</i>
Panel G:										
Price to Book Ratio	PBR0	5	3	2	2	1	1	2	6	2.8
	PBR1	50	57	72	75	82	84	88	95	75.4
	PBR2	54	69	78	79	85	84	89	95	79.1
	PBR3	56	67	82	77	82	80	87	95	78.3
	PBR4	53	64	72	80	92	86	89	95	78.9
	Sample Size:	218	260	306	313	342	335	355	386	314.4
	Average*	53.3	64.3	76.0	77.8	85.3	83.5	88.3	95.0	77.9
Panel H:										
Price to Debt Ratio	PDR0	0	0	0	0	0	0	0	0	0.0
	PDR1	52	57	68	74	83	80	88	95	74.6
	PDR2	51	66	80	82	82	81	88	97	78.4
	PDR3	56	68	75	72	85	88	89	97	78.8
	PDR4	59	69	83	84	92	87	90	97	82.6
	Sample Size:	218	260	306	312	342	336	355	386	314.4
	Average*	54.5	65.0	76.5	78.0	85.5	84.0	88.8	96.5	78.6
Panel I:										
Equally Weighted Composite Variable	EWCV0	0	0	0	0	0	0	0	0	0.0
	EWCV1	40	48	68	71	71	62	50	63	59.1
	EWCV2	45	59	64	63	67	62	49	63	59.0
	EWCV3	48	54	69	67	67	61	49	62	59.6
	EWCV4	42	59	72	73	71	64	50	64	61.9
	Sample Size:	175	220	273	274	276	249	198	252	239.6
	Average*	43.8	55.0	68.3	68.5	69.0	62.3	49.5	63.0	59.9
Panel J:										
Anomaly Weighted Composite Variable	AWCV0	0	0	0	0	0	0	0	0	0.0
	AWCV1	39	48	69	71	72	62	50	64	59.4
	AWCV2	48	60	64	64	66	61	49	62	59.3
	AWCV3	45	54	68	68	67	62	49	62	59.4
	AWCV4	43	58	72	71	71	64	50	64	61.6
	Sample Size:	175	220	273	274	276	249	198	252	239.6
	Average:	43.8	55.0	68.3	68.5	69.0	62.3	49.5	63.0	59.9

*Averaging across four *positive-value quartile* portfolios in the given year under consideration.

**Time-series average across the period of 1986–93.

It should be noted that the portfolio size is not equal among the four positive-value quartile portfolios, given a price-related variable and a year. This is because some stocks in the StockGuide database are not included in the TSE/Western database and these missing stocks are not evenly distributed among four positive-value quartile portfolios. Indeed, prior to utilizing the TSE/Western database for return data, i.e., before running the last sample selection screen, each positive-value quartile portfolio holds the same number of stocks for each of the ten price-related variables in every year over the 1986–93 period (see Appendix C for details).

However, the histogram and descriptive statistics presented in Appendix D indicate that this portfolio size difference may be too small to have a material impact on the results

of this study. As shown, quartile 1 portfolio has, on average, only 3.51 fewer stocks than its quartile 4 counterpart.³⁹ In over seventy per cent of the cases, the portfolio size difference between corresponding quartile 1 and quartile 4 portfolios is not more than five stocks. Since a majority of the portfolios hold more than sixty stocks, a difference of three to five stocks does not seem to be significant.

5.2 Test periods

A test period is equivalent to an investment horizon in practice. To make full use of the available data, the comparative portfolio return performances are evaluated for this study over the test period from January 1986 to December 1993 (1986.1–93.12). In an effort to check the persistency of price-related anomalies over time,⁴⁰ analyses are also performed over two four-year non-overlapping test periods, i.e., from January 1986 to December of 1989 (1986.1–89.12), and from January 1990 to December 1993 (1990.1–93.12).

5.3 Stock and portfolio returns

5.3.1 Stock return

Stock return (R_{it}) in this study follows the definition of the monthly return for the TSE/Western database. In the case of “cash dividend,”⁴¹ it is expressed as:

$$R_{it} = \frac{P_{it} + D_{it} - P_{it-1}}{P_{it-1}} \quad (5.1)$$

where:

³⁹This study is more interested in quartile 1 and quartile 4 portfolios as opposed to quartile 2 and quartile 3 portfolios (see Section 3.3).

⁴⁰It can be suspected that anomalies observed during one sample period may be due to whatever factors unique to that period. Hence, the observed anomalies may not be persistent over time.

⁴¹In other cases, such as stock splits, stock dividends, rights issues, and stock recapitalizations, stock returns will be adjusted accordingly. For details, see the TSE/Western database manual.

i = a sample firm;

$t = 1, \dots, T$, any month in a test period;

T = total number of months in a test period;

Time Line: t = month #	1	2	3	...	$T - 1$	T

R_{it} = stock return on firm i in month t ;

P_{it} = stock price per share of firm i at end of month t ;

P_{it-1} = stock price per share of firm i at end of month $t - 1$, and

D_{it} = cash dividend per share paid by firm i during month t , i.e., during the period $[t - 1, t]$.

5.3.2 Portfolio return

Portfolio return (R_{pt}) in this study is defined as the arithmetic mean of individual stock returns of all firms within portfolio p in month t during a test period, i.e.,

$$R_{pt} = \frac{1}{N} \sum_{i=1}^N R_{it} \quad (5.2)$$

where:

R_{pt} = return on portfolio p in month t ;

N = total number of sample firms within portfolio p ;

Other terms are as previously defined.

5.4 Portfolio cumulative wealth index (PCWI)

In order to demonstrate the comparative return performance between portfolios during a test period, the "portfolio cumulative wealth index" is used as an illustrative tool. The portfolio cumulative wealth index shows how much a \$100 initial investment in a

portfolio would have appreciated or depreciated over time through a pre-determined investment period. That is,

$$PCWI_{pt} = \$100 \times \prod (1 + R_{pt}) \quad (5.3)$$

where:

$PCWI_{pt}$ = portfolio cumulative wealth index for portfolio p at the end of month t. Thus,

$PCWI_{PT}$ represents the portfolio cumulative wealth effect over an entire test period.

Other terms are as previously defined.

5.5 Methodological process⁴²

Exhibit 5-1 shows the complete methodological process designed for this study. Starting from the first year ($y = 1$) in a test period with the first of the ten price-related variables ($v = 1$), sample selection and portfolio formation are performed according to the procedures specified in Sections 4.2 and 5.1.1. As a result of the sample selection and portfolio formation procedures, five portfolios (one *negative-value* portfolio plus four *positive-value quartile* portfolios) are constructed, and the stock ticker symbols pertaining to the sample firms within each of the five portfolios are identified. Twelve monthly returns for each sample firm are then retrieved from the TSE/Western database based on the ticker symbols just identified, and twelve monthly returns for each of the five portfolios are computed by cross-sectionally averaging the individual stock returns within each portfolio. The same process is duplicated for the second year ($y = 2$), the third year ($y = 3$), ..., and the last year ($y = Y$) of the test period. Upon completion of the above procedures, a time-series of $12 \times Y$ portfolio returns is generated for each of the five

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⁴²This section is intended to provide readers with an overall picture of the methodological design for this study, even though some steps described here may sound repetitive.

portfolios constructed with the given price-related variable over the entire test period. To test the null hypotheses concerning the given price-related variable as specified in Section 3.3.2, this time-series of portfolio returns is subjected to the PCWI analysis (see Section 5.4), and the three risk-adjusted performance measures: the Sharpe measure (1966), the Treynor measure (1965), and the Jensen measure (1968, 1969). Related statistical tests, such as the Jobson and Korkie test (1981) (hereafter, the JK test) for the Sharpe measure, and the arbitrage portfolio based time-series OLS are also employed. (For descriptions of the three performance measures, the JK test, and the arbitrage portfolio based time-series OLS, see Section 5.6)

To investigate anomalous effect associated with another price-related variable ($v = 2, \dots, \text{or } 10$), the same process described above is repeated, using a different price-related variable.

Exhibit 5-1: The methodological process

5.6 Hypothesis testing

As indicated by the null hypotheses for this study (see Section 3.3.2), the fundamental task of this study is to assess the relative return performance between two portfolios on a risk-adjusted basis. To this end, this study adopts the following analytical techniques: the Sharpe performance measure; the Jobson and Korkie test; the Jensen and Treynor performance measures; and the arbitrage portfolio based time-series OLS⁴³

5.6.1 Sharpe performance measure

The Sharpe (1966) performance measure for a portfolio p , Φ_p , is defined as:

$$\Phi_p = \frac{\mu_p}{\sigma_p} \quad (5.4)$$

where:

μ_p = the mean monthly *excess* return, $E(R_{pt} - R_{ft})$, on portfolio p across a test period (i.e., the mean return on portfolio p minus the mean return on a risk-free asset across a test period); and

σ_p = the standard deviation of monthly excess returns, $\{E[(R_{pt} - R_{ft}) - \mu_p]^2\}^{1/2}$, on portfolio p across a test period.

As shown in (5.4), the mean monthly excess return of a portfolio is normalized by the standard deviation of the monthly excess returns with the Sharpe performance measure. It is known that the standard deviation of a portfolio's return measures the return variability, hence the total risk of the portfolio. The Sharpe performance measure of a portfolio, therefore, gauges the portfolio's return performance per unit of its total risk.

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⁴³The Sharpe (1964), Jensen (1968, 1969), and Treynor (1965) measures are three conventional performance measures based on the mean-variance framework and the CAPM. For a background review of the performance measurement literature, see Jog (1986).

5.6.2 Jobson and Korkie (JK) test

Jobson and Korkie (1981) developed a test to statistically compare the Sharpe measures of two portfolios. The JK test ensures that the difference between two Sharpe performance measures does not occur by chance.

To conduct the JK test, the difference of the Sharpe performance measures between portfolio p and p' is first transformed into the following:

$$Sh_{pp'} = \mu_p \sigma_{p'} - \mu_{p'} \sigma_p \quad (5.5)$$

where:

$Sh_{pp'}$ = the transformed difference of the Sharpe performance measures between portfolio p and portfolio p';

μ_p and $\mu_{p'}$ = the mean monthly excess return on portfolio p and p', respectively, across a test period; and

σ_p and $\sigma_{p'}$ = the standard deviation of the monthly excess returns on portfolio p and p', respectively, across a test period.

Next, the variance of $Sh_{pp'}$, $\theta_{pp'}$, is obtained by:

$$\theta_{pp'} = \frac{1}{T} [2\sigma_p^2 \sigma_{p'}^2 - 2\sigma_p \sigma_{p'} \sigma_{pp'} + \frac{1}{2} \mu_p^2 \sigma_{p'}^2 + \frac{1}{2} \mu_{p'}^2 \sigma_p^2 - \frac{\mu_p \mu_{p'}}{2\sigma_p \sigma_{p'}} (\sigma_{pp'}^2 + \sigma_p^2 \sigma_{p'}^2)] \quad (5.6)$$

where:

$\sigma_{pp'}$ = the covariance between the monthly excess returns on portfolio p and those on portfolio p', $E\{[(R_{pt} - R_{ft}) - \mu_p][(R_{p't} - R_{ft}) - \mu_{p'}] \}$, across a test period;

Other terms are as previously defined.

Jobson and Korkie (1981) have shown that the asymptotic distribution of the difference between two Sharpe performance measures of portfolio p and p' is normal with mean $Sh_{pp'}$ and variance $\theta_{pp'}$. Thus, the test statistic for the null hypothesis that $Sh_{pp'} = 0$ is equal to:

$$Z_{pp'} = \frac{Sh_{pp'}}{\sqrt{\theta_{pp'}}} \quad (5.7)$$

If portfolio p' is considered as a performance benchmark for portfolio p, then the JK test provides a method to detect statistically the difference of the total risk-adjusted return performance of portfolio p relative to its benchmark. Portfolio p' can be the market portfolio, or any other pre-determined control portfolio.

It should be noted that theoretically μ_p , $\mu_{p'}$, σ_p , $\sigma_{p'}$, Φ_p , $Sh_{pp'}$, $\theta_{pp'}$, $\sigma_{pp'}$, and $Z_{pp'}$ are the parameters pertaining to an underlying population; in practice, sample estimators are used instead. For convenience, however, the same set of notations is retained for the sample estimators here.

5.6.3 Jensen and Treynor performance measures

The Jensen and Treynor performance measures are derived from the CAPM. An empirical version of the CAPM is expressed as the following time-series OLS regression:

$$R_{pt} - R_{ft} = \alpha_p + \beta_p (R_{mt} - R_{ft}) + e_{pt} \quad (5.8)$$

where:

$t = 1, \dots, T$, any month in a test period;

R_{pt} = return on portfolio p in month t during a test period, computed as per Equation (5.2);

R_{ft} = return on a "risk free" asset in month t during a test period, measured by the realized monthly rate of return on 90-day Canadian government treasury bills;

R_{mt} = return on the market portfolio in month t during a test period, proxied by the realized rate of return on the TSE300 index;⁴⁴

α_p = estimated time-series OLS intercept that indicates the abnormal rate of return on the portfolio p after adjusting for its systematic (or market) risk;

β_p = estimated time-series OLS slope that indicates the market risk of the portfolio p ;

e_{pt} = residual return on portfolio p in month t .

The Jensen performance measure is simply equal to α_p . Thus, the Jensen performance measure captures the return on a portfolio unexplained by the CAPM. The presence of a significant Jensen measure indicates that the portfolio produces “abnormal” returns even after adjusting for the market risk of the portfolio. The null hypothesis that $\alpha_p = 0$ can be tested using a two-tailed *student-t* test with $T - 2$ degree of freedom. The test statistic, $t(\alpha_p)$, is given by:

$$t(\alpha_p) = \frac{\alpha_p}{\sqrt{\frac{\sum \alpha_p^2}{T - 2}}} \quad (5.9)$$

The Treynor performance measure, similar to the Sharpe performance measure, is constructed to assess a portfolio’s return performance per unit of risk. Instead of using the portfolio’s return variability or standard deviation as the indicator of portfolio risk, however, the Treynor performance measure, relying on the CAPM, employs the portfolio’s market beta as the estimator of portfolio risk. While the Sharpe measure gauges portfolio return performance accounting for portfolio’s total risk, the Treynor

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⁴⁴Originally, this study intended to employ separately two different market indices, namely the TSE300 index and the value-weighted TSE/Western index, as proxies for the market portfolio to ensure that the results of this study are robust to the effect of errors in estimating portfolios’ systematic risk. But, it turns out that the correlation coefficient between these two market indices over the 1986.1–93.12 period is as high as 0.98. Therefore, this study will proxy the market portfolio using only the TSE300 index.

measure, like the Jensen measure, assesses portfolio return performance on a market risk-adjusted basis. By substituting the standard deviation of portfolio p's excess returns with portfolio p's market beta in Equation (5.4), the Treynor performance measure for portfolio p, T_p , is obtained as follows:

$$T_p = \frac{\mu_p}{\beta_p} \quad (5.10)$$

where both terms on the right side of Equation (5.10) are defined previously.

