The Disappearance of the Small Stock Premium: Size as a Narrowly-Held Risk

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Abstract

This paper looks at the behavior of the size effect since 1962 and investigates arbitrage of a narrowly-shared small-cap risk to explain for its disappearance for most of the last two decades. Using returns-based style analysis to evaluate mutual funds' investment style, we find that the small stock loading is quite consistent over time apart from a temporal drop in the 1975 – 1977 period, leading to rejection of the hypothesis that the size effect is the premium for a narrowly-held risk. Instead, the various size-based style analyses suggest that the small stocks may have been oversold in the vicious 1974 – 1975 bear market, as the size effect is strongly positive only in the subsequent 1975 – 1983 period.

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I. Introduction

In one of the landmark papers in the financial anomalies literature, Banz (1981) shows that small stocks have abnormally high returns even after accounting for market beta, thereafter popularly known as the 'size effect'. Cochrane (1999a, 2001) and Campbell (2000) note that the size effect has disappeared in the 1980's, shortly after the publication of Banz's (1981) results. This observation led them to suggest that the size effect may have been arbitraged away successfully by the mid-1980's, after the popularization of the small stock premium and the introduction of small-cap funds designed to capture the advantages of investing in small stocks. An alternative interpretation of the disappearance of the size effect is offered by Hirshleifer (2001) and Siegel, who (2002) suggest that small stocks have been overpriced by the mid-1980's due to the huge run-up in the prices of small-caps in the 1975 – 1983 period, resulting in the subsequent underperformance of the small stocks relative to the large stocks.

The research on the anomalous returns from certain investment strategies and some classes of investment assets for the past two decades has been very fruitful. Various efficient- and behavioral-based theories have been posited to explain these anomalous empirical regularities.[1] Surprisingly, the subsequent disappearance and poor performance of the size effect have not been studied in detail, despite its serious implications to the common application of ad-hoc risk and return factor models in financial research, which usually incorporate firm size as one of the explanatory factors.[2]

This paper contributes to the literature in two ways. First, we link the emergence and disappearance of the size effect to the popularity of size-based investment styles, as suggested by Barberis and Shleifer (2003). Second, we introduce the use of a simple returns-based style

[1] See Berk (1995), Berk, Green, and Naik (1999), Fama (1996), Johnson (2002), and Poterba and Weisbenner (2001) for rational-based explanations. See Kahneman and Tversky (1979), Haugen and Lakonishok (1988), Barberis, Shleifer, and Vishny (1998), Daniel, Hirshleifer, and Subrahmanyam (1998), and Hong and Stein (1999) for behavioral-based explanations.

[2] The most popular model is Fama and French's (1993) three-factor model. Different versions of the Fama and French model have been applied in various finance papers. Carhart (1997) adds a momentum factor to the three-factor model to explain for the mutual fund returns, while Elton, Gruber, and Blake (1996) use a modified four-factor model (the three factors plus a bond index factor) to get risk-adjusted returns for common stock funds.

analysis with style drift as suggested by Sharpe (1992, 1995) to study relationship between the popularity and the returns of size-based investment styles. While style analysis has been widely-used in the appraisal of mutual fund performance, this is probably the first time that this methodology has been applied to study the role of investment decisions (asset allocation) in determining the returns of financial styles / anomalies.[3]

We hypothesize a sigmoid-shaped small stock loading, which would support the arbitrage explanation that the small stocks are narrowly-held in the 1960's and 1970's, and become more widely-held in the 1980's and 1990's as size effect become well-known. The results, however, reveal a U-shaped small stock loading suggesting that the small-caps are were not narrowly-held, apart from a temporal drop in the 1975 – 1977 period. The results are consistent with Hirshleifer's (2001) and Siegel's (2002) proposition, that the small stocks may have been oversold in the vicious 1974 – 1975 bear market, giving rise to a rebound in the subsequent 1975 – 1983 period.

This paper is organized into five sections. Section 2 reviews the various theories forwarded to explain for the size effect and discusses the hypothesis behind the disappearance of the size factor. Section 3 outlines the data and methodological specification used in this research. Section 4 analyses the empirical results, and Section 5 concludes.

II. Discussion and Hypotheses

Various institutional / market imperfection factors have been forwarded as possible causes for the size effect. Lakonishok, Shleifer, and Vishny (1994) argue that small and value stocks are undervalued relative to their risk and return characteristics because they are overlooked by ordinary investors, as well as professional analysts and money managers. In practice, many of the larger stock funds would have to screen out small-cap stocks since small-cap investments are not likely to bring significant results.

Stocks that are not covered by analysts also tend to be the small, financially distressed firms. La Porta (1996) finds that IBES data are heavily biased towards large stocks: 74 percent of the stocks in IBES are above the median size in CRSP, and only 2 percent of the stocks in

[3] Campbell (2000) laments that the lack of econometric tools specifically developed to test the relative strength of an anomaly and to check whether the anomalous returns have been arbitraged away is the main reason behind the lack of progress in the financial anomalies research.

the smallest size decile in CRSP are present in IBES. This result provides additional evidence that investors tend to ignore small stocks since analysts will only cover stocks in which there is substantial investment interest.

Hirshleifer (2001) suggests that empirical regularities such as value and momentum effect tend to be strongest in small (and presumably less liquid) firms because illiquid markets are likely to be less efficient. The close relationship between the size and value effect has been well-documented and studied. Siegel (2002) and Zarowin (1989, 1990) show that the value effect is strongly visible among the smaller stocks and relatively weak among the largest stocks. Interestingly, Hong, Lim, and Stein's (2000) findings also suggest a relationship between the momentum effect, firm size, and analyst following. They find the momentum effect to be stronger in small firms, growth firms, and firms with low analyst following.