As pointed out by Jobson and Korkie in their 1981 study, there are a number of unresolved issues with the Treynor performance measure in terms of hypothesis testing. Therefore, no attempt is made in this study to conduct a statistical test based upon the Treynor performance measure.

5.6.4 Arbitrage portfolio based time-series OLS⁴⁵

The arbitrage portfolio based time-series OLS is a performance evaluation technique that builds upon the Jensen method. As with the Jensen technique, the arbitrage portfolio based time-series OLS uses an estimated time-series OLS intercept as indicator of abnormal portfolio performance. Unlike the Jensen technique, the arbitrage portfolio based time-series OLS assesses portfolio return performance relative to a benchmark other than the market portfolio. In this study, this technique is represented by the time-series OLS regression as follows:

$$R_{pt} - R_{p't} = \alpha_{p-p'} + \beta_{p-p'} (R_{mt} - R_{ft}) + e_{p-p't} \quad (5.11)$$

where:

R_{pt} and $R_{p't}$ = returns on portfolio p and p', respectively, in month t during a test period, computed according to Equation (5.2);

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⁴⁵Banz (1981), for example, uses this technique.

R_{ft} = return on a “risk free” asset in month t during a test period, measured by the realized monthly rate of return on 90-day Canadian government treasury bills;

R_{mt} = return on the market portfolio in month t during a test period, proxied by return on the TSE300 index;

$\alpha_{p-p'}$ = estimated time-series OLS intercept which indicates the abnormal return on the portfolio $p - p'$ adjusting for its systematic (or market) risk;

$\beta_{p-p'}$ = estimated time-series OLS slope that indicates the market risk of the portfolio $p-p'$;

e_{pt} = residual return on portfolio $p - p'$ in month t .

In words, this technique first obtains the monthly return series on the portfolio $p - p'$, $R_{pt} - R_{p't}$, then regresses this return series on the market excess return series, $R_{mt} - R_{ft}$. The estimated regression intercept, $\alpha_{p-p'}$, shows the extent to which portfolio p outperforms portfolio p' *beyond* that which can be attributed to the market risk differential between the two portfolios.⁴⁶ Again, portfolio p' may be considered as a performance benchmark for portfolio p , which can be either the market portfolio, or any other pre-determined control portfolio. Moreover, it can be shown that when portfolio p' is equal to the market portfolio, the arbitrage portfolio based time-series OLS is analogous to the Jensen method.

Since portfolio $p - p'$ is equivalent to holding portfolio p long while selling portfolio p' short, investing in $p - p'$ represents an new investment without putting up additional funds, given that an equal dollar amount is allocated to portfolio p and p' , respectively. Therefore, portfolio $p - p'$ possesses a property that characterizes the

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⁴⁶Therefore, emergence of significant $\alpha_{p-p'}$ is not consistent with the CAPM.

“arbitrage portfolio.”⁴⁷ This is why the technique is named as the “arbitrage portfolio based time-series OLS.”

As with the Jensen measure, to verify the presence of the abnormal return $\alpha_{p-p'}$, the null hypothesis that $\alpha_{p-p'} = 0$ is tested using a two-tailed *student-t* test with $T - 2$ degree of freedom. The Equation (5.12) presents the test statistic, $t(\alpha_{p-p'})$:

$$t(\alpha_{p-p'}) = \frac{\alpha_{p-p'}}{\sqrt{\frac{\sum \alpha_{p-p'}^2}{T-2}}} \quad (5.12)$$

5.7 Industry effect adjustment

Within the context of this study, an industry bias can arise when sample stocks of an industry are disproportionally assigned to different quartile portfolios constructed with a price-related variable. This may reflect a significant disparity in values of the price-related variable across securities within the industry, or across different industries. In extreme cases, taking PER as an example, all sample stocks from the same industry may cluster into a single PER quartile portfolio. Consequently, the observed return difference between different PER quartile portfolios may be attributable to variance in industry performance, rather than a difference in PER value.

To adjust for this industry bias, this study also utilizes the “industry standardized price-related variables” to construct portfolios for performance evaluation. The industry

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⁴⁷Two conditions for constructing an arbitrage portfolio relative to original holdings are (1) no additional wealth (sum of change in weight is equal to zero); and (2) no additional risk (weighted sum of the factor coefficients is equal to zero). Mathematically, let ΔW_i denote the percentage change of a fund's investment in the i th asset(s), where $i = [1, N]$, over the fund's total invested wealth, and β_{ik} represents the sensitivity coefficient of the i th asset's returns on the k th risk factor, where: $k = [1, K]$, then arbitrage portfolio must satisfy (1) $\sum \Delta W_i = 0$, (2) $\sum \Delta W_i \times \beta_{ik} = 0$

standardized value of a price-related variable for a firm is equal to the difference between the firm's value and the cross-sectional industry average value of the price-related variable, divided by the standard deviation of the price-related variable across all sample firms within the industry. Mathematically, again taking PER as an example, the industry standardized PER value for a firm is transformed from the firm's original PER value for any given year as follows:

$$PER_{Iiy} = \frac{PER_{Iiy} - \frac{1}{N_I} \sum_{i=1}^{N_I} PER_{Iiy}}{\sqrt{\frac{1}{N_I - 1} \sum_{i=1}^{N_I} (PER_{Iiy} - \frac{1}{N_I} \sum_{i=1}^{N_I} PER_{Iiy})^2}} \quad (5.13)$$

where:

I = any industry group classified for this study (see Appendix A-2);

PER_{Iiy} = the industry standardized PER value for firm i of industry I in year y ;

PER_{Iiy} = the original PER value for firm i of industry I in year y ;

N_I = total number of sample stocks within industry I .

In order to calculate the industry standardized values for a price-related variable other than PER, simply replace PER with the other price-related variable of interest in Equation (5.13).

Chapter 6: Empirical Results

6.1 Results based on the analysis of portfolio cumulative wealth index (PCWI)

As described in Section 5.4, the portfolio cumulative wealth index (PCWI) illustrates the value of a portfolio with a \$100 initial investment through an investment period. PCWI can be used to assess the relative return performance of various investment strategies. Table 6-1 presents the end-period PCWI values associated with the quartile 1 (Q1) and corresponding quartile 4 (Q4) portfolios for the eight individual and two composite price-related variables under study over the period of 1986.1–93.12. For each of these ten price-related variables, Table 6-1 also gives the difference of the end-period PCWI values between the corresponding Q1 and Q4 portfolios, and the fraction of total number of months during the period (96 months) that the Q1 portfolio returns exceed the corresponding Q4 portfolio returns. To show the extent to which the industry effect affects the results, findings before and after the industry standardization are both presented in the table.

Table 6-1: PCWI of corresponding Q1 and Q4 portfolios (1986.1–93.12)

	<i>Without Industry Effect Adjustment</i>				<i>With Industry Effect Adjustment</i>			
	<i>Q1</i>	<i>Q4</i>	<i>Q1-Q4</i>	<i>P(Q1>Q4)¹</i>	<i>Q1</i>	<i>Q4</i>	<i>Q1-Q4</i>	<i>P(Q1>Q4)¹</i>
P	\$505.68	\$117.51	\$388.17	0.708***	\$412.31	\$127.04	\$285.27	0.646***
MC	\$280.28	\$183.75	\$96.53	0.583	\$262.87	\$180.12	\$82.75	0.563
PSR	\$211.20	\$306.04	-\$94.84	0.438	\$236.27	\$186.81	\$49.46	0.573
PER	\$460.17	\$217.23	\$242.95	0.635***	\$540.83	\$152.63	\$388.20	0.720***
POER	\$305.74	\$192.52	\$113.21	0.573	\$297.80	\$186.42	\$111.37	0.615**
PCR	\$302.73	\$193.01	\$109.72	0.564	\$310.54	\$184.72	\$125.82	0.605**
PBR	\$249.85	\$305.05	-\$55.20	0.543	\$243.84	\$251.78	-\$7.94	0.490
PDR	\$172.60	\$244.40	-\$71.81	0.406*	\$189.64	\$219.92	-\$30.28	0.448
EWCV	\$458.00	\$237.91	\$220.09	0.604**	\$432.02	\$166.38	\$265.64	0.698***
AWCV	\$448.61	\$214.80	\$233.82	0.604**	\$449.68	\$137.75	\$311.94	0.719***

¹P(Q1>Q4) denotes the fraction of total number of months through the 1986.1–1993.12 period that returns on the quartile 1 portfolio exceed those on the corresponding quartile 4 portfolio. Since P(Q1>Q4) is binomially distributed, the test statistic for the null hypothesis that P(Q1>Q4) = 0.5 is $[P(Q1>Q4) - 0.5] + (0.5 \times 0.5/N)^{1/2}$, where: N = total number of months during the period, 96 in this case.

*Statistically different from 0.5 at 10 per cent level of significance.

**Statistically different from 0.5 at 5 per cent level of significance.

***Statistically different from 0.5 at 1 per cent level of significance.

Consider the results with *individual* price-related variables before the industry effect adjustment. Table 6-1 shows that five of the eight Q1 portfolios, P1, MC1, PER1, POER1, and PCR1, perform better than the corresponding Q4 portfolios, and two Q1 portfolios, P1 and PER1, demonstrate significantly higher performance over their Q4 counterparts from a statistical point of view. Note that, with P and PER, the end-period value difference between investing \$100 initial capital in the Q1 portfolios and corresponding Q4 portfolios is more than \$240; and the Q1 portfolio returns dominate the corresponding Q4 portfolio returns for more than 63 per cent of time, which is statistically significant. After controlling for the industry effect, the relative performance seems to favor Q1 portfolios even more. Q1 portfolios gain more value than Q4 portfolios with six of the eight individual price-related variables, and in four of these six cases, results are statistically significant. Also note that although with two individual price-related variables, PBR and PDR, do the Q4 portfolios seem to perform better than their Q1 counterparts, the end-period value differences between these Q1 and Q4 portfolios are so small (-\$7.94 and -\$30.28, respectively) that they may be attributable simply to chance.

In the cases of the composite price-related variables, EWCV and AWCV, Q1 portfolios also demonstrate significantly superior performance over their corresponding Q4 portfolios. This pattern is more evident with the industry standardized results.

It appears, however, that the EWCV1 and AWCV1 underperform the P1 and PER1 before adjusting for the industry effect. Although industry standardization seems improve the relative performance of EWCV1 and AWCV1, it does not alter the pattern completely. The EWCV1 and AWCV1 still show end-period values lower than that of

PER1. Given that two of the eight constituent individual price-related variables show a relationship opposite to what was expected even after industry standardization, this result seems reasonable (see footnote 33). Nevertheless, Table 6-1 does indicate that, in most of the cases, the Q1 portfolios with the composite price-related variables dominate the Q1 portfolios with the individual price-related variables.

In conclusion, Table 6-1 suggests that four individual price-related anomalies may exist: P, PER, PCR, and POER. Consequently, composite price-related anomalies may emerge as well.

Figures 6-1 through 6-6 (presented at the end of this chapter, pp.79-91) illustrate graphically the PCWI values associated with the four positive-value quartile portfolios for those four seemingly anomalous individual price-related variables, P, PER, PCR, and POER, and for the two composite price-related variables, EWCV and AWCV.⁴⁸ In order to show the impact of the industry effect adjustment, each figure contains two graphical representations. The first depicts PCWI values *without* the industry effect adjustment, whereas the second shows the industry standardized PCWI values. Also shown is the TSE300 index's PCWI values through the same period. These figures clearly demonstrate that the Q1 portfolios constructed with P, PER, PCR, POER, EWCV, and AWCV tend to dominate their corresponding Q4 portfolios, as well as the TSE300 index.

It should be noted that although PCWI analysis gives a good indication of relative portfolio performance, it does not take into account portfolio risk factors. The following sections of this chapter present and discuss the risk-adjusted results, i.e., those with the

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⁴⁸For similar figures with MC, PSR, PBR, and PDR, see Appendix C.

Sharpe, Treynor, and Jensen performance measures, their related statistical significance tests, and the arbitrage portfolio based OLS.

6.2 Portfolio return performances conditional on the TSE300 index

Tables 6-2 and 6-3 present the average returns, risks, and three risk-adjusted performance measures for portfolios constructed with each of the eight individual and two composite price-related variables over the three test periods. Table 6-3 is the industry standardized version of Table 6-2. There are 3 sub-tables under Table 6-2 or 6-3. Each sub-table corresponds to a particular test period. Specifically, sub-tables 1, 2, and 3 correspond to the overall period of 1986.1–93.12, the sub-period 1986.1–89.12, and the sub-period 1990.1–93.12, respectively. These sub-tables allow one to check whether the results are consistent across the sample periods. In order to show the extent to which the portfolios constructed with the price-related variables are diversified, the Pearson correlation coefficients between the portfolios' returns and the returns on the TSE300 index are presented in the last column. The third column gives the values of the portfolio means of the corresponding price-related variable.

When results of Tables 6-3 and 6-2 are compared, a distinctive difference emerges. The portfolio mean values of price-related variables (column 3) vary consistently in smaller ranges in Table 6-3 than in Table 6-2. For instance, the positive portfolio PER values vary from 10.19 to 78.07 in Table 6-3, compared to a wider range of 8.00 to 83.76 in Table 6-2. This suggests that the industry standardization reduces the total variance of the price-related variables, hence produces better results. For this reason, the remaining discussion of this chapter will focus primarily on the results that have been adjusted for the industry effect. However, the findings without industry effect adjustment are also presented throughout this chapter for the sake of comparison.