Small stocks are also more likely to be mispriced because the problems of information incompleteness and illiquidity make small-cap investment less appealing to investors in general. Klein and Bawa (1977) suggest that estimation risk deter investors from holding a subset of securities where they face the problem of information asymmetries. Since the amount of information is related to the size of the firm, as shown by La Porta (1996), it is very likely that small-caps command a higher premium because the small-cap risk is 'narrowly-shared', as suggested by Banz (1981) and Cochrane (1999b). Furthermore, the illiquid nature of small-caps also makes it harder for smart traders to arbitrage away any apparent mispricing of small stocks.

Campbell (2000) suggests that these anomalies may not reflect any kind of risk but are simply 'mistakes' that would be corrected once market participants are aware of them. Campbell (2000) argues that a slow process of learning (e.g. investors' education) and industry innovations (e.g. small-cap funds) would enable more investors to participate in 'narrowly-held risks' such as reinsurance / catastrophe bonds and small stocks. As the risk becomes more widely shared, the average returns will fall. This line of argument has empirical support since the size effect has disappeared in the mid-1980's, and the returns from January- and value-based strategies have been inconsistent in recent years.

Cochrane (1999b) posits a theory that the demise of the size effect is caused by the efficient arbitrage of a previously 'narrowly-held small-cap risk'. A particular risk could be

narrowly-held because that risk is not well-known, not well-understood, or simply not available to the average investor. Based on Klein and Bawa (1977)'s paper, Banz (1981) suggests that small stocks have to offer a higher premium because estimation risk deter investors from holding a subset of securities where they face the problem of information asymmetries. Due to its characteristics, a narrowly-held risk such as small stocks tends to be illiquid as well, potentially resulting in mispricing of small stocks. However, after the popularization of the small-cap effect, many small-cap funds were started, thus enabling more investors to invest in small-caps.

Small-cap funds made it possible for investors to get the higher returns without facing the risk of holding illiquid small-caps, since they can move in and out of funds, depending on their investment-consumption decisions (assuming the fees and loads are not too prohibitive). As more investors invest in small-caps, the prices will rise and hence, average returns will fall. Thus, as the risks are now more widely spread, the small-cap risk premium drops and the abnormal returns disappear.

A recent paper by Barberis and Shleifer (2003) show that prices of risky assets (and hence, their respective returns) deviate from fundamental values as certain investment styles become popular or unpopular. In Barberis and Shleifer's (2003) model, investors are assumed to allocate funds based on relative past performance by investing into investment styles that have performed well in recent years, and they withdraw funds from styles that have performed poorly to finance this shift in investment style. As more funds flow into the popular investment style, the prices of the assets belonging to this style will rise until the style collapse, due to arbitrage or bad fundamental news.

III. Data and Methodology

The sample consists of all firms listed on the Centre for Research in Security Prices (CRSP) data files from January 1962 to December 2002. From January 1962 to December 1972, the CRSP data files include NYSE and AMEX firms only, and NASDAQ firms are added to the sample beginning December 14, 1972. Mutual fund returns are also from the CRSP database.

The SMB, HML, MKRF, RF, size and B/M portfolio returns are generously provided by Dr. Kenneth French.[4] The CRSP stock database is divided into various size-sorted portfolios (e.g. Hi, Med, Lo, deciles, and quintiles). Traditionally, the size decile portfolios are the subject of most size-related research. However, analyzing the size effect using these size-sorted portfolios may give misleading results since size and value effect is high correlated.

Fama and French (1993) divide the CRSP database into six portfolios, which are formed from intersections of two size-sorted groups (S and B) and three value-sorted groups (L, M, and H). SL, SM, and SH are the portfolios that comprise of small stocks with low B/M, medium B/M, and high B/M ratios, respectively. BL, BM, and BH are the portfolios that comprise of large stocks with low B/M, medium B/M, and high B/M ratios, respectively.

The return of the Small portfolio is the equally-weighted average return on the three small-cap portfolios.[5] By equally-weighting the returns of three value-sorted small stocks portfolios (SL, SM, and SH), the value effect on the Small portfolio would be minimized. Similar procedure is used to compute the returns of the Big portfolio which would be free of the value effect. SMB (Small minus Big) is the difference between Small and Big portfolios.

Fama and French (1993) introduce the double-sorted methodology (sorting by size and value) to create Small and Big portfolios are relatively free from the influence of value effects. Fama and French (1993) report that the monthly correlation between size-mimicking portfolio, SMB and the value-mimicking portfolio, HML (High minus Low) is -0.08. Therefore, the focus of this research will be the Small, Big, and SMB portfolios, which represent the returns of the small stocks, large stocks, and the size premium, that are relatively free from the value effect.

We use equity mutual funds as the proxy for the representative investor. Equity funds are the practical choice to proxy for the representative investor due to the rapid growth of the mutual fund industry in the past two decades, as well as the availability of mutual fund data

[4] Dr. Kenneth R. French's dataset is downloaded from http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

[5] The definition of 'small-caps' is different according to different researchers. Some researchers define deciles 1 – 2 as micro-caps, deciles 3 – 5 as small-caps, deciles 6 – 8 as mid-caps, and deciles 9 – 10 as large-caps. We follow Fama and French's (1993) definition that deciles 1 – 5 represent small-caps, and the rest are large-caps.

since 1962.[6] Bogle (2001) reports that the mutual fund industry's total assets have grown 70-fold, from less than $100 billion in 1980 to $6.5 trillion in 2000, while at the same time, stock funds have risen by 120-fold to almost $4 trillion.