Table 6-2-1: Portfolio risk-Return characteristics and return performance without industry effect adjustment (1986.1–93.12)

	Portfolio	Variable ¹	Return	Standard Deviation	Beta	Sharpe Measure	Treynor Measure	Jensen Measure	PT-MKT Correlation ²
Panel A:									
Price Level	P1	\$3.18	0.0186	0.0561	1.056	0.3321***	0.0176	0.0108***	0.78
	P2	\$7.63	0.0109	0.0460	0.963	0.2363	0.0113	0.0031	0.87
	P	\$12.01	0.0054	0.0445	0.966	0.1202	0.0055	-0.0025	0.89
	P4	\$27.90	0.0026	0.0418	0.879	0.0619**	0.0029	-0.0052**	0.87
Panel B:									
Market Capitalization	MC1	\$20,401.42	0.0121	0.0501	0.926	0.2412	0.0130	0.0043	0.77
	MC2	\$71,142.28	0.0092	0.0461	0.914	0.1988	0.0100	0.0014	0.82
	MC3	\$219,751.54	0.0083	0.0452	0.962	0.1838	0.0086	0.0005	0.88
	MC4	\$1,837,101.56	0.0075	0.0476	1.051	0.1583	0.0072	-0.0003	0.92
Panel C:									
Price to Sales Ratio	PSR1	0.20	0.0089	0.0457	0.912	0.1943	0.0097	0.0011	0.83
	PSR2	0.51	0.0087	0.0442	0.948	0.1978	0.0092	0.0010	0.89
	PSR3	1.10	0.0058	0.0466	0.984	0.1250	0.0059	-0.0020	0.88
	PSR4	4.55	0.0133	0.0561	1.009	0.2376	0.0132	0.0055	0.75
Panel D:									
Price to Earnings Ratio	PER0	N.A.	0.0052	0.0553	1.113	0.0947	0.0047	-0.0026	0.83
	PER1	8.00	0.0172	0.0475	0.920	0.3612***	0.0187	0.0094	0.80
	PER2	13.42	0.0071	0.0420	0.859	0.1697	0.0083	-0.0006	0.85
	PER3	19.77	0.0075	0.0449	0.926	0.1672	0.0081	-0.0003	0.85
	PER4	83.76	0.0096	0.0533	0.976	0.1793	0.0098	0.0017	0.76
Panel E:									
Price to After Tax Operating Earnings Ratio	POER0	-408.75	0.0071	0.0645	1.122	0.1102	0.0063	-0.0008	0.72
	POER1	4.77	0.0129	0.0481	0.988	0.2679*	0.0131	0.0051*	0.85
	POER2	8.77	0.0087	0.0448	0.939	0.1948	0.0093	0.0009	0.87
	POER3	13.56	0.0077	0.0426	0.879	0.1801	0.0087	-0.0001	0.85
	POER4	79.65	0.0082	0.0512	0.970	0.1601	0.0084	0.0004	0.79
Panel F:									
Price to Cashflows Ratio	PCR0	-86.14	0.0086	0.0671	1.152	0.1280	0.0075	0.0007	0.71
	PCR1	4.36	0.0129	0.0493	1.018	0.2605*	0.0126	0.0050*	0.86
	PCR2	7.93	0.0079	0.0448	0.926	0.1754	0.0085	0.0001	0.86
	PCR3	12.13	0.0084	0.0427	0.900	0.1969	0.0093	0.0006	0.87
	PCR4	71.16	0.0081	0.0493	0.937	0.1650	0.0087	0.0003	0.79
Panel G:									
Price to Book Ratio	PBR1	0.78	0.0107	0.0464	0.964	0.2302	0.0111	0.0029	0.86
	PBR2	1.23	0.0067	0.0433	0.944	0.1536	0.0070	-0.0011	0.90
	PBR3	1.74	0.0061	0.0439	0.931	0.1396	0.0066	-0.0017	0.88
	PBR4	4.38	0.0132	0.0550	1.001	0.2404	0.0132	0.0054	0.76
Panel H:									
Price to Debt Ratio	PDR1	0.34	0.0071	0.0527	1.114	0.1349	0.0064	-0.0008	0.88
	PDR2	0.84	0.0103	0.0461	0.979	0.2241	0.0106	0.0025	0.88
	PDR3	1.65	0.0086	0.0422	0.879	0.2034	0.0098	0.0008	0.86
	PDR4	9.35	0.0106	0.0498	0.899	0.2133	0.0118	0.0029	0.75
Panel I:									
Equally-Weighted Composite Variable	EWCV1	63.90	0.0172	0.0493	0.919	0.3492***	0.0187	0.0094***	0.77
	EWCV2	108.80	0.0078	0.0419	0.901	0.1862	0.0087	0.0000	0.89
	EWCV3	142.80	0.0058	0.0430	0.908	0.1336	0.0063	-0.0020	0.87
	EWCV4	183.32	0.0105	0.0527	0.958	0.1998	0.0109	0.0027	0.75
Panel J:									
Anomaly- Composite Variable	AWCV1	65.49	0.0170	0.0492	0.924	0.3454***	0.0184	0.0092***	0.78
	AWCV2	111.89	0.0082	0.0424	0.905	0.1935	0.0091	0.0004	0.88
	AWCV3	146.18	0.0069	0.0426	0.904	0.1613	0.0076	-0.0009	0.88
	AWCV4	186.99	0.0094	0.0521	0.953	0.1800	0.0098	0.0016	0.76
Panel K:									
TSE300		N.A.	0.0078	0.0415	1.000	0.1884	0.0078	0.0000	1.00

Table 6-2-2: Portfolio risk-Return characteristics and return performance without industry effect adjustment (1986.1-89.12)

	Portfolio	Variable ¹	Return	Standard Deviation	Beta	Sharpe Measure	Treynor Measure	Jensen Measure	PT-MKT Correlation ²
Panel A:									
Price Level	P1	\$3.34	0.0173	0.0649	1.115	0.2669	0.0155	0.0066	0.82
	P2	\$7.52	0.0113	0.0493	0.962	0.2281	0.0117	0.0009	0.93
	P3	\$12.76	0.0063	0.0503	1.008	0.1258	0.0063	-0.0041*	0.95
	P4	\$29.99	0.0040	0.0478	0.942	0.0839**	0.0043	-0.0063**	0.94
Panel B:									
Market Capitalization	MC1	\$19,702.11	0.0091	0.0571	1.012	0.1592	0.0090	-0.0014	0.85
	MC2	\$67,729.31	0.0096	0.0512	0.938	0.1872	0.0102	-0.0007	0.88
	MC3	\$208,009.80	0.0096	0.0500	0.973	0.1919	0.0099	-0.0008	0.93
	MC4	\$1,624,636.81	0.0099	0.0541	1.089	0.1821	0.0091	-0.0008	0.96
Panel C:									
Price to Sales Ratio	PSR1	0.22	0.0122	0.0473	0.920	0.2586	0.0133	0.0020	0.93
	PSR2	0.54	0.0096	0.0488	0.952	0.1966	0.0101	-0.0007	0.93
	PSR3	1.09	0.0079	0.0560	1.056	0.1403	0.0074	-0.0027	0.90
	PSR4	3.95	0.0082	0.0598	1.081	0.1369	0.0076	-0.0025	0.86
Panel D:									
Price to Earnings Ratio	PER0	N.A.	0.0032	0.0620	1.150	0.05192*	0.0028	-0.0076	0.88
	PER1	7.43	0.0179	0.0530	0.950	0.3384	0.0189	0.0076*	0.85
	PER2	12.32	0.0084	0.0479	0.890	0.1749	0.0094	-0.0018	0.89
	PER3	17.15	0.0066	0.0506	0.961	0.1308	0.0069	-0.0037	0.91
	PER4	61.16	0.0089	0.0575	1.085	0.1555	0.0082	-0.0017	0.90
Panel E:									
Price to After Tax Operating Earnings Ratio	POER0	-127.28	0.0013	0.0701	1.117	0.0181	0.0011	-0.0095	0.76
	POER1	4.77	0.0162	0.0532	1.013	0.3053	0.0160	0.0058*	0.91
	POER2	8.29	0.0101	0.0504	0.987	0.2006	0.0103	-0.0003	0.93
	POER3	12.33	0.0084	0.0488	0.910	0.1714	0.0092	-0.0018	0.89
	POER4	52.34	0.0060	0.0558	1.059	0.1079	0.0057	-0.0046	0.91
Panel F:									
Price to Cashflows Ratio	PCR0	-123.84	0.0013	0.0708	1.132	0.0179	0.0011	-0.0095	0.76
	PCR1	4.14	0.0161	0.0547	1.042	0.2950	0.0155	0.0056	0.91
	PCR2	7.43	0.0095	0.0499	0.976	0.1899	0.0097	-0.0009	0.93
	PCR3	11.14	0.0098	0.0483	0.911	0.2032	0.0108	-0.0004	0.90
	PCR4	45.63	0.0054	0.0553	1.051	0.0978	0.0051	-0.0052	0.91
Panel G:									
Price to Book Ratio	PBR1	0.84	0.0128	0.0498	0.981	0.2569	0.0130	0.0024	0.94
	PBR2	1.33	0.0089	0.0498	0.981	0.1799	0.0091	-0.0014	0.94
	PBR3	1.86	0.0063	0.0511	1.006	0.1239	0.0063	-0.0041	0.94
	PBR4	5.24	0.0104	0.0593	1.032	0.1748	0.0101	-0.0002	0.83
Panel H:									
Price to Debt Ratio	PDR1	0.39	0.0114	0.0560	1.133	0.2027	0.0100	0.0005	0.96
	PDR2	0.91	0.0119	0.0524	1.033	0.2266	0.0115	0.0013	0.94
	PDP3	1.75	0.0086	0.0472	0.886	0.1827	0.0097	-0.0015	0.90
	PDR4	9.31	0.0064	0.0542	0.970	0.1181	0.0066	-0.0040	0.85
Panel I:									
Equally-Weighted Composite Variable	EWCV1	65.85	0.0200	0.0544	0.979	0.3666**	0.0204	0.0096***	0.86
	EWCV2	109.32	0.0071	0.0468	0.903	0.1520	0.0079	-0.0031	0.92
	EWCV3	143.26	0.0075	0.0503	0.967	0.1484	0.0077	-0.0029	0.92
	EWCV4	185.43	0.0074	0.0557	1.042	0.1330	0.0071	-0.0032	0.89
Panel J:									
Anomaly-Weighted Composite Variable	AWCV1	67.71	0.0204	0.0545	0.985	0.3749**	0.0208	0.0100**	0.86
	AWCV2	113.18	0.0067	0.0479	0.919	0.1406	0.0073	-0.0035	0.92
	AWCV3	147.36	0.0078	0.0491	0.947	0.1582	0.0082	-0.0025	0.92
	AWCV4	189.69	0.0073	0.0551	1.041	0.1316	0.0070	-0.0033	0.90
Panel K:									
TSE300		N.A.	0.0104	0.0477	1.000	0.2191	0.0104	0.0000	1.00

Table 6-2-3: Portfolio risk-Return characteristics and return performance without industry effect adjustment (1990.1-93.12)

	Portfolio	Variable ¹	Return	Standard Deviation	Beta	Sharpe Measure	Treynor Measure	Jensen Measure	PT-MKT Correlation ²
Panel A:									
Price Level	P1	\$3.02	0.0199	0.0463	0.963	0.4307**	0.0207	0.0147***	0.72
	P2	\$7.75	0.0105	0.0429	0.974	0.2443	0.0108	0.0052	0.79
	P3	\$11.26	0.0044	0.0384	0.894	0.1140	0.0049	-0.0010	0.80
	P4	\$25.81	0.0012	0.0354	0.767	0.0331	0.0015	-0.0045	0.75
Panel B:									
Market Capitalization	MC1	\$21,100.74	0.0151	0.0423	0.785	0.3561*	0.0192	0.0095*	0.64
	MC2	\$74,555.24	0.0088	0.0410	0.876	0.2136	0.0100	0.0033	0.74
	MC3	\$231,493.28	0.0070	0.0404	0.948	0.1741	0.0074	0.0017	0.81
	MC4	\$2,049,566.30	0.0052	0.0404	0.983	0.1287	0.0053	0.0000	0.84
Panel C:									
Price to Sales Ratio	PSR1	0.18	0.0055	0.0442	0.892	0.1246	0.0062	0.0001	0.70
	PSR2	0.49	0.0079	0.0396	0.946	0.1993	0.0084	0.0026	0.83
	PSR3	1.10	0.0038	0.0352	0.852	0.1076	0.0044	-0.0017	0.83
	PSR4	5.15	0.0185	0.0523	0.907	0.3533**	0.0204	0.0131**	0.60
Panel D:									
Price to Earnings Ratio	PER0	N.A.	0.0073	0.0483	1.062	0.1503	0.0068	0.0022	0.76
	PER1	8.57	0.0164	0.0420	0.871	0.3911**	0.0189	0.0110**	0.72
	PER2	14.52	0.0059	0.0356	0.807	0.1651	0.0073	0.0003	0.78
	PER3	22.38	0.0084	0.0389	0.874	0.2158	0.0096	0.0030	0.77
	PER4	106.35	0.0102	0.0493	0.785	0.2060	0.0130	0.0046	0.55
Panel E:									
Price to After Tax Operating Earnings Ratio	POER0	-690.22	0.0130	0.0586	1.165	0.2210	0.0111	0.0081	0.70
	POER1	4.76	0.0095	0.0428	0.938	0.2232	0.0102	0.0042	0.76
	POER2	9.25	0.0073	0.0389	0.854	0.1887	0.0086	0.0019	0.75
	POER3	14.78	0.0070	0.0359	0.826	0.1946	0.0085	0.0015	0.79
	POER4	106.96	0.0104	0.0466	0.823	0.2224	0.0126	0.0048	0.61
Panel F:									
Price to Cashflows Ratio	PCR0	-48.43	0.0159	0.0631	1.230	0.2520	0.0129	0.0112	0.68
	PCR1	4.59	0.0096	0.0436	0.970	0.2192	0.0099	0.0043	0.77
	PCR2	8.43	0.0062	0.0394	0.837	0.1580	0.0074	0.0007	0.73
	PCR3	13.11	0.0070	0.0368	0.883	0.1907	0.0079	0.0016	0.82
	PCR4	96.69	0.0109	0.0428	0.747	0.2532	0.0145	0.0052	0.60
Panel G:									
Price to Book Ratio	PBR1	0.71	0.0086	0.0432	0.935	0.1986	0.0092	0.0033	0.75
	PBR2	1.13	0.0044	0.0361	0.877	0.1205	0.0050	-0.0011	0.84
	PBR3	1.61	0.0059	0.0357	0.799	0.1656	0.0074	0.0003	0.77
	PBR4	3.52	0.0161	0.0508	0.964	0.3164*	0.0167	0.0108*	0.66
Panel H:									
Price to Debt Ratio	PDR1	0.30	0.0029	0.0493	1.073	0.0580	0.0027	-0.0022	0.75
	PDR2	0.77	0.0088	0.0392	0.881	0.2238	0.0100	0.0034	0.77
	PDR3	1.54	0.0085	0.0370	0.875	0.2308	0.0098	0.0031	0.82
	PDR4	9.39	0.0149	0.0452	0.792	0.3285*	0.0188	0.0093*	0.61
Panel I:									
Equally-Weighted Composite Variable	EWCV1	61.94	0.0145	0.0440	0.807	0.3291*	0.0179	0.0089*	0.63
	EWCV2	108.27	0.0085	0.0369	0.911	0.2302	0.0093	0.0031	0.85
	EWCV3	142.35	0.0040	0.0347	0.801	0.1162	0.0050	-0.0015	0.79
	EWCV4	182.21	0.0136	0.0500	0.822	0.2711	0.0165	0.0080	0.57
Panel J:									
Anomaly-Weighted Composite Variable	AWCV1	63.24	0.0135	0.0435	0.807	0.3111	0.0168	0.0080	0.64
	AWCV2	110.58	0.0097	0.0367	0.894	0.2644	0.0108	0.0043	0.84
	AWCV3	144.98	0.0060	0.0355	0.830	0.1685	0.0072	0.0005	0.80
	AWCV4	184.26	0.0115	0.0494	0.807	0.2328	0.0142	0.0059	0.57
Panel K:									
TSE300		N.A.	0.0052	0.0346	1.000	0.1503	0.0052	0.0000	1.00

Table 6-3-1: Industry standardized portfolio risk-Return characteristics and return performance (1986.1-93.12)

	Portfolio	Variable ¹	Return	Standard Deviation	Beta	Sharpe Measure	Treynor Measure	Jensen Measure	PT-MKT Correlation ²
Panel A:									
Price Level	P1	\$3.92	0.0163	0.0525	1.052	0.3102**	0.0155	0.0084***	0.83
	P2	\$6.60	0.0129	0.0482	0.950	0.2684	0.0136	0.0051*	0.82
	P3	\$13.03	0.0048	0.0446	0.970	0.1069	0.0049	-0.0030	0.90
	P4	\$25.99	0.0034	0.0417	0.887	0.0813**	0.0038	-0.0044	0.88
Panel B:									
Market Capitalization	MC1	\$56,201.50	0.0112	0.0466	0.885	0.2407	0.0127	0.0035	0.79
	MC2	\$85,828.80	0.0087	0.0478	0.905	0.1826	0.0096	0.0009	0.79
	MC3	\$272,144.90	0.0097	0.0486	1.036	0.1999	0.0094	0.0019	0.88
	MC4	\$1,772,610.00	0.0072	0.0460	1.015	0.1574	0.0071	-0.0006	0.91
Panel C:									
Price to Sales Ratio	PSR1	0.41	0.0101	0.0465	0.952	0.2171	0.0106	0.0023	0.85
	PSR2	0.81	0.0089	0.0455	0.971	0.1949	0.0091	0.0011	0.88
	PSR3	1.61	0.0104	0.0486	0.973	0.2132	0.0106	0.0026	0.83
	PSR4	3.63	0.0077	0.0480	0.956	0.1611	0.0081	-0.0001	0.83
Panel D:									
Price to Earnings Ratio	PER1	10.19	0.0188	0.0453	0.877	0.4146***	0.0214	0.0110***	0.80
	PER2	14.16	0.0078	0.0436	0.904	0.1791	0.0086	0.0000	0.86
	PER3	22.12	0.0090	0.0511	0.906	0.1767	0.0100	0.0013	0.73
	PER4	78.07	0.0056	0.0468	0.996	0.1190	0.0056	-0.0022	0.88
Panel E:									
Price to After Tax Operating Earnings Ratio	POER1	5.98	0.0126	0.0478	0.956	0.2637	0.0132	0.0048*	0.83
	POER2	10.46	0.0110	0.0447	0.961	0.2465	0.0115	0.0032	0.89
	POER3	15.82	0.0066	0.0435	0.922	0.1511	0.0071	-0.0012	0.88
	POER4	77.54	0.0078	0.0496	0.937	0.1567	0.0083	0.0000	0.78
Panel F:									
Price to Cashflows Ratio	PCR1	5.34	0.0130	0.0478	0.965	0.2728*	0.0135	0.0052*	0.84
	PCR2	9.33	0.0104	0.0447	0.963	0.2331	0.0108	0.0026	0.89
	PCR3	13.43	0.0064	0.0459	0.963	0.1398	0.0067	-0.0014	0.87
	PCR4	72.77	0.0075	0.0462	0.880	0.1627	0.0085	-0.0003	0.79
Panel G:									
Price to Book Ratio	PBR1	0.86	0.0104	0.0455	0.942	0.2282	0.0110	0.0026	0.86
	PBR2	1.27	0.0067	0.0434	0.936	0.1550	0.0072	-0.0011	0.89
	PBR3	1.86	0.0085	0.0460	0.944	0.1839	0.0090	0.0007	0.85
	PBR4	4.01	0.0111	0.0518	1.021	0.2134	0.0108	0.0032	0.82
Panel H:									
Price to Debt Ratio	PDR1	0.55	0.0079	0.0496	1.023	0.1600	0.0078	0.0001	0.85
	PDR2	1.00	0.0087	0.0448	0.942	0.1948	0.0093	0.0009	0.87
	PDR3	2.00	0.0105	0.0526	1.015	0.1997	0.0104	0.0027	0.80
	PDR4	8.59	0.0093	0.0447	0.876	0.2077	0.0106	0.0015	0.81
Panel I:									
Equally-Weighted Composite Variable	EWCV1	71.73	0.0165	0.0478	0.891	0.3457**	0.0185	0.0087***	0.77
	EWCV2	113.69	0.0092	0.0439	0.946	0.2096	0.0097	0.0014	0.89
	EWCV3	146.23	0.0089	0.0446	0.939	0.1991	0.0095	0.0011	0.87
	EWCV4	178.90	0.0065	0.0485	0.905	0.1345	0.0072	-0.0013	0.78
Panel J:									
Anomaly-Weighted Composite Variable	AWCV1	71.24	0.0169	0.0471	0.852	0.3588**	0.0199	0.0092***	0.75
	AWCV2	113.67	0.0106	0.0449	0.968	0.2356	0.0109	0.0028	0.89
	AWCV3	147.54	0.0093	0.0452	0.934	0.2056	0.0099	0.0015	0.86
	AWCV4	177.81	0.0046	0.0487	0.924	0.0936	0.0049	-0.0032	0.79
Panel K:									
TSE300		N.A.	0.0078	0.0415	1.000	0.1884	0.0078	0.0000	1.00

Table 6-3-2: Industry standardized portfolio risk-Return characteristics and return performance (1986.1–89.12)

	Portfolio	Variable ¹	Return	Standard Deviation	Beta	Sharpe Measure	Treynor Measure	Jensen Measure	PT-MKT Correlation ²
Panel A:									
Price Level	P1	\$4.07	0.0189	0.0599	1.126	0.3158*	0.0168	0.0081***	0.90
	P2	\$7.29	0.0098	0.0517	0.935	0.1902	0.0105	-0.0004	0.86
	P3	\$13.97	0.0052	0.0511	1.008	0.1026*	0.0052	-0.0052**	0.94
	P4	\$27.98	0.0048	0.0476	0.954	0.1013**	0.0051	-0.0055**	0.95
Panel B:									
Market Capitalization	MC1	\$57,710.14	0.0132	0.0531	0.935	0.2484	0.0141	0.0029	0.84
	MC2	\$74,540.31	0.0079	0.0533	0.949	0.1490	0.0084	-0.0024	0.85
	MC3	\$249,380.70	0.0075	0.0541	1.059	0.1382	0.0071	-0.0031	0.93
	MC4	\$1,562,531.00	0.0095	0.0521	1.054	0.1825	0.0090	-0.0011	0.96
Panel C:									
Price to Sales Ratio	PSR1	0.33	0.0117	0.0479	0.94 ^a	0.2444	0.0123	0.0014	0.94
	PSR2	0.85	0.0099	0.0518	1.027	0.1919	0.0097	-0.0006	0.95
	PSR3	1.57	0.0081	0.0533	1.032	0.1530	0.0079	-0.0024	0.92
	PSR4	3.07	0.0086	0.0567	0.998	0.1511	0.0086	-0.0019	0.84
Panel D:									
Price to Earnings Ratio	PER1	9.13	0.0204	0.0518	0.920	0.3928**	0.0221	0.0101**	0.85
	PER2	13.56	0.0076	0.0499	0.937	0.1529	0.0081	-0.0026	0.90
	PER3	19.06	0.0062	0.0490	0.931	0.1258	0.0066	-0.0041	0.90
	PER4	57.18	0.0073	0.0579	1.103	0.1269	0.0067	-0.0034	0.91
Panel E:									
Price to After Tax Operating Earnings Ratio	POER1	5.59	0.0160	0.0521	0.972	0.3072	0.0165	0.0056	0.89
	POER2	9.38	0.0116	0.0520	1.025	0.2232	0.0113	0.0011	0.94
	POER3	15.06	0.0061	0.0506	0.974	0.1209	0.0063	-0.0043	0.92
	POER4	47.55	0.0072	0.0542	1.001	0.1326	0.0072	-0.0033	0.88
Panel F:									
Price to Cashflows Ratio	PCR1	4.87	0.0155	0.0530	0.992	0.2934	0.0157	0.0051	0.89
	PCR2	8.61	0.0126	0.0507	1.003	0.2477	0.0125	0.0021	0.94
	PCR3	13.06	0.0057	0.0523	1.008	0.1082	0.0056	-0.0048	0.92
	PCR4	41.57	0.0069	0.0527	0.968	0.1312	0.0072	-0.0034	0.88
Panel G:									
Price to Book Ratio	PBR1	0.94	0.0110	0.0490	0.959	0.2243	0.0115	0.0007	0.93
	PBR2	1.38	0.0101	0.0505	0.995	0.2008	0.0102	-0.0003	0.94
	PBR3	2.00	0.0066	0.0499	0.977	0.1325	0.0068	-0.0038	0.93
	PBR4	4.94	0.0104	0.0598	1.067	0.1739	0.0097	-0.0002	0.85
Panel H:									
Price to Debt Ratio	PDR1	0.64	0.0107	0.0531	1.059	0.2010	0.0101	0.0001	0.95
	PDR2	1.07	0.0107	0.0486	0.927	0.2195	0.0115	0.0004	0.91
	PDR3	1.98	0.0071	0.0585	1.080	0.1222	0.0066	-0.0035	0.88
	PDR4	8.53	0.0094	0.0540	0.935	0.1735	0.0100	-0.0009	0.83
Panel I:									
Equally-Weighted Composite Variable	EWCV1	72.85	0.0169	0.0524	0.924	0.3228	0.0183	0.0067	0.84
	EWCV2	115.52	0.0099	0.0515	1.008	0.1922	0.0098	-0.0006	0.93
	EWCV3	148.00	0.0100	0.0502	0.956	0.1999	0.0105	-0.0003	0.91
	EWCV4	181.46	0.0044	0.0521	1.001	0.0851*	0.0044	-0.0060*	0.92
Panel J:									
Anomaly-Weighted Composite Variable	AWCV1	72.86	0.0177	0.0524	0.894	0.3380	0.0198	0.0076*	0.81
	AWCV2	115.27	0.0108	0.0519	1.023	0.2077	0.0105	0.0003	0.94
	AWCV3	149.72	0.0083	0.0498	0.933	0.1674	0.0089	-0.0019	0.89
	AWCV4	179.81	0.0047	0.0532	1.035	0.0886*	0.0046	-0.0058**	0.93
Panel J:									
TSE300		N.A.	0.0104	0.0477	1.000	0.2191	0.0104	0.0000	1.00

Table 6-3-3: Industry standardized portfolio risk-Return characteristics and return performance (1990.1-93.12)