The growth of the mutual fund industry is fueled by the increasing number of households investing via mutual funds rather than directly. According to Investment Company Institute (ICI) and the Federal Reserve, net purchases of corporate equity by individuals / households have dropped, while net purchases of mutual funds by individuals / households have increased.[7] ICI reports that the number of households that invest in mutual funds have increased from 4.6 million households, representing 5.7 percent of all households in 1980, to 54.2 million households, representing 49.6 percent of all households by 2002. Mutual fund investments represent 17.8 percent of total household financial assets by 2002 compared to 6.7 percent in 1990. Apparently, U.S. households prefer to farm out money to professionals to manage rather than make investment decisions themselves. These mutual fund statistics suggest that equity mutual funds are likely to play an important role in arbitraging the size anomaly, given the extremely high growth of the mutual fund industry coupled with the gradual decrease of the numbers of individual investors over time.

It is difficult to draw an empirical link between the growth of small-cap funds and the disappearance of the small-cap premium because, as the literature on mutual and pension funds has shown, that the actual investment styles of equity fund managers are vastly different from the advertised investment strategies. For example, Lakonishok, Shleifer, and Vishny (1992) find that the average value fund underperforms the Standard & Poor's (S&P) 500 by about 1 percent, just like other pension funds. Obviously, these funds are not faithful to investment style as advertised, since their returns correlate with the market portfolio instead of the marketed style portfolio. It is also possible that the managers of these funds may be following suboptimal strategies e.g. switching in and out of value strategies even though value strategies take an average of three to five years to be profitable. Therefore, it is highly possible that funds

[6] We do not consider the role of individual investor in the arbitrage model because of the impossible task of getting decades-old individual investors' trading records.

[7] Source: Table F.213: Corporate Equities of Federal Reserve's Flow of Funds Account (2003) (http://www.federalreserve.gov/releases/Z1/) and ICI's Mutual Fund Fact Book (2003).

who market themselves as 'small-cap funds' may not actually invest in small capitalized stocks or are not entirely faithful to the small-cap strategy.

Besides that, existing mutual fund databases such as CRSP or Morningstar do not have long historical holdings and trading records of equity funds. Chan, Chen and Lakonishok (2002) uses the Morningstar monthly fund returns dataset and funds' portfolio holdings dataset, which dates back to 1976 and 1983, respectively. However, the presence of survivorship bias in the Morningstar datasets as well as the unavailability of data for the 1960's and 1970's makes them less appealing for this research.

This research uses the CRSP mutual fund database which is generally regarded as free from survivorship bias, but is found to suffer from omission bias where the returns data of small funds under $15 million are missing (see Elton, Gruber, and Blake (2001)). The omission bias problem could skew the findings of this research if small funds play a major role in arbitraging the size effect.

The portfolio of diversified equity funds consist of equity funds only and has been extensively studied in the literature.[8] Generally, balanced funds, flexible funds, and sector funds invest a sizeable portion of the assets into stocks as well. These funds have not been studied extensively in the literature. Therefore, we create a portfolio of 'enlarged equity funds' comprising diversified equity funds, balanced funds, flexible funds, and sector funds as the alternative proxy for the representative investor. The balanced, flexible, sector and hedge funds must fulfill a criterion whereby their holdings of common stocks must be at least 50% of the total assets.[9]

Most of the empirical studies on arbitrage focus on deviations from a known, fundamental value, such as: the difference between the prices of the 'twin-securities', which are listed in different stock exchanges (Rosenthal and Young (1990), Froot and Dabora (1998)); the difference between the traded price of closed-end funds and their net asset values

[8] See: Elton, Gruber, and Blake (1996), Malkiel (1995), Carhart (1997), Elton, Gruber, Das, and Hlavka (1993), Zheng (1999), and Wermers (2000).

[9] This criterion may be conservative because CRSP's set of mutual fund holdings record is not complete. Therefore, by implementing such criterion, many funds may be excluded due to missing holdings record. However, the criterion is necessary since some of the funds in the enlarged equity fund portfolio have investment mandate that allow them to be involved in short-selling, leveraged investment, option-writing, etc. we have also experimented with the returns of Lehman Brothers Aggregate Bond index and the returns of Blume-Keim high-yield index by adding these two variables into the style analysis. However, these two variables are not statistically significant, probably due to the 50 percent equity holdings criterion.

(Lee, Shleifer, and Thaler (1990, 1991)); and 'negative stub values' – the situation where a firm's market value is less than the value of its ownership stake in a publicly listed subsidiary (Mitchell, Pulvino, and Stafford (2002)). There is no reference or fundamental value against which the size premium can be compared over time.[10] Our study thus approaches arbitrage in a manner different from the empirical norm. We compare the participation rate of investors / arbitrageurs, as measured by the level of small-cap loading over time, against the level of abnormal returns of the size effect. Cochrane (1999b) suggests that arbitrage of the size effect would not be immediate, nor would the abnormal returns of small stocks vanish overnight. An increase in the participation rate of investors would initially result in a period of high average returns of small stocks as investors bid the prices of small stocks up to equilibrium levels. Subsequently, the abnormal returns of the size effect would gradually decline as the prices of the small stocks reach the equilibrium levels.

As such, the evidence of efficient arbitrage in this case is much weaker compared to the other studies where divergence from and convergence to a certain reference or fundamental value can be measured and studied. However, the returns-based style analysis would be useful in determining whether the small stocks are narrowly-held in the past. A sigmoid-shaped small stock loading over time would indicate that small stocks are narrowly-held in the past, and become more widely-held following the popularization of the size effect in the 1980's and 1990's and the introduction of small-cap funds.

The two most common approaches to evaluate mutual funds' investment style over time are portfolio-based style analysis (PBSA) and returns-based style analysis (RBSA). Both approaches have unique advantages and disadvantages. The PBSA approach is to derive the investment style of a mutual fund by analyzing the characteristics of the holdings over a period of time. As such, executing PBSA is expensive as it requires a security database that contains the characteristics of each security (e.g. CRSP U.S. stock and indices database) as well as a database that records the security holdings of each fund (e.g. Morningstar).