	Portfolio	Variable ¹	Return	Standard Deviation	Beta	Sharpe Measure	Treynor Measure	Jensen Measure	PT-MKT Correlation ²
Panel A:									
Price Level	P1	\$3.79	0.0136	0.0443	0.917	0.3077*	0.0149	0.0083*	0.72
	P2	\$6.04	0.0160	0.0446	0.999	0.3589**	0.0160	0.0108**	0.78
	P3	\$12.27	0.0043	0.0376	0.907	0.1143	0.0047	-0.0011	0.83
	P4	\$24.36	0.0020	0.0353	0.766	0.0555	0.0026	-0.0037	0.75
Panel B:									
Market Capitalization	MC1	\$54,982.18	0.0093	0.0396	0.794	0.2338	0.0117	0.0037	0.69
	MC2	\$95,073.16	0.0095	0.0420	0.837	0.2259	0.0113	0.0040	0.68
	MC3	\$290,877.30	0.0120	0.0430	1.012	0.2785*	0.0118	0.0068*	0.81
	MC4	\$1,942,620.00	0.0050	0.0395	0.944	0.1261	0.0053	-0.0003	0.83
Panel C:									
Price to Sales Ratio	PSR1	0.47	0.0085	0.0455	0.961	0.1865	0.0088	0.0032	0.73
	PSR2	0.78	0.0078	0.0387	0.873	0.2014	0.0089	0.0024	0.78
	PSR3	1.64	0.0126	0.0439	0.882	0.2863	0.0143	0.0072	0.69
	PSR4	4.07	0.0069	0.0381	0.885	0.1816	0.0078	0.0015	0.80
Panel D:									
Price to Earnings Ratio	PER1	11.27	0.0172	0.0382	0.799	0.4507***	0.0215	0.0116***	0.72
	PER2	14.76	0.0080	0.0367	0.854	0.2176	0.0093	0.0025	0.80
	PER3	25.20	0.0119	0.0535	0.879	0.2224	0.0135	0.0065	0.57
	PER4	99.37	0.0038	0.0327	0.801	0.1158	0.0047	-0.0018	0.84
Panel E:									
Price to After Tax Operating Earnings Ratio	POER1	6.32	0.0092	0.0433	0.924	0.2123	0.0099	0.0038	0.74
	POER2	11.42	0.0104	0.0365	0.849	0.2856	0.0123	0.0049	0.80
	POER3	16.49	0.0070	0.0356	0.838	0.1977	0.0084	0.0015	0.81
	POER4	104.08	0.0084	0.0452	0.829	0.1852	0.0101	0.0028	0.63
Panel F:									
Price to Cashflows Ratio	PCR1	5.75	0.0105	0.0424	0.916	0.2484	0.0115	0.0052	0.75
	PCR2	9.96	0.0083	0.0381	0.891	0.2168	0.0093	0.0029	0.81
	PCR3	13.75	0.0072	0.0390	0.893	0.1840	0.0080	0.0018	0.79
	PCR4	99.97	0.0081	0.0391	0.728	0.2074	0.0111	0.0024	0.64
Panel G:									
Price to Book Ratio	PBR1	0.79	0.0098	0.0422	0.917	0.2317	0.0107	0.0044	0.75
	PBR2	1.19	0.0033	0.0351	0.822	0.0943	0.0040	-0.0022	0.80
	PBR3	1.74	0.0103	0.0422	0.900	0.2444	0.0114	0.0049	0.74
	PBR4	3.26	0.0117	0.0430	0.947	0.2723	0.0124	0.0064	0.76
Panel H:									
Price to Debt Ratio	PDR1	0.49	0.0052	0.0463	0.956	0.1125	0.0055	-0.0001	0.72
	PDR2	0.93	0.0068	0.0411	0.973	0.1652	0.0070	0.0015	0.81
	PDR3	2.02	0.0139	0.0464	0.916	0.2990*	0.0151	0.0085*	0.68
	PDR4	8.65	0.0092	0.0335	0.775	0.2747	0.0119	0.0036	0.80
Panel I:									
Equally-Weighted Composite Variable	EWCV1	70.59	0.0161	0.0432	0.839	0.3729**	0.0192	0.0106**	0.67
	EWCV2	111.85	0.0085	0.0351	0.837	0.2418	0.0101	0.0030	0.82
	EWCV3	144.42	0.0077	0.0386	0.913	0.1997	0.0084	0.0023	0.82
	EWCV4	176.31	0.0086	0.0450	0.746	0.1911	0.0115	0.0029	0.57
Panel J:									
Anomaly-Weighted Composite Variable	AWCV1	69.59	0.0161	0.0418	0.778	0.3857**	0.0207	0.0105***	0.64
	AWCV2	112.04	0.0104	0.0373	0.876	0.2790	0.0119	0.0050	0.81
	AWCV3	145.33	0.0102	0.0405	0.949	0.2526	0.0108	0.0049	0.81
	AWCV4	175.78	0.0044	0.0444	0.725	0.0992	0.0061	-0.0013	0.57
Panel K:									
TSE300		N.A.	0.0052	0.0346	1.000	0.1503	0.0052	0.0000	1.00

The following notes apply to all sub-tables under Table 6-2 or Table 6-3:

¹The portfolio mean values of price-related variables, averaged across all stocks within a portfolio *and* across all years over the test period corresponding to the table. MC is expressed in thousands of Canadian dollars.

²The Pearson correlation coefficient between the portfolio's returns and the returns on the TSE300 index over the test period corresponding to the table, which measures the extent of diversification.

*Statistically different from the corresponding figure of the TSE300 index at 10 per cent level of significance.

**Statistically different from the corresponding figure of the TSE300 index at 5 per cent level of significance.

***Statistically different from the corresponding figure of the TSE300 index at 1 per cent level of significance.

Consider the results with the individual price-related variables. As shown in Table 6-3-1, for the overall test period, the Q1 portfolios tend to outperform the market on either a pure return or risk-adjusted basis. From the raw return perspective, all eight Q1 portfolios register higher mean monthly returns (0.79% to 1.88%) than the mean monthly return for the TSE300 index (0.78%). However, these eight Q1 portfolios also have higher total risks (measured by the portfolio's standard deviations, which range from 4.53% to 5.25%) than that of the TSE300 index (4.15%).⁴⁹ In view of the risk-adjusted returns, seven of the eight Q1 portfolios possess higher Sharpe performance scores (0.2171 to 0.4146) than the TSE300 index's 0.1884; and all eight Q1 portfolios perform better than the TSE300 index with the Treynor and Jensen performance measures (comparing the figures in the first row, 8th and 9th columns of Panel A through H to the corresponding figures in Panel K). Furthermore, after accounting for the total or systematic risk, four of the eight Q1 portfolios (P1, PER1, PCR1, and POER1) generate statistically significant abnormal returns relative to the TSE300 index, which reinforces the results of the PCWI analysis in Section 6-1.

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⁴⁹The same *cannot* be said about the systematic risks (measured by the portfolios' betas) associated with the Q1 portfolios (see column 6 of Table 6-3). Hence, adjusting for total risk seems more critical in assessing the relative performance involving Q1 portfolios. The Sharpe performance measure and the JK test should, therefore, be applied in those events.

In contrast, the Q4 portfolios tend to underperform the market. Table 6-3-1 shows that six of the eight Q4 portfolios earn less monthly returns (0.34% to 0.77%) than the TSE300 index's 0.78%; six of the eight Q4 portfolios exhibit lower Sharpe scores (0.0813 to 0.1627) than that of the TSE300 index (0.1884); and five of the eight Q4 portfolios have negative "abnormal" monthly returns when the Jensen measure is applied (-0.44% to -0.01%). However, a caveat is that only one of these eight Q4 portfolios underperforms the TSE300 index in a statistical sense.

Consider then the EWCV and AWCV. Panels I and J of Table 3-1 show the comparable results. Not surprisingly, the Q1 portfolios with EWCV and AWCV dominate the TSE300 index, while their Q4 counterparts underperform. Further, when comparing the results in Panel J with those in Panel I of Table 6-3-1, it reveals that portfolio returns are *not* sensitive to the weighting schemes used to construct the composite price-related variables defined in this study.⁵⁰ AWCV appears to be only marginally better than EWCV at separating high performing stocks from low performing ones. For example, the Sharpe performance measure with AWCV1 (AWCV4) is 0.3588 (0.0936), compared to 0.3457 (0.1345) with EWCV1 (EWCV4). Based on this observation, EWCV is considered to be a more useful security screening device than AWCV in practice because of its simplicity in construction.

In addition, most portfolios formulated with price-related variables appear to be well diversified. Referring to the last column of Table 6-3-1, the Pearson correlation coefficients between returns on those portfolios and returns on the TSE300 index range

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⁵⁰This may be due to the fact that by definition the weighting schemes are applied to the value *rankings* as opposed to the actual values of the individual price-related variables in constructing composite price-related variables.

from 0.73 to 0.91. In other words, investment strategies based on price-related variables do not seem to tradeoff diversification benefit for return performance.

Furthermore, inconsistent with the findings by Jaffe et al. (1989) for the US common stock market, there is no evidence within the context of this study suggesting that portfolios with negative earnings consistently outperform many portfolios with positive earnings in the Canadian common stock market. On the contrary, Table 6-2 reveals that negative value portfolios tend to underperform a majority of the positive value portfolios in Canada for all three price-related variables, PER, PCR, and POER, that have negative value portfolios.

Finally, as seen from Table 6-3-2 and 6-3-3, similar results hold for the two sub-periods, except that during the sub-period 1990.1–93.12, more Q4 portfolios outperform the TSE300 index, rather than underperform it.

In summary, it appears that four individual price-related variables, P, PER, PCR, and POER, and consequently the two composite price-related variables, EWCV and AWCV, exhibit abilities to generate “abnormal” risk-adjusted returns contingent upon the TSE300 index. It also appears that price-related variables tend to be inversely related to portfolio returns, in the sense that the portfolios with the *lowest* positive values of price-related variables produce the *highest* return performance. Stated alternatively, these results provide evidence that price-related anomalies do exist in the Canadian common stock market.

6.3 Relative return performance of Q1 portfolios against Q4 portfolios

How do Q1 portfolios perform relative to the corresponding Q4 portfolios on a risk-adjusted basis? Answering this question is part of testing hypotheses 1 through 10 of this study. As specified in Section 5.6, the arbitrage portfolio based OLS, and the Sharpe measure and the JK test are adopted to address this question. Regardless of methodology, the central idea is to treat the Q4 portfolio as a benchmark, against which the return performance of the Q1 portfolio is assessed.

Table 6-4 shows the “abnormal” returns that could have been earned by the “arbitrage portfolios” (Q1–Q4) for each of the eight individual and two composite price-related variables under consideration over the three test periods. Again, as noted in Section 6.2, results before and after the industry effect adjustment are both presented, but only the industry standardized results will be discussed.

Table 6-4: “Abnormal” Returns with “arbitrage” portfolios (Q1–Q4)

	<i>Without Industry Effect Adjustment</i>			<i>With Industry Effect Adjustment</i>		
	<i>1986.1–93.12</i>	<i>1986.1–89.12</i>	<i>1990.1–93.12</i>	<i>1986.1–93.12</i>	<i>1986.1–89.12</i>	<i>1990.1–93.12</i>
P	0.0160***	0.0128**	0.0191***	0.0128***	0.0136***	0.0120***
MC	0.0046	-0.0006	0.0095**	0.0040	0.0040	0.0040
PSR	-0.0044	0.0045	-0.0130*	0.0024	0.0033	0.0017
PER	0.0076**	0.0094**	0.0064	0.0133***	0.0135***	0.0134***
POER	0.0047	0.0103**	-0.0006	0.0048*	0.0089**	0.0010
PCR	0.0047	0.0108***	-0.0009	0.0055**	0.0085**	0.0028
PBR	-0.0025	0.0026	-0.0076	-0.0006	0.0009	-0.0020
PDR	-0.0036	0.0045	-0.0115*	-0.0014	0.0010	-0.0036
EWCV	0.0067*	0.0127***	0.0009	0.0100***	0.0127***	0.0077
AWCV	0.0076*	0.0133***	0.0020	0.0124***	0.0134***	0.0118**

*Statistically different from zero at 10 per cent level of significance.

**Statistically different from zero at 5 per cent level of significance.

***Statistically different from zero at 1 per cent level of significance.

Table 6-4 mirrors the results of the PCWI analysis shown in Table 6-1. Consider the results for the overall period. It is shown that Q1 portfolios generate positive “abnormal” returns relative to Q4 portfolios for six of the eight individual price-related variables. These “abnormal” returns range from 0.24%, to as high as 1.33% per month. Also, four of these six individual price-related variables (P, PER, PCR, and POER) produce positive “abnormal” returns at a statistically significant level of 10 per cent or better. In addition, the results for the sub-periods, on the whole, are fairly consistent with those for the overall period, despite the fact that the number of statistically significant abnormal returns dropped from four to two in the sub-period 1990.1–93.12.

Table 6-5 presents the differences in the Sharpe performance measure between corresponding Q1 and Q4 portfolios for each of the eight individual and two composite price-related variables over the three test periods.

Table 6-5: Differences in the Sharpe measures between Q1 and Q4 portfolios

	<i>Without Industry Effect Adjustment</i>			<i>With Industry Effect Adjustment</i>		
	<i>1986.1–93.12</i>	<i>1986.1–89.12</i>	<i>1990.1–93.12</i>	<i>1986.1–93.12</i>	<i>1986.1–89.12</i>	<i>1990.1–93.12</i>
P	0.3134***	0.2252***	0.4389***	0.2633***	0.2471***	0.2881***
MC	0.0903	-0.0154	0.2328***	0.0848	0.0686	0.1067
PSR	-0.0729	0.0877	-0.2505**	0.0507	0.0682	0.0352
PER	0.1638**	0.1707***	0.1574	0.2884***	0.2501***	0.3587***
POER	0.0977	0.1900***	-0.0129	0.1004*	0.1683***	0.0199
PCR	0.0950	0.1952***	-0.0304	0.1146*	0.1623***	0.0546
PBR	-0.0351	0.0567	-0.1407	-0.0052	0.0218	-0.0432
PDR	-0.0700	0.0890	-0.2544***	-0.0311	0.0250	-0.1018
EWCV	0.1389*	0.2295***	0.0365	0.2071***	0.2380***	0.1718**
AWCV	0.1555**	0.2408***	0.0575	0.2578***	0.2466***	0.2714***

*Statistically different from zero at 10 per cent level of significance.

**Statistically different from zero at 5 per cent level of significance.

***Statistically different from zero at 1 per cent level of significance.

Consistent with the results presented in Table 6-4, six of the eight Q1 portfolios manifest higher Sharpe performance scores than their Q4 counterparts for the overall period. Many of these positive *differences* in the Sharpe performance scores exceed 0.2, which is greater than the Sharpe performance score achieved by the TSE300 index (0.1884, see Table 6-3-1). Not incidentally, four of the eight individual price-related variables (P, PER, PCR, and POER) generate the positive differences in the Sharpe performance scores that are statistically different from zero at 10 per cent level or better. Again, the results with either subperiod do not appear to be substantially different.

With respect to EWCV and AWCV, the Q1 portfolios strongly dominate their corresponding Q4 portfolios. This is a result of the strong anomalous effects associated with four of the eight constituent individual price-related variables.

The findings of this section reinforce the results of Sections 6-1 and 6-2. Four individual price-related variables, P, PER, PCR, and POER, and consequently two composite price-related variables, EWCV and AWCV, really stand out to show anomalous effects on portfolio returns. The results of this section also suggest that price-related variables are inversely related to portfolio returns.

6.4 Return performance: Composite vs. Individual price-related anomalies

Section 3.3.1 hypothesizes that the composite price-related anomalies, which incorporate multiple factors, dominate most of the individual price-related anomalies. To operationalize this conjecture, null hypotheses 11 and 12 are specified in Section 3.3.2. Testing hypotheses 11 and 12 requires that returns on the Q1 portfolio of a composite price-related variable be compared to those on the Q1 portfolios of the eight constituent

individual price-related variables. These tests are conducted using the arbitrage portfolio based OLS.

Table 6-6 presents the results of the tests. There are two sub-tables under Table 6-6. Table 6-6-1 compares the return performances of the Q1 portfolios between the equally-weighted composite price-related variable (EWCV1) and the individual price-related variables. Table 6-6-2 shows a similar comparison, but substituting EWCV1 with the Q1 portfolio of the anomaly-weighted composite price-related variable (AWCV1).