Sharpe (1992, 1995) pioneers the RBSA methodology in which a factor model is used to explain fund returns. RBSA is a low-cost approach that uses the constrained quadratic optimization to regress fund returns against a set of predetermined benchmark indices,

[10] If we assume market efficiency, the reference or fundamental value for any stock is its current price.

representing asset classes or investment styles that approximate the behavior of the fund. These equity funds are assumed to adopt a long-only investment approach. Hence, the coefficients on the benchmark indices are constrained to be non-negative and sum to one (or 100%).[11]

Beutow, Johnson, and Runkle (2000), Chan, Chen, and Lakonishok (2002), Kaplan (2003), and Rekenthaler, Gambera, and Charlson (2004) show empirical evidence, which suggests that the PBSA approach is more accurate in determining the investment style of a particular fund. On the other hand, Cummisford and Lummer (1996) argue that difficulty of obtaining timely portfolio holdings data make PBSA less reliable. While monthly fund and indices returns are easily available, Rekenthaler, Gambera, and Charlson (2004) admit that holdings data is only available on a semi-annual or annual basis, although their findings suggest that the unavailability of up-to-date holdings data should not be a major problem as many funds do not change their portfolio holdings significantly in a year.[12] However, a more significant problem involving the usage of portfolio holdings data in this study is that it would be very difficult to determine the level of small-cap investment over time because usually only the larger holdings (and therefore large-cap or mid-cap holdings) are documented.

In a recent paper, Horst, Nijman, and de Roon (2004) prove theoretically that the RBSA approach gives a better estimate of the actual fund's investment style because of cross-correlations between the asset classes and the likelihood that the fund manager choose to invest in assets with relatively high or low betas relative to the benchmark index.[13] Horst, Nijman, and de Roon (2004) also show empirically that RBSA is more accurate in determining the actual factor exposures that are relevant in predicting future returns and identifying the risk exposures of the fund.

We use the RBSA approach to analyze the level of small-cap investing due to the unavailability of holdings data for much of the 1960's and 1970's. Following Sharpe (1992,

[11] These constraints are relaxed for hedge funds, since hedge funds use leverage and short strategies (see Agarwal and Naik (2000)).

[12] This result is similar to ter Horst, Nijman, and de Roon's (2004) findings that current portfolio holdings are better predictors of future portfolio holdings compared to RBSA. Likewise, RBSA is better at predicting future fund returns than PBSA.

[13] This depends on the particular fund's marketing strategy. A certain fund that wants to market itself as a fund achieving superior return (relative to its benchmark index) would choose to have a high beta relative to its benchmark index. Another fund that advertises itself as a low-risk fund (relative to its benchmark index) would choose to have a low beta relative to its benchmark index.

1995), style drift is modeled into the 36-month rolling RBSA constrained quadratic regression, as follows:[14]

$$R_{t-35:t} = \sum_{k=1}^{N} b_k I_{k,t-35:t} + e_{t-35:t}\,; \qquad t = 36,37,.....,T \tag{1}$$

where $R_{t-35:t}$ denotes the 36-month mutual fund returns, N is the number of style factors, b_k represents the sensitivity of the fund's return to the style factor k, $I_{k,t-35:t}$ refers to the 36-month returns of style factor k, and $e_{t-35:t}$ is the error term. We use 36-month rolling regressions with the dual objective of reducing beta measurement errors (since statistical theory suggest at least 30 observations are necessary for a regression to yield consistent betas) and trying to get as many rolling regressions as possible at the same time.

Value-weighted returns are used in RBSA estimation. Replacing value-weighted returns with equally-weighted returns has no material effect in the results, probably due to the high correlation between the two returns (see Table).

Since most equity fund managers are subjected to leverage and short-selling constraints, the following constraints are imposed on the factor loadings, b_k:

$$\sum_{k=1}^{N} b_k = 1; \quad b_k \geq 0; \quad k = 1,.....,N \tag{2}$$

Taking style drift into account, the objective function to be minimized is:

$$w_{t-35:t}(e_{t-35:t} - \bar{e})^2\,; \qquad t = 36,37,.....,T \tag{3}$$

where $w_{t-35:t}$ represents the 36-month adjusted weights $e_{t-35:t}$ denotes the 36-month residuals, and $\bar{e}$ is the average of the 36-month residuals.

[14] Style drift refers to changes in asset allocation or investment style over time. As Rekenthaler, Gambera, and Charlson (2004) point out, in the presence of style drift, RBSA estimates is the average of the actual factor exposures over time rather than the most recent estimate. Sharpe (1995) proposes an adjustment to improve style factor estimates by placing greater weights on recent months than on the more distant months. This adjustment minimizes the weighted tracking variance by assigning a weight of 1.00 to the first month of the square of the difference between the observed residual value and the mean of the residuals, $(e_t - \bar{e})^2$, and subsequently assigning a weight equal to 2^(1/35) times the weight assigned to the previous month. This '36-month half-life' adjustment results in each month receiving slightly over 2% more weight than its predecessor, and the weight assigned to month t is twice of that assigned to month *t*-35. An alternative method is to model time variation of style weights using Kalman filter as in Speigel, Mamaysky, and Zhang (2003) and Swinkels and van der Sluis (2002).

IV. Empirical Results

Kenneth French's CRSP dataset is rebalanced at the middle of the year using June-end market equity, while the original CRSP's dataset is rebalanced at the end of the year using December-end market equity. Correlations between the deciles of the CRSP and KF datasets range from 0.88 to 0.99 for the July 1962 – December 2002 period. This suggests that rebalancing at a different time should not have any material effect on the subsequent empirical findings.

Descriptive statistics for the various size- and double-sorted portfolios in Table 1 show that the portfolios representing the small-caps outperform the portfolios representing large-caps for the 1962 – 2002 period. The small-cap portfolios are also riskier, with higher standard deviation and range values.

(insert table 1)

Siegel (2002) shows that the size and value effects are highly correlated, with the value effect being the strongest among the smaller stocks. Loughran (1997) and Siegel (2002) also find that both small and value stocks exhibit the January effect, and a substantial portion of the anomalous high returns of the size and value strategies are specific to the 1975 – 1983 period. Interestingly, Siegel (2002) shows that the small stocks actually under-performed against the large stocks for the 1927 – 2002 period if the abnormal returns of the 1975 – 1983 period are excluded. Unfortunately, most of the earlier studies on the size effect did not control for the value effect. Failure to control for the value effect may lead researchers to different conclusions as the value effect is still significant, though much reduced in recent years.

To test the robustness of the size effect, we use different definitions of the size premium – with and without the value effect, small stock returns versus large stock returns, and small stock returns versus the market returns. Table 2 reveals that the size effect exhibits periodic fluctuations. The size effect is very positive from the mid-1960's to mid-1980's, particularly in the 1965 – 1968 period and the 1975 – 1983 period. Regardless on how the size effect is being defined, it seems to have disappeared, and only resurfaces occasionally during

recessionary periods, as in the 1991 – 1993 period and 2001 – 2002 period.[15] Small stocks outperformed the large stocks in the 1960's and 1970's, and subsequently underperformed the large stocks in the 1980's and 1990's. The negative size premium for much of the 1980's and 1990's lead many researchers to infer that the size effect has been arbitraged away over time.

(insert table 2)

Table 3 reports the descriptive statistics for the double-sorted portfolios in different time periods. The Small portfolio outperforms the Big portfolio slightly for the entire 1962 – 2002 period. This shows that the small stocks have higher returns compared to the large stocks, even after accounting for the value effect. However, the size effect is unmistakably strong only in the 1974 – 1983 period. The Small portfolio is also riskier, with higher values for range and standard deviation as compared to the Big portfolio. The descriptive statistics of the Big portfolio is close to those of the market portfolio, especially since the Big portfolio represents more than 85 percent of the total market capitalization for the entire 1962-2002 period.

(insert table 3)

Figure 1 plots the 12-month returns of the Small and Big portfolios.[16] The top graph in Figure 1 indicates that the returns of the Small and Big are highly correlated. The graphs show that stock returns often fall prior to or on the onset of adverse economic periods, and then rise in the middle or at the end of these recessionary periods. The top graph in Figure 1 also shows that the returns of the small stocks tend to fall and rise at a greater magnitude compared to the large stocks, especially during recessionary periods. As the result, the SMB portfolio show the same variation in returns across the business cycles because small stocks fall and rise at a much greater magnitude compared to large stocks.

[15] The positive size premium in 1988 and 1999 is probably due to outlier events linked to the October 1987 market crash and the 1999 tech boom. Due to the volatility differential between safer (large, growth stocks) and riskier (small, value stocks) securities in adverse market environment, small stocks fall more than large stocks in the October 1987 crash, and subsequently rise faster in 1988. In 1999, investors are probably too enamored by the growth prospects of tech firms, and (irrationally) bid up the prices of these firms (see Chan, Karceski, and Lakonishok (2000)).

[16] The monthly returns are too volatile to show any discernible patterns.

(insert figure 1)

Figure 2 shows that the size effect is highly positive in mid- and late-1960's and from the mid-1970's to the mid-1980's. Figure 2 also shows a huge drop in the stock market returns in the early 1970's. Consistent with the 'flight to quality' phenomenon, investors choose to invest in 'safer' securities (large, growth stocks) during time of economic distress and avoid the 'riskier' investment such as small stocks. Figure 2 seems to suggest that the small stocks are oversold as the 12-month moving averages of SMB returns were negative during the early 1970's to mid-1970's period and became highly positive in the mid-1970's to mid-1980's period. The huge run-up in the prices (and returns) of small stocks in the mid-1970's to mid-1980's period and the subsequent the negative size premium in the mid-1980's to the late-1990's also lead some researchers to speculate that the small stocks could have overpriced by the mid-1980's.

(insert figure 2)

Tables 4 and 5 reveal that both portfolios of equity funds are very highly correlated with the market portfolio, which should be the case for a well-diversified portfolio. The equally-weighted returns for diversified and enlarged equity funds are slightly more correlated with the Small portfolio returns and slightly less correlated with the Big portfolio returns compared to the value-weighted equity fund returns. This result implies that smaller equity funds invest a greater percentage of assets into small stocks compared to larger equity funds. This result is not surprising since larger funds will find it difficult to make substantial investment in small stocks. For example, Sharpe (1992) shows that the popular common stock fund, the Magellen Fund increased its exposure to large stocks and decreased its small-cap investments as the fund grew in the 1980's.

(insert tables 4 & 5)

Table 6 shows the correlations between different size- and double-sorted portfolios. The high correlations between the portfolios are troubling, as multicollinearity may skew the estimates. Nevertheless, due to the lack of portfolio holdings data to run PBSA, we run different size- and double-sorted style analysis instead to confirm the RBSA estimates, and the results are comparatively consistent.

(insert table 6)

Figure 3 shows the style analysis estimates using the Small and Big portfolios. Consistent with the arbitrage hypothesis, investors increased their small-cap loadings due to the robust positive size effect from the mid-1970's to the mid-1980's. More intriguingly is the dramatic increase in small-cap loadings in the 1981-1982 recession, as small-cap loadings tend to fall before or during recessionary periods.