Table 6-6-1: "Abnormal" returns on EWCV1 relative to Q1 portfolios of individual price-related variables

	<i>Without Industry Effect Adjustment</i>			<i>With Industry Effect Adjustment</i>		
	<i>1986.1-93.12</i>	<i>1986.1-89.12</i>	<i>1990.1-93.12</i>	<i>1986.1-93.12</i>	<i>1986.1-89.12</i>	<i>1990.1-93.12</i>
P	-0.0014	0.0030	-0.0058	0.0003	-0.0014	0.0023
MC	0.0051**	0.0110***	-0.0006	0.0053**	0.0038	0.0069**
PSR	0.0083***	0.0076**	0.0088***	0.0065***	0.0053*	0.0074**
PER	0.0000	0.0020	-0.0021	-0.0023	-0.0035	-0.0010
POER	0.0044***	0.0038**	0.0047*	0.0040**	0.0010	0.0068***
PCR	0.0044***	0.0040**	0.0046**	0.0035**	0.0016	0.0054**
PBR	0.0065***	0.0072**	0.0056	0.0062***	0.0060**	0.0062*
PDR	0.0102***	0.0090**	0.0111***	0.0086***	0.0066*	0.0107***

*Statistically different from zero at 10 per cent level of significance.

**Statistically different from zero at 5 per cent level of significance.

***Statistically different from zero at 1 per cent level of significance.

Table 6-6-2: "Abnormal" returns on AWCV1 relative to Q1 portfolios of individual price-related variables

	<i>Without Industry Effect Adjustment</i>			<i>With Industry Effect Adjustment</i>		
	<i>1986.1-93.12</i>	<i>1986.1-89.12</i>	<i>1990.1-93.12</i>	<i>1986.1-93.12</i>	<i>1986.1-89.12</i>	<i>1990.1-93.12</i>
P	-0.0016	0.0035	-0.0067*	0.0007	-0.0006	0.0022
MC	0.0049*	0.0114***	-0.0015	0.0057***	0.0046*	0.0068*
PSR	0.0081***	0.0080**	0.0079**	0.0069***	0.0062*	0.0073**
PER	-0.0002	0.0024	-0.0030*	-0.0019	-0.0026	-0.0011
POER	0.0041***	0.0043**	0.0037	0.0044**	0.0019	0.0067***
PCR	0.0042***	0.0045**	0.0037	0.0039**	0.0024	0.0053**
PBR	0.0063***	0.0076**	0.0047	0.0066***	0.0069**	0.0061*
PDR	0.0100***	0.0095**	0.0102***	0.0090***	0.0075*	0.0106***

*Statistically different from zero at 10 per cent level of significance.

**Statistically different from zero at 5 per cent level of significance.

***Statistically different from zero at 1 per cent level of significance.

According to Table 6-6-1, EWCV1 exhibits statistically significant positive "abnormal" returns over the Q1 portfolios for three quarters of the individual price-related variables considered in this study. For the overall period, these significant "abnormal" returns range from 0.35% to 0.86% a month. Only PER1 seems to consistently perform better than EWCV1, but not from a statistical point of view. Table 6-6-2 gives similar results to those in Table 6-6-1. These results indicate that a composite price-related anomaly dominates most of the individual price-related anomalies. Note again that AWCV1 appears to offer *slightly* better relative performance against the Q1 portfolios of the individual price-related variables than EWCV1 does, but the overall relative performance patterns remain virtually unchanged between the two. This confirms the earlier observation that portfolio returns are insensitive to weighting schemes used to construct composite price-related variables defined in this study.

To provide further insight into how a multi-factor price-related anomaly may dominate single-factor price-related anomalies in return performance, two extreme value

portfolios are constructed. One portfolio, named the Combined Quartile 1 (CQ1) portfolio, consists of only those stocks that were placed into *every* quartile 1 portfolio of four individual price-related variables—P, PER, PCR, and POER. Another portfolio, named the Combined Quartile 4 (CQ4) portfolio, holds only those stocks that were assigned to *every* quartile 4 portfolio of the same four individual price-related variables. Table 6-7 presents the “abnormal” returns of CQ1 portfolio against the Q1 portfolios of the eight individual price-related variables examined in this study over the three test periods. This table gives a clear picture that the CQ1 portfolio outperforms each of the best performing portfolio of all individual price-related variables, including P and PER, by a considerable margin, regardless of test period.

Table 6-7: “Abnormal” returns of CQ1 over the Q1 portfolios of individual price-related variables

	<i>Without Industry Effect Adjustment</i>			<i>With Industry Effect Adjustment</i>		
	<i>1986.1–93.12</i>	<i>1986.1–89.12</i>	<i>1990.1–93.12</i>	<i>1986.1–93.12</i>	<i>1986.1–89.12</i>	<i>1990.1–93.12</i>
P	0.0191***	0.0267**	0.0114*	0.0098*	0.0106	0.0082
MC	0.0256***	0.0346***	0.0166**	0.0147***	0.0158**	0.0128*
PSR	0.0288***	0.0312**	0.0259***	0.0159***	0.0173***	0.0133
PER	0.0205***	0.0256**	0.0150**	0.0072	0.0086	0.0048
POER	0.0249***	0.0275**	0.0218***	0.0134***	0.0131*	0.0126*
PCR	0.0249***	0.0276**	0.0217***	0.0130***	0.0136**	0.0113
PBR	0.0271***	0.0308**	0.0228***	0.0156***	0.0180***	0.0121
PDR	0.0307***	0.0327**	0.0282***	0.0181***	0.0186***	0.0166**

*Statistically different from zero at 10 per cent level of significance.

**Statistically different from zero at 5 per cent level of significance.

***Statistically different from zero at 1 per cent level of significance.

To show the relative performance of the CQ1 portfolio in a more reader-friendly format, Figure 6-7 (p.91) graphically displays the industry standardized PCWI values associated with the CQ1 portfolio, the CQ4 portfolio, and the TSE300 index through the period of 1986.1–93.12. As illustrated, the CQ1 portfolio is the indisputable performance

winner over the CQ4 portfolio, and the TSE300 index. The CQ1 portfolio appreciated \$837.05 above the initial \$100 investment over the eight year investment period, compared to \$27.3 flat gain of the CQ4 portfolio, and \$92.3 moderate growth with the TSE300 index over the same period. Table 6-7 and Figure 6-7 provide strong evidence supporting the contention that investment strategies based on a multi-factor composite price-related anomaly outperform those based on a single-factor individual price-related anomaly alone.

It should be cautioned however that the CQ1 portfolio seems to accomplish its remarkable performance at the expense of diversification. Note that the CQ1 portfolio averaged only 11.38 stocks in its holdings each year (see Table 6-8), and that the cumulative returns on the CQ1 portfolio appear to be much more volatile than those on the TSE300 index (see Figure 6-7 at the end of this chapter, p.91). Nevertheless, while the CQ1 strategy should not be naively followed in practice, it clearly points out that a multi-factor strategy works better than a single-factor strategy for generating superior investment performance.

Table 6-8: Sample size of CQ1 and CQ4 portfolios

	1986	1987	1988	1989	1990	1991	1992	1993	Average
CQ1	8	10	10	13	17	11	11	11	11.38
CQ4	4	6	9	7	12	12	7	9	8.25

6.5 Missing value adjustment

In calculating portfolio returns for a month, this study deleted those stocks that do not have returns for that month. This may bias the results if the deleted stocks are not distributed randomly among the four positive value quartile portfolios. Particularly, relative return performance may favor Q1 portfolios if most of the deleted stocks belong there. To check robustness of the results to this potential missing value bias, this study

also conducts PCWI analysis replacing all missing returns with a zero. Table 6-9 presents the industry standardized results after this missing value adjustment. To facilitate comparison, the industry standardized PCWI values from Table 6-1 are also presented in the table.

Table 6-9: Industry standardized PCWI of corresponding Q1 and Q4 portfolios with and without missing value adjustment (1986.1–93.12)

	<i>Without Missing Value Adjustment</i>			<i>With Missing Value Adjustment</i>		
	<i>Q1</i>	<i>Q4</i>	<i>Q1-Q4</i>	<i>Q1</i>	<i>Q4</i>	<i>Q1-Q4</i>
P	\$412.31	\$127.04	\$285.27	\$391.52	\$128.10	\$263.42
MC	\$262.87	\$180.12	\$82.75	\$257.31	\$180.10	\$77.21
PSR	\$236.27	\$186.81	\$49.46	\$229.47	\$183.96	\$45.51
PER	\$540.83	\$152.63	\$388.20	\$501.26	\$150.35	\$350.91
POER	\$297.80	\$186.42	\$111.37	\$286.40	\$182.89	\$103.51
PCR	\$310.54	\$184.72	\$125.82	\$298.73	\$182.14	\$116.59
PBR	\$243.84	\$251.78	-\$7.94	\$234.88	\$248.65	-\$13.77
PDR	\$189.64	\$219.92	-\$30.28	\$188.28	\$217.13	-\$28.85
EWCV	\$432.02	\$166.38	\$265.64	\$406.70	\$166.29	\$240.41
AWCV	\$449.68	\$137.75	\$311.94	\$421.60	\$137.91	\$283.69

Table 6-9 suggests that missing value bias does not affect the results of this study significantly. As shown, the missing value adjusted end-period values of Q1 portfolios are slightly lower than those without the adjustment, while there is virtually no difference in end-period values of the corresponding Q4 portfolios before and after the missing value adjustment. Furthermore, although not shown here, it is observed (through PCWI graphs) that the return movement patterns for all portfolios are, to a great extent, independent of the missing value adjustment. Risk-adjusted results, therefore, should be similar before and after the adjustment.

6.6 Comparison of results with earlier studies

In order to compare the results of this study with the results of earlier anomaly studies for the US common stock market, Table 6-10 summarizes the results of this study in conjunction with those presented in Table 2-1. As shown in Table 6-10, the overall results of this study seem to be consistent with those of the earlier studies for the US market. There is a consensus among all studies cited here regarding the direction of individual price-related anomalies (mainly based upon the Jensen measure for the overall period). The strengths of these individual price-related anomalies in terms of the magnitude of “abnormal” returns seem to be of comparable scale as well. It should be noted, however, that half of the individual price-related anomalies examined in this study are not statistically significant as found by the earlier studies.

Table 6-10: The results of this study in comparison of earlier studies

<i>Author(s) for the US Study (year)</i>	<i>Variable</i>	<i>Sign</i>	<i>US Study (t-stat)</i>	<i>This Study (t-stat)</i>
Blume & Husic (1973)	P	-	0.0204 (4.1)*	0.84% (2.82)*
Basu (1977)	PER	-	0.27% (3.73)	1.1% (3.94)
Banz (1981)	MC	-	1.01% (3.07)**	0.4% (1.35)**
Rosenberg, Reid, & Lanstein (1985)	PBR	-	0.36% (5.7)	0.26% (1.06)
Wilson (1986)	PCR	-	0.230 (3.8)	0.52% (1.94)*
Senchack & Martin (1987)	PSR	-	0.31%	0.23% (0.91)
Bhandari (1988)	PDR	-	0.13% (3.84)	0.01% (0.04)

*Results are not directly comparable due to difference in methodology.

**“Abnormal” returns on the “arbitrage portfolio.”

It may be helpful to note here that, strictly speaking, the above comparison is meaningful only if the research designs with respect to methodology and sample are identical between studies being compared. As this condition may not be necessarily met, the findings of such a comparison should be interpreted with caution. For example, consider the “size (MC) effect.” As shown in Table 6-10, there appears no significant “size effect” in this study, which is inconsistent with the finding of Banz (1981). Recall that in

the sample selection process of this study, three size screens (total revenue, total assets, and price) are imposed to control for some potential biases (see Section 4.2). As a result, the small firms of this study may not be small at all in the context of the Canadian stock market. Indeed, the mean market capitalization of the smallest size portfolio is over \$56 million, which by no means represents small firms in Canada. In contrast, Banz includes all common stocks quoted on the NYSE in the sample of his 1981 study. Similar remarks can also be made for comparing results with other price-related variables. Since MC, PDR, and PBR are considered direct indicators of financial distress, and the size screens used in this study may effectively eliminate those stocks that have higher level of financial distress, the differences in findings like those in Table 6-10 with MC, PDR, and PBR might be well expected.

6.7 Conclusions

The empirical evidence presented in this study suggests that price-related anomalies existed in the Canadian common stock market during the period from January 1986 to December 1993. Portfolio returns exhibited statistically significant inverse relationships with price-related variables. Using active trading strategies based upon some price-related variables, investors could have earned considerably higher returns, compared to passively investing in a broadly-based index fund. Among the eight individual price-related variables under study, stock price and price-to-earnings ratio demonstrated the highest ability to generate abnormal returns, while price-to-cash flows ratio and price-to-adjusted after-tax operating earnings ratio also show an ability to produce superior investment performance. These individual price-related anomalies seem to be consistent over time.

This study also provides evidence that investment strategies based on *multi-factor* price-related anomalies tend to outperform strategies based on a *single-factor* price-related anomaly alone. Furthermore, in construction of a composite price-related variable as defined in this study, the simple equally weighting scheme is shown to be more useful than a complex weighting scheme, because portfolio return performance appears to be insensitive to the weights attached to the cross-sectional rankings associated with constituent individual price-related variables.

Figure 6-1-1: PCWI with P

Figure 6-1-2: PCWI with industry standardized P

Figure 6-2-1: PCWI with PER

Figure 6-2-2: PCWI with industry standardized PER

Figure 6-3-1: PCWI with PCR

Figure 6-3-2: PCWI with industry standardized PCR

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Figure 6-4-1: PCWI with POER

Figure 6-4-2: PCWI with Industry standardized POER

Figure 6-5-1: PCWI with EWCV

Figure 6-5-2: PCWI with industry standardized EWCV

Figure 6-6-1: PCWI with AWCV

Figure 6-6-2: PCWI with industry standardized AWCV

Figure 6-7: PCWI with industry standardized CQ portfolios

Chapter 7: Benefits, Limitations, and Suggestions for Future Research

7.1 Benefits

This study offers benefits to both academics and market participants. For academics, this is the first empirical study that examines the relationship between common stock returns and a set of price-related variables for the Canadian stock market, and it yields some interesting findings. This study thereby helps understand the risk-return tradeoffs in the Canadian common stock market. In addition, by adding the Canadian evidence to the US-result dominated anomaly literature, this study also helps improve our understanding of the return behavior in a cross-market context. Specifically, the results of this study suggest that the US and the Canadian common stock markets are integrated in the sense that stock returns in both markets relate to the same set of price-related factors in a similar fashion.

This study also has some unique features in terms of research design. For example, while the JK test (1981), which compares the Sharpe measures between two portfolios, offers an effective technique in evaluating investment performance on a total risk-adjusted basis, it has not yet been utilized in any other anomaly study. In addition, this study introduced some composite price-related variables into the portfolio formation scheme for anomaly studies. Except that this design represents a close emulation to “attribute investing” in practice, it also allows researchers to incorporate multiple factors into analysis without using a multivariate regression based methodology.