(insert figure 3)

However, Figure 3 also shows that small-cap loadings are unexpectedly high prior to the 1974-1975 recession. Controversially, the precipitous fall in the small-cap loading during the 1974-1975 recession suggests that small stocks may have been oversold in the vicious bear market, resulting in the subsequent anomalous size effect in the 1975-1983 period. The findings here are consistent with the results of Siegel's (2002) study that uses CRSP stock return beginning 1927 which show that the size effect is only strongly positive in the 1975-1983 period. The small-cap loading drops drastically during the recession and only start to rise in 1978, even though the SMB returns are positive beginning 1975.[17] Therefore, this result provides evidence that the small-cap factor is not narrowly-shared as suggested by Cochrane (1999b), except during the 1975-1977 period.

The size effect in the first few years after the 1974-1975 recession is probably due to the usual upward bounce after every recessions, and the subsequent size effect from 1978 to

[17] The result here also proves the importance of modeling style drift into returns-based style analysis by attaching more weights to the more recent observations as earlier estimates without style drift (not reported here) shows that the small-cap loading bottomed in 1976 instead of 1975, as reported here.

1984 is probably due to increased investor participation in small-caps. As suggested by Cochrane (1999b) and Barberis and Shleifer's (2003), investors allocate funds based on relative past performance by investing into the small-caps that have performed after the 1974-1975 recession. Arbitrage is not instantaneous since the prices of the small stocks continue to rise as more funds flow into the small-caps (and small-cap funds). However, by 1984, the average prices of the small-caps have risen to (or past) fundamental values, and the size effect is no longer evident.[18] Figure 4 shows the six size- and value-sorted portfolios that make up the Small and Big portfolios. The estimates are relatively similar to the earlier estimates, shown in Figure 3.

(insert figure 4)

Figure 5 shows the style analysis estimates using the Lo, Med, and Hi portfolios. The estimates are more consistent with the Cochrane's (1999b) hypothesis that the size factor is a narrowly-shared risk in the past, as the Lo factor loading is almost negligible until the mid-1980's.

(insert figure 5)

Figure 6 and Figure 7 reveal that the differences between the Small and Big estimated loadings and the Lo, Med, and Hi estimated loadings are due to the construction of respective portfolios. The Small and Big portfolios represent deciles 1 – 5 and deciles 6 – 10 of the CRSP stock dataset, respectively. Lo and Hi are comprised of the 30% smallest and largest stocks in the CRSP stock dataset, while Med makes up the rest. Therefore, the sum of the estimated loadings of deciles 1 – 3 and 1 – 5 are quite close to the estimated Lo and Small loadings, respectively. Therefore, the returns of the Small portfolio are largely driven by the returns of deciles 4 – 5. Likewise, the quintile loadings in Figure 6 are roughly equivalent to the decile

[18] Whether the small stocks are fairly priced or overpriced by 1984 is subject to debate, and will not be studied here. However, this is surely an interesting topic to ponder and focus on.

loadings in Figure 7.[19] These results demonstrate the reliability and validility of the RBSA estimates.

(insert figures 6 & 7)

The estimated loadings of various size portfolios for the enlarged equity fund portfolio in Figures 8 through 12 are similar to the estimated loadings for the diversified equity fund portfolio, shown in Figures 3 through 7. The results support the stability and validility of size- and double-sorted RBSA loadings.

(insert figures 8 - 12)

Importantly, the graphs in Figure 13 show that the volatility of the size loadings are not influenced by the market capitalization of the size portfolios, despite the high correlations between mutual fund portfolio's returns with market returns.

(insert figure 13)

Figures 3 through 12 show that the level of small-cap investments by investors suffered a major drop in the mid-1970's, which coincided with major drop in the stock market prices between 1974 and 1975. The 1974-1975 bear market is a well-researched event. However, most of the previous studies had focused on the large growth stocks, called the 'Nifty-Fifty'. The stock market crash of 1973-1975 is blamed on the burst of the 'Nifty Fifty' bubble (see Malkiel (1990)). The Nifty Fifty were a group of 50 large growth stocks with stellar earnings and dividend growth records, and these stocks became institutional darlings in the early 1970's. However, the Nifty Fifty suffered a meltdown in the 1973-1975 bear market and are often held up as examples of irrational exuberance – unwarranted optimism over the prospects of growth stocks.

[19] A size-sorted quintile is comprised of two size-sorted deciles.

However, Siegel (1995, 2002) suggests that the Nifty-Fifty are fairly priced; the high price-earnings ratios of these stocks are actually justified, even at the market peak in December 1972, due to their future realized returns. Siegel (1995) calculates that the prices of these stocks were almost 35% below their true values, based on their future returns.

Using S&P Composite Index data, Shiller (1984) also shows that the real stock prices drop during the 1974-1975 bear market even though the real earnings and real dividends are relatively stable during that period. Together with Siegel's findings, the results suggest that investors' sudden pessimism, rather than irrational optimism, that caused the bear market in the 1974-1975 period.

Figures 1 and 2 indicate that small stocks suffered a larger fall in prices compared to the large stocks, which is not surprising given that small stocks have higher volatility, as shown in Tables 1, 2, 4, and 5. Figures 3 through 12 also indicate that investors prefer safer investments relative to riskier ones during periods of economic distress – the classic 'flight to quality' phenomenon. Since most equity fund managers are mandated to invest a certain percentage of the fund's assets in stocks, the money managers would increase their large-cap investments and simultaneously decrease their small-cap investments in a bearish stock market environment.[20]

The U-shaped small-cap loadings suggest that small-caps were oversold in the vicious 1974-1975 bear market, due to irrational pessimism at that period. Subsequently, as investors began to realize the outsized returns from small-cap investments, they began to increase their small-cap loadings, even during the 1981-1982 recessionary period. However, by 1984, the small stocks were fairly-valued, or even over-valued, and the size effect is no longer apparent.