This study offers added-value to market participants, as well. Through this study, market participants may gain a better perspective on the Canadian equity market, thereby improving their security selection decisions. For example, based upon the findings of this study, market participants see that portfolios constructed with some price-related variables

such as price level, price-to-earnings ratio, and price-to-cashflows ratio, etc. have persistently generated superior risk-adjusted return performance since the beginning of 1986. Although it is considered unwise for market participants to naively follow the strategies based on the price-related anomalies found in this study, it would be well worth the effort to examine carefully the patterns and trends of these price-related factors before deciding in which stocks to invest. Furthermore, given that multiple factors should be taken into consideration when making a security selection decision, the composite price-related variable approach used in this study may provide a useful and practical portfolio formation technique for this purpose. Overall, the price-related anomalies demonstrated in this study should warrant attention from active institutional or individual investors.

7.2 Limitations

This study also has some limitations. It does not present a “purified anomaly” in the sense of Jacobs and Levy (1988) with respect to each individual price-related variable, because the methodology employed here does not control for the interactive effects among different individual price-related variables.⁵¹ This would be a serious problem if this study attempted to determine whether individual price-related anomalies were independent of one another, or attempted to identify which one of the individual price-related anomalies dominated. However, it does not seem to be a problem for the purposes of this study as outlined in Section 1.2.2. Alternatively speaking, this study regards an investigation into the interactions among individual price-related variables as a separate issue that is beyond the scope of this study. Furthermore, there are two technical concerns which may reduce the effectiveness of using multiple regression based methodology for this study. First, the sample size of this study seems insufficient to undertake the “multi-way grouping

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⁵¹Recall that multiple regression based methodology is required to disentangle the interactive effect of various price-related variables on stock returns.

procedures” (see Section 2.1.1). Second, it seems inevitable that there is a high degree of correlation among the price-related variables examined in this study, because all of them are directly related to a common factor—common stock price, and some of them are even mathematically related to each other.⁵² Indeed, our sample shows a very high positive correlation between each pair among POER, PCR, PER, PSR and PDR, and between MC and P (see Appendix B for details). Consequently, an examination of these price-related variables jointly through a multiple regression based methodology would have to be carefully designed and implemented to tackle the potentially severe multicollinearity problem.

There are also a number of potential biases that may have an impact on the results of this study. Survivorship bias may affect the generalizability of the study. Survivorship bias is induced in the sample of this study because any given edition of the StockGuide database excludes all firms that have been delisted due to merger and acquisition, or bankruptcy, etc.⁵³ It is difficult to predict the magnitude and direction of this bias in this study due to lack of data. It is also doubtful to see it completely altering the results, especially given the care that has been taken in the sample selection process to reduce this bias (see Section 4.2).

Look-ahead bias might also influence the result of this study. Look-ahead bias refers to a systematic error that is introduced because public releases of corporate annual reports for all sample firms usually lag several months behind their corresponding fiscal year-ends. The relevant information carried within annual reports, therefore, are not known to public investors until after the end of fiscal periods. Ideally, instead of using the

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⁵²For example, $MC = P \times \text{Number of shares outstanding}$; $PSR = P/(\text{Earnings} \times \text{Net Margin})$; $PCR = P/(\text{Operating earnings} + \text{R\&D adjustment} + \text{Changes in deferred credits})$.

⁵³For more about the survivorship bias, see, for example, Banz and Breen (1986).

market prices at fiscal year-ends, the market prices on the dates of public releases should be used to calculate price-related variables for portfolio formation purpose. Since the StockGuide database does not provide interim stock prices, this bias seems unavoidable using the StockGuide database *alone* for the portfolio formation process.

Finally, this study does not incorporate transaction costs into its analyses.⁵⁴ Obviously, to engage in an active trading strategy, such as an attribute investing scheme, investors will incur some transaction costs. In some circumstances, transaction costs may effectively reduce the economic significance of potential "abnormal" performances warranted by the trading strategy.⁵⁵ However, since this study adopts a *yearly* portfolio rebalancing, portfolio turnovers are expected to be relatively low. It may be reasonable to assume that transaction costs range from 30 to 50 basis points. If this assumption holds true, then the impact of transaction costs in this study is negligible, given that the weakest significant price-related anomaly, POER effect, shows the annualized magnitude of 591 basis points.⁵⁶

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⁵⁴Transaction costs may include a dealer's bid-ask spread, a broker's commission, in-house and retained research/monitor costs, and administrative expenses, etc.

⁵⁵Evidence concerning the transaction cost effect on observed price-related anomalies seems indeterminate based on the anomaly literature. For example, Stoll and Whaley (1983) argue that trading costs are responsible for the low price effect of Blume and Husic (1973) and the small size effect of Banz (1981). According to them, after adjusting for trading costs, both the low price and the small size effects remain strong in magnitude, but appear reversed in direction for one month portfolio rebalancing period. Schultz (1983) however disagrees with Stoll and Whaley (1983). He includes AMEX as well as NYSE stocks in his sample, thereby, allowing his small size portfolio to get even smaller, hence costlier to trade. He shows that, net of trading cost, his small size portfolio still earns a mean annual abnormal return as high as 30.9% with yearly portfolio rebalancing. He concludes that "the anomalous behavior of small firm returns cannot be explained solely on the basis of differences in transaction costs between small and large firms." An earlier survey by Ball (1978) is consistent with Schultz (1983).

⁵⁶Based on the industry standardized result for the overall period.

7.3 Suggestions for future research

In view of the limitations of this study discussed in the previous section, this study can be extended in at least two areas.

Following Jacobs and Levy (1988), future research may be designed to analyze multiple individual price-related variables of interest jointly with a multivariate regression based methodology (for example, GLS), so that the individual price related anomalies identified in this study can be “purified.” Given that small sample size tends to characterize anomaly studies for the Canadian stock market, it may yield more reliable results running the multivariate regression on a stock-by-stock basis, as opposed to at portfolio level.

Look ahead bias should also be checked in future research. The future research may divide stock price in June by the year-end accounting variables of the previous year, or divide year-end stock price by cumulative third quarter accounting variables in calculating price-related variables for portfolio formation.

Appendix A: Classification of industry groups

Appendix A-1: Classifications of industry groups by the StockGuide database

<i>STOCKGUIDE INDUSTRY GROUP #</i>	<i>TITLES OF THE STOCKGUIDE INDUSTRY GROUPS</i>
1	TSE 100 Index
2	TSE 200 Index
3	TSE 300 Index
5	TSE 35 Index
10	Integrated Mines
11	Mining
13	Gold and Precious Minerals
14	Mining Exploration — No production
16	Integrated Oils
18	Oil & Gas Producers
21	Oil & Gas, Mining, or Forest Services
23	Pipelines
26	Paper & Forest Products
27	Building Material
31	Autos and Parts
32	Breweries & Beverages
34	Distilleries
36	Food Processing
37	Household Goods
39	Tobacco
41	Department Stores
42	Food Stores
43	Biotechnology / Pharmaceuticals
44	Hospitality
45	Restaurants
46	Specialty Stores
47	Wholesale Distributors & Importers
50	Business Services
52	Chemicals and Fertilizers
54	Electrical & Electronic Products
55	Machinery & Structural Steel
56	Fabricating & Engineering
57	Specialty Industries
60	Steel producers
61	Steel Distributing & Servicing
62	Transportation Equipment
63	Industrial Contractors
70	Technology — Hardware

<i>STOCKGUIDE</i> <i>INDUSTRY GROUP #</i>	<i>TITLES OF THE STOCKGUIDE INDUSTRY GROUPS</i>

71	Technology — Software
75	Transportation & Environment Services
77	Gas & Electrical Utilities
79	Telephone Utilities
80	Broadcasting
81	Cable & Entertainment
83	Publishing & Printing
85	Real Estate & Construction
90	Banks and Trusts
92	Leasing, Financing, Mortgages
95	Investment Companies & Funds
96	Insurance
97	Financial Management Companies
98	Conglomerates

Appendix A-2: Classifications of industry groups for this study

Following the TSE sector classifications with a slight variation, the industry classifications for this study are grouped from the StockGuide database classifications as follows:

<i>INDUSTRY CODE OF THIS STUDY</i>	<i>STOCKGUIDE INDUSTRY GROUP #</i>	<i>TITLE OF THE INDUSTRIES FOR THIS STUDY</i>
1	10 and 11	Metals and Minerals
2	16	Integrated Oils
3	18	Oil & Gas Producers
4	21	Oil & Gas, Mining, or Forest Service
5	26	Paper & Forest Products
6	31	Auto and Parts
7	32, 34 and 39	Sin Products
8	36	Food Processing
9	37	Household Goods
10	41, 42, 44, 45, and 47	Merchandising
11	46	Specialty stores
12	43	Biotechnology & Pharmaceuticals
13	50 through 63 plus 27	Industrial Products
14	70 and 71	Technology
15	75	Transportation & Environmental Services
16	85	Real Estate
17	80, 81, and 83	Communications
18	98	Conglomerates
Deleted groups	13, 14, 77, 79, 90, 92, 95, 96, and 97	Gold & Silver; Exploration W/O Production; Utilities; and Financial Services

Appendix B: Average correlation coefficients between price-related variables

Appendices B-1, B-2, and B-3 show the average Pearson correlation coefficients between each pair of the eight individual price-related variables examined in this study over the period of 1986–93, 1986–89, and 1990–93, respectively. These average Pearson correlation coefficients are obtained as follows:

- (1) Calculate the values of the eight individual price-related variables pertaining to every sample firm according to the computational definitions specified in Table 3-1 for a given year under consideration;
- (2) Delete those sample firms that have negative values with any of the eight individual price-related variables;⁵⁷
- (3) Compute the Pearson correlation coefficient between each pair of the eight individual price-related variables for the given year;
- (4) Repeat steps (1) to (3) for all other years over the period 1986 to 1993, producing a time-series of Pearson correlation coefficients between each pair of the eight individual price-related variables during the period;
- (5) Average the Pearson correlation coefficients between each pair of the eight individual price-related variables across time over the period of 1986–93, 1986–89, or 1990–93, resulting in the average Pearson correlation coefficients matrices shown in Appendices B-1, B-2, or B-3, respectively.

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⁵⁷Because the StockGuide database assigns 999.99 to PSR, PER, and PBR if they are negative, it may significantly bias the results in many cases to include firms with negative values of the individual price-related variables in calculating Pearson correlation coefficients.

Appendix B-1: Correlation coefficients between price-related variables (1986-93)

	<i>POER</i>	<i>PCR</i>	<i>P</i>	<i>MC</i>	<i>PSR</i>	<i>PER</i>	<i>PBR</i>	<i>PDR</i>
POER	1.00							
PCR	0.93	1.00						
P	0.01	0.02	1.00					
MC	-0.01	-0.01	0.39	1.00				
PSR	0.51	0.49	-0.03	-0.04	1.00			
PER	0.43	0.42	-0.03	-0.04	0.22	1.00		
PBR	0.25	0.24	0.08	0.00	0.30	0.14	1.00	
PDR	0.44	0.47	-0.02	-0.05	0.45	0.15	0.12	1.00

Appendix B-2: Correlation coefficients between price-related variables (1986-89)

	<i>POER</i>	<i>PCR</i>	<i>P</i>	<i>MC</i>	<i>PSR</i>	<i>PER</i>	<i>PBR</i>	<i>PDR</i>
POER	1.00							
PCR	0.98	1.00						
P	0.00	0.01	1.00					
MC	-0.01	-0.01	0.26	1.00				
PSR	0.45	0.45	-0.02	-0.02	1.00			
PER	0.47	0.45	-0.03	-0.06	0.26	1.00		
PBR	0.26	0.28	0.09	-0.01	0.24	0.27	1.00	
PDR	0.66	0.69	-0.02	-0.05	0.42	0.26	0.16	1.00

Appendix B-3: Correlation coefficients between price-related variables (1990-93)

	<i>POER</i>	<i>PCR</i>	<i>P</i>	<i>MC</i>	<i>PSR</i>	<i>PER</i>	<i>PBR</i>	<i>PDR</i>
POER	1.00							
PCR	0.88	1.00						
P	0.02	0.04	1.00					
MC	-0.01	-0.01	0.52	1.00				
PSR	0.57	0.52	-0.05	-0.05	1.00			
PER	0.39	0.40	-0.03	-0.02	0.18	1.00		
PBR	0.23	0.20	0.07	0.02	0.36	0.00	1.00	
PDR	0.21	0.26	-0.01	-0.05	0.47	0.04	0.07	1.00

Appendix C: Portfolio size based on the StockGuide database only

The following table presents the portfolio size for each of the five portfolios constructed with each of the eight individual and two composite price-related variables under study based on the StockGuide database only, i.e., before running sample selection criteria (7) specified in Section 4.2. As shown, each positive-value quartile portfolio holds the same number of stocks for each of the ten price-related variables of interest in every year over the period from 1986 to 1993.