The anomalous subsequent negative size premium after the mid-1980's is troubling as the efficient arbitrage hypothesis could not provide a plausible explanation for the subsequent underperformance of small-caps relative to the market. As pointed out by Berk (1995), the size effect should be a common fixture, whereas the disappearance of the size effect should be considered as an anomaly.

[20] The enlarged equity fund portfolio includes flexible funds which may choose to lower their stock investments drastically if the fund manager deems it necessary to do so. However, that particular fund would be dropped from the enlarged equity fund portfolio if its stock holdings drop below 50 percent.

Berk's (1995) reasoning centers on a theoretical argument that a firm's market value will always measure the firm's discount rate, and hence is inversely related to the firm's expected return, even in an economy in which firm size and risk are unrelated. Berk (1995) also shows how market value will always provide additional explanatory power in any incorrectly specified asset pricing test, as long as the omitted risk factors are uncorrelated to the market value. Therefore, Berk (1995) concludes that size-related regularities (such as size, E/P, D/P and B/M effects) should not be regarded as anomalies; rather, it would be an anomaly if the inverse relation between size and return is not observed. However, Berk's line of argument is hard to defend in light of Siegel's (2002, Figure 8-1) result showing that the size effect is only strongly positive in the 1975-1983 period.

Another possible explanation for the underperformance of a riskier investment such as small stocks is that riskier investments offer higher average returns over a long period of time but may underperform less risky investments (such as Treasury bonds, high quality corporate bonds, or a well-diversified stock portfolio) in some years. Standard finance theory suggests that riskier investments should offer higher average returns relative to the return of less risky investments, but the theory is silent on a fixed time period in which riskier investments must offer higher relative returns e.g. yearly, 3 to 5 years, a decade or longer. [21]

Stylized facts about the cyclical returns of the different classes of stocks (small stocks, big stocks, value stocks, and growth stocks) suggest that the differences in the returns of different classes of stocks appear to wax and wane over long cycles. For example, Siegel (2002) finds that large growth stocks have outperformed large value stocks in about half the years since 1963. Similarly, Table 3 shows that large stocks have outperformed small stocks about half the years since 1962. A substantial portion of the size effect is attributed to the 1974-1983 period. The size effect then 'disappeared' for next 15 years, only to reappear briefly after each recession.

The third hypothesis to consider is that the size effect may have been overexploited. Siegel (2002) suggests that the huge run-up in the prices of small-caps in the 1975-1983 period caused small stocks to be overpriced by the mid-1980's, resulting in the end of the size effect. Hirshleifer (2001) argues that it is almost impossible for an investor to know whether other

[21] I would like to thank my supervisor, Dr. Julia Sawicki for pointing this out.

investors have yet detected and acted upon an arbitrage opportunity. Thus, this uncertainty suggests that investors may have inadvertently overexploited the size effect by the mid-1980's.

V Conclusion

This paper represents a rare investigation into a financial anomaly that has disappeared. It is also novel in using style analysis to study the relationship between the popularity of investment styles and the relative returns of the underlying assets.

A sigmoid-shaped small-cap loading, supportive of an arbitrage explanation to the disappearance of the small stock premium did not emerge from our tests. The U-shaped small-cap loadings we find suggest that a more appropriate explanation lies in other areas of investigation, such as a time-varying risk premium, a study we report in another paper. This paper also yields a few new and interesting stylized facts: (i) the size effect is not a premium for a narrowly-shared risk, as the small stocks are not narrowly-held, except for the 1975-1977 period, (ii) the small-cap loading suffers a huge drop in the 1974-1975 recessionary period, and (iii) the small stocks are underpriced due to the massive small stock sell-off in the 1974-1975 bear market, resulting in the anomalous size effect in the 1975-1984 period.

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Table 4.1

Descriptive statistics for the size- and double-sorted portfolios

This table shows the descriptive statistics for the size-sorted portfolios from the CRSP dataset for the 1962 - 2002 period. The CRSP stock dataset is divided into Small and Big portfolios, which represent the small and large stocks with value adjustment. Lo, Med, and Hi represents the bottom 30%, middle 40%, and top 30% of the CRSP stock dataset by market capitalization. The CRSP stock dataset is also divided into 5 size-sorted quintiles and 10 size-sorted deciles, where Qnt1 and Dec1 represent the smallest stocks and Qnt5 and Dec10 represent the largest stocks.

Variable	Mean	Std Dev	Sum	Minimum	Maximum	Range
Small	0.0118	0.0584	5.7863	-0.2916	0.2718	0.5634
Big	0.0098	0.0431	4.8288	-0.2086	0.1625	0.3711
Lo	0.0114	0.0621	5.5960	-0.2919	0.2678	0.5597
Med	0.0106	0.0536	5.1939	-0.2694	0.2277	0.4971
Hi	0.0087	0.0441	4.2992	-0.2076	0.1771	0.3847
Qnt1	0.0114	0.0637	5.6250	-0.2933	0.2727	0.5660
Qnt2	0.0111	0.0593	5.4538	-0.2921	0.2490	0.5411
Qnt3	0.0105	0.0542	5.1725	-0.2682	0.2263	0.4945
Qnt4	0.0103	0.0511	5.0670	-0.2486	0.2022	0.4508
Qnt5	0.0086	0.0438	4.2374	-0.2034	0.1802	0.3836
Dec1	0.0116	0.0647	5.7209	-0.2876	0.2900	0.5776
Dec2	0.0113	0.0635	5.5656	-0.3001	0.2841	0.5842
Dec3	0.0114	0.0607	5.5946	-0.2887	0.2573	0.5460
Dec4	0.0109	0.0587	5.3475	-0.2947	0.2416	0.5363
Dec5	0.0112	0.0562	5.4896	-0.2770	0.2496	0.5266
Dec6	0.0100	0.0532	4.9345	-0.2606	0.2083	0.4689
Dec7	0.0105	0.0520	5.1745	-0.2601	0.2246	0.4847
Dec8	0.0101	0.0509	4.9889	-0.2403	0.1897	0.4300
Dec9	0.0095	0.0465	4.6577	-0.2232	0.1812	0.4044
Dec10	0.0085	0.0437	4.1619	-0.1973	0.1800	0.3773