	<i>Portfolio</i>	<i>1986</i>	<i>1987</i>	<i>1988</i>	<i>1989</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>Average**</i>
<i>Panel A:</i>										
Price Level	P0	0	0	0	0	0	0	0	0	0.0
	P1	60	72	84	84	92	88	90	98	83.5
	P2	59	72	83	84	92	88	90	96	83.0
	P3	60	72	84	84	92	87	90	97	83.3
	P4	60	72	84	85	92	88	91	98	83.8
	Sample Size:	239	288	335	337	368	351	361	389	333.5
	Average*	59.8	72.0	83.8	84.3	92.0	87.8	90.3	97.3	83.4
<i>Panel B:</i>										
Market Capitalization	MC0	0	0	0	0	0	0	0	0	0.0
	MC1	60	72	84	84	92	88	90	98	83.5
	MC2	59	72	83	84	92	87	90	97	83.0
	MC3	60	72	84	84	92	88	90	97	83.4
	MC4	60	72	84	85	92	88	91	98	83.8
	Sample Size:	239	288	335	337	368	351	361	390	333.6
	Average*	59.8	72.0	83.8	84.3	92.0	87.8	90.3	97.5	83.4
<i>Panel C:</i>										
Price to Sales Ratio	PSR0	0	0	0	0	0	0	0	0	0.0
	PSR1	60	72	83	84	91	87	90	96	82.9
	PSR2	59	72	83	84	91	87	89	97	82.8
	PSR3	58	70	83	83	91	86	89	96	82.0
	PSR4	59	72	83	83	91	87	89	97	82.6
	Sample Size:	236	286	332	334	364	347	357	386	330.3
	Average*	59.0	71.5	83.0	83.5	91.0	86.8	89.3	96.5	82.6

	<i>Portfolio</i>	<i>1986</i>	<i>1987</i>	<i>1988</i>	<i>1989</i>	<i>1990</i>	<i>1991</i>	<i>1992</i>	<i>1993</i>	<i>Average**</i>
<i>Panel D:</i>										
Price to Earnings Ratio	PER0	36	49	39	45	78	93	153	124	77.1
	PER1	50	59	73	72	72	64	51	66	63.4
	PER2	50	59	73	72	71	63	51	65	63.0
	PER3	50	59	74	72	71	63	51	65	63.1
	PER4	50	59	73	73	72	64	51	66	63.5
	Sample Size:	236	285	332	334	364	347	357	386	330.1
	Average*	50.0	59.0	73.3	72.3	71.5	63.5	51.0	65.5	63.3
<i>Panel E:</i>										
Price to After Tax Operating Earnings Ratio	POER0	20	25	23	17	34	37	74	62	36.5
	POER1	55	67	78	80	84	78	72	82	74.5
	POER2	55	64	78	80	83	78	71	82	73.9
	POER3	54	66	78	80	82	78	71	81	73.8
	POER4	55	66	78	80	84	79	72	82	74.5
	Sample Size:	239	288	335	337	367	350	360	389	333.1
	Average*	54.8	65.8	78.0	80.0	83.3	78.3	71.5	81.8	74.2
<i>Panel F:</i>										
Price to Cashflows Ratio	PCR0	20	21	23	16	30	35	64	55	33.0
	PCR1	55	67	78	81	85	80	74	84	75.5
	PCR2	55	66	78	79	83	78	74	83	74.5
	PCR3	54	67	78	80	85	78	74	83	74.9
	PCR4	55	67	78	81	84	79	74	84	75.3
	Sample Size:	239	288	335	337	367	350	360	389	333.1
	Average*	54.8	66.8	78.0	80.3	84.3	78.8	74.0	83.5	75.0
<i>Panel G:</i>										
Price to Book Ratio	PBR0	5	3	2	2	1	2	3	6	3.0
	PBR1	58	70	83	83	90	86	88	95	81.6
	PBR2	57	72	81	83	90	87	89	95	81.8
	PBR3	57	70	83	83	91	85	88	95	81.5
	PBR4	59	70	83	83	92	87	89	95	82.3
	Sample Size:	236	285	332	334	364	347	357	386	330.1
	Average*	57.8	70.5	82.5	83.0	90.8	86.3	88.5	95.0	81.8
<i>Panel H:</i>										
Price to Debt Ratio	PDR0	0	0	0	0	0	0	0	0	0.0
	PDR1	59	72	84	84	92	87	91	97	83.3
	PDR2	60	72	82	84	91	87	89	97	82.8
	PDR3	59	71	83	83	91	88	89	97	82.6
	PDR4	60	72	84	84	92	87	90	97	83.3
	Sample Size:	238	287	333	335	366	349	359	388	331.9
	Average*	59.5	71.8	83.3	83.8	91.5	87.3	89.8	97.0	83.0
<i>Panel I:</i>										
Equally Weighted Composite Variable	EWCV0	0	0	0	0	0	0	0	0	0.0
	EWCV1	48	59	73	72	71	62	50	63	62.3
	EWCV2	47	59	73	72	70	62	50	64	62.1
	EWCV3	49	58	72	72	72	63	50	63	62.4
	EWCV4	46	59	73	73	71	64	50	64	62.5
	Sample Size:	190	235	291	289	284	251	200	254	249.3
	Average*	47.5	58.8	72.8	72.3	71.0	62.8	50.0	63.5	62.3

*Averaging across four positive-value quartile portfolios in the given year of interest.

**Time-series average across the period of 1986-93.

Appendix D: Comparison of portfolio size between quartile 1 and 4 portfolios

Histogram: the difference in portfolio size

$\Delta(Q1-Q4)^1$	Frequency	%	Cumulative %
-15	1	1.3%	100.0%
-13	3	3.8%	98.8%
-11	6	7.5%	95.0%
-9	3	3.8%	87.5%
-7	10	12.5%	83.8%
-5	12	15.0%	71.3%
-3	19	23.8%	56.3%
-1	16	20.0%	32.5%
1	5	6.3%	12.5%
3	3	3.8%	6.3%
5	2	2.5%	2.5%

¹ $\Delta(Q1-Q4)$ = number of stocks held in quartile 1 portfolio - number of stocks held in quartile 4 portfolio

Descriptive statistics:

Mean average of portfolio size difference = - 3.51

Standard Deviation of portfolio size difference = 4.27

Appendix E-1-1: PCWI with PSR

Appendix E-1-2: PCWI with industry standardized PSR

Appendix E-2-1: PCWI with MC

Appendix E-2-2: PCWI with industry standardized MC

Appendix E-3-1: PCWI with PBR

Appendix E-3-2: PCWI with industry standardized PBR

Appendix E-4-1: PCWI with PDR

Appendix E-4-2: PCWI with industry standardized PDR

References

- Ball, Ray, "Anomalies in Relationships Between Securities' Yields and Yield-Surrogates," *Journal of Financial Economics* 6, 1978, pp. 103-126
- Banz Rolf W., "The Relationship Between Return and Market Value of Common Stocks," *Journal of Financial Economics* 9, 1981, pp. 3-18
- Banz, Rolf and William Breen, "Sample-Dependent Results Using Accounting and Market Data: Some Evidence," *The Journal of Finance*, Vol. XLI, No. 4, September, 1986, pp. 779-793
- Basu, S., "Investment performance of Common Stocks in Relation to Their Price-Earnings Ratios: A test of the Efficient Market Hypothesis," *The Journal of Finance* Vol. XXXII, No. 3, June 1977, pp. 663-682
- Basu, Sanjoy, "The Relationship Between Earnings' Yield, Market Value and Return For NYSE Common Stocks, Further Evidence," *Journal of Financial Economics* 12, 1983, pp. 129-156
- Berges, Angel, John J. McConnell, and Gary G. Schlarbaum, "The Turn-of-the-Year in Canada," *The Journal of Finance*, Vol. XXXIX, No. 1, March 1984, pp. 185-192
- Bernard, Victor L. and Thomas Stober, "The Nature and Amount of Information in Cash Flows and Accruals," *The Accounting Review*, Vol. LXIV, October 1989, pp. 624-652
- Bhandari, Laxmi Chand, "Debt/Equity Ratio and Expected Common Stock Returns: Empirical Evidence," *The Journal of Finance*, Vol. XLIII, No. 2, June 1988, pp. 507-528
- Bjerring, James H., Josef Lakonishok, and Theo Vermaelen, "Stock Prices and Financial Analysts' Recommendations," *The Journal of Finance*, Vol. XXXVIII, No. 1, March 1983, pp. 187-204
- Blume, Marshall E. and Frank Husic, "Price, Beta and Exchange Listing," *The Journal of Finance*, 28, 1973, pp. 283-299
- Blume, Marshall E. and Stambaugh, Robert F., "Biases in Computed Returns, An Application to the Size Effect," *Journal of Financial Economics* 12, 1983, pp. 387-404
- Brown, Philip, Allan W. Kleidon, and Terry A. Marsh, "New Evidence on the Nature of Size-Related Anomalies in Stock Prices," *Journal of Financial Economics* 12, 1983, pp. 33-56

- Chan, K. C., Nai-Fu Chen, and David Hsieh, "An Exploratory Investigation of the Firm size Effect," *Journal of Financial Economics*, 14, no. 3, September 1985, pp. 451-471
- Chan, Louis, K. C and Nai-Fu Chen, "An Unconditional Asset-Pricing Test and the Role of Firm Size as an Instrumental Variable for Risk," *The Journal of Finance*, Vol. XLIII, No. 2, June 1988, pp. 309-325
- Chan, Louis, K. C and Nai-Fu Chen, "Structural and Return Characteristics of Small and Large Firms," *The Journal of Finance*, Vol. XLVI, No. 4, September 1991, pp. 1467-1484
- Chan, Louis K. C., Yasushi Hamano, and Josef Lakonishok, "Fundamentals and Stock Returns in Japan," *The Journal of Finance*, Vol. XLVI, No. 5, December 1991, pp. 1739-1763
- Chen, Nai-Fu, Richard Roll, and Stephen A. Ross, "Economic Forces and the Stock Market," *Journal of Business*, Vol. 59, No. 3, 1986, pp. 383-403
- Cook, Thomas J. and Michael S. Rozeff, "Size and Earnings/Price Ratio Anomalies: One Effect or Two?," *Journal of Financial and Quantitative Analysis*, Vol. 19, No. 4, December 1984, pp. 449-465
- Fama, Eugene F., "Efficient Capital Markets: A Review of Theory and Empirical Work," *The Journal of Finance*, May 1970, pp. 383-417
- Fama, Eugene F., "Efficient Capital Markets: II," *The Journal of Finance*, Vol. XLVI, No. 5, December 1991, pp. 1575-1617
- Fama, Eugene, and K. French, "The Cross-section of Expected Stock Returns," *The Journal of Finance*, Vol. XLVII, No. 2, June 1992, pp. 427-466
- Fama, Eugene, and James, MacBeth, "Risk, Return, and Equilibrium: Empirical Tests," *Journal of Political Economy*, 71, May-June 1973, pp. 607-636
- Friend, Irwin and Marshall Blume, "Measurement of Portfolio Performance Under Uncertainty," *The American Economic Review*, September 1970, pp. 561-575
- Goodman, David A. and John W. Peavy, III, "Industry Relative Price-Earnings Ratios as Indicators of Investment returns," *Financial Analysts Journal*, July-August 1983, pp. 60-66

- Goodman, David A. and John W. Peavy, III, "The Interaction of firm Size and Price-Earnings Ratio on Portfolio Performance," *Financial Analysts Journal*, January-February 1986, pp. 9-12
- Jacobs, Bruce I., and Kenneth N. Levy, "Disentangling Equity Return Regularities: New Insights and Investment Opportunities," *Financial Analysts Journal*, May-June 1988, pp. 18-43
- Jaffe, Jeffrey, Donald B. Keim, and Randolph Westerfield, "Earnings Yields, Market Values, and Stock Returns," *The Journal of Finance*, Vol. XLIV, No. 1, March 1989, pp. 135-148
- Jensen, M. C., "The Performance of Mutual Funds In The Period 1945-1964," *The Journal of Finance*, Vol. 23, May 1968, pp. 389-416
- Jensen, M. C., "Risk, The Pricing of Risky Assets, and The Evaluation of Investment Portfolios," *Journal of Business*, 42, April 1969, pp. 167-247
- Jobson, J. D. and Bob M. Korkie, "Performance Hypothesis Testing with the Sharpe and Treynor Measures," *The Journal of Finance*, Vol. XXXVI, No. 4, September 1981, pp. 889-908
- Jog, Vijay M., "Investment Performance of Pension Funds— A Canadian Study," *Canadian Journal of Administrative Sciences*, June 1986, pp. 146-163
- Jog, Vijay M., "Stock Pricing Anomalies: Canadian Experience," *Canadian Investment Review*, Fall 1988, pp. 55-62
- Keim, Donald B., "Stock Market Regularities: A Synthesis of the Evidence and Explanations," in E. Dimson (eds.) *Stock Market Anomalies*, 1988, Cambridge University Press. pp. 16-39
- Lakonishok, Josef and Alan C. Shapiro, "Systematic Risk, Total Risk and Size as Determinants of Stock Market Returns," *Journal of Banking and Finance*, 10, 1986, pp. 115-132
- Minard, Lawrence, "The Case Against Price/Earnings Ratio," *Forbes*, February 13, 1984, pp. 172-176
- Reinganum, Marc R., "Misspecification of Capital Asset Pricing, Empirical Anomalies Based on Earnings' Yields and Market Values," *Journal of Financial economics*, 9, 1981, pp. 19-46
- Reinganum, Marc R., "The Anatomy of a Stock Market Winner," *Financial Analysts Journal*, March-April 1988, pp. 16-28

- Roll, Richard, "A Critique of the Asset Pricing Theory's Test," *Journal of Financial Economics*, 4, May 1977, pp. 129-176
- Roll, Richard, "A Possible Explanation of the Small Firm Effect," *The Journal of Finance*, Vol. XXXVI, No. 4, September 1981, pp. 879-888
- Rosenberg, Barr, Kenneth Reid, and Ronald Lanstein, "Persuasive Evidence of Market Inefficiency," *The Journal of Portfolio Management*, Spring 1985, pp. 9-16
- Sharpe, W.F., "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," *The Journal of Finance*, Vol. XIX, September 1964, pp. 425-442
- Sharpe, W.F., "Mutual Fund Performance," *Journal of Business*, 39, January 1966, pp. 119-138
- Schultz, Paul, "Transaction Cost and The Small Firm Effect," *Journal of Financial economics* 12, 1983, pp. 81-87
- Senchack, A. J., Jr. and John D. Martin, "The Relative Performance of the PSR and PER Investment Strategies," *Financial Analysts Journal*, March-April, 1987, pp. 46-56
- Smirlock, Michael, and Laura Starks, "Day-of-the-Week And Intraday Effects in Stock Returns," *Journal of Financial Economics*, 17, 1986, pp. 197-210
- Stichel, Scott E., "The Effect of Value Line Investment Survey Rank Changes on Common Stock Prices," *Journal of Financial Economics*, 1985, pp. 121-143
- Stoll, Hans R. and Robert E. Whaley, "Transaction Costs And The Small Firm Effect," *Journal of Financial economics* 12, 1983, pp. 57-79
- Tinic, Seha M. and Giovanni Barone-Adesi, "Stock Return Seasonality and the Tests of Asset Pricing Models: Canadian Evidence," in E. Dimson (eds.) *Stock Market Anomalies*, 1988, pp. 129-146, Cambridge University Press.
- Wilson, G. Peter, "The Relative Information Content of Accruals and Cash Flows: Combined Evidence at the Earnings Announcement and Annual Report Release Date," *Journal of Accounting Research*, Vol. 24, Supplement 1986, pp. 165-200
- Wilson, G. Peter, "The Incremental Content of the Accrual and Funds Components of Earnings After Controlling for Earning," *The Accounting Review*, April 1987, pp. 293-322

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