Table 4.2

The annual returns for size- and double-sorted portfolios and the size effect across time

This table shows the annual raw returns for the various size sorted portfolios from the CRSP dataset. MK is the CRSP market portfolio. Lo and Hi are the portfolios that comprises of the 30% smallest and largest securities in the CRSP database. The CRSP database is also divided into 5 size-sorted quintiles and 10 size-sorted deciles, where Qnt1 and Dec1 represent the smallest stocks and Qnt5 and Dec10 represent the largest stocks. The portfolios are constructed at the end of June. The value-weighted annual returns are from January to December. SMB is the difference between Small and Big portfolios. The highlighted areas for Lo-Hi, Qnt1-Qnt5, Dec1-Dec10, and SMB indicate periods when small stocks outperform large stocks. The highlighted areas for Lo-MK, Qnt1-MK, Dec1-MK, and Small-MK indicate periods when small stocks outperform the market portfolio.

Year	Lo-Hi	Qnt1-Qnt5	Dec1-Dec10	SMB	Lo-MK	Qnt1-MK	Dec1-MK	Small-MK
1962	-0.0219	-0.0260	-0.0079	-0.0901	-0.0095	-0.0098	0.0067	-0.0527
1963	-0.0222	-0.0411	-0.0344	-0.0630	-0.0128	-0.0276	-0.0189	-0.0336
1964	0.0347	0.0358	0.0680	-0.0179	0.0310	0.0295	0.0656	-0.0005
1965	0.2459	0.2862	0.3684	0.2160	0.2188	0.2472	0.3111	0.2256
1966	0.0305	0.0293	0.0142	0.0276	0.0251	0.0176	-0.0093	0.0225
1967	0.7181	0.8163	0.9358	0.5085	0.6551	0.7475	0.8686	0.4798
1968	0.3602	0.4071	0.5230	0.2418	0.3237	0.3610	0.4576	0.2554
1969	-0.2074	-0.2413	-0.2715	-0.1437	-0.1759	-0.2044	-0.2206	-0.1362
1970	-0.1759	-0.2040	-0.2121	-0.1163	-0.1466	-0.1749	-0.1858	-0.0736
1971	0.0309	0.0380	0.0232	0.0631	0.0170	0.0170	0.0042	0.0441
1972	-0.1737	-0.1983	-0.2159	-0.1205	-0.1601	-0.1712	-0.1695	-0.1237
1973	-0.2170	-0.2381	-0.2530	-0.2360	-0.1788	-0.1931	-0.1971	-0.1630
1974	-0.0008	0.0029	0.0120	-0.0067	0.0044	0.0076	0.0130	0.0225
1975	0.2207	0.2469	0.2517	0.1480	0.2005	0.2147	0.2090	0.2123
1976	0.2433	0.2657	0.2763	0.1425	0.2099	0.2197	0.2136	0.2162
1977	0.3186	0.3555	0.3956	0.2309	0.2766	0.3041	0.3342	0.2308
1978	0.1656	0.1866	0.2271	0.1409	0.1407	0.1600	0.2030	0.1126
1979	0.2094	0.2280	0.2622	0.2036	0.1589	0.1644	0.1706	0.1678
1980	0.0684	0.0724	0.0881	0.0573	0.0596	0.0685	0.0839	0.0189
1981	0.0488	0.0460	0.0364	0.0699	0.0381	0.0247	0.0014	0.1080
1982	0.0787	0.0936	0.0843	0.0928	0.0680	0.0743	0.0706	0.1101
1983	0.1347	0.1400	0.1435	0.1364	0.1103	0.1147	0.1187	0.1320
1984	-0.1557	-0.1855	-0.2289	-0.0800	-0.1119	-0.1338	-0.1746	-0.0415
1985	-0.0192	-0.0359	-0.0770	-0.0003	-0.0068	-0.0235	-0.0699	0.0064
1986	-0.1350	-0.1444	-0.1622	-0.0991	-0.1107	-0.1169	-0.1348	-0.0664
1987	-0.1566	-0.1816	-0.1911	-0.1069	-0.1362	-0.1576	-0.1583	-0.0980
1988	0.0428	0.0211	0.0042	0.0592	0.0353	0.0105	-0.0065	0.0711
1989	-0.1866	-0.2318	-0.2585	-0.1221	-0.1539	-0.1939	-0.2141	-0.1041
1990	-0.1993	-0.2486	-0.2693	-0.1422	-0.1736	-0.2113	-0.2159	-0.1406
1991	0.1487	0.1734	0.1617	0.1585	0.1366	0.1511	0.1240	0.1309
1992	0.1180	0.1420	0.2013	0.0735	0.1071	0.1204	0.1641	0.1163
1993	0.0977	0.1078	0.1866	0.0604	0.0751	0.0749	0.1433	0.0774
1994	-0.0517	-0.0658	-0.0687	-0.0144	-0.0368	-0.0460	-0.0425	-0.0137
1995	-0.0506	-0.0536	-0.0756	-0.0774	-0.0280	-0.0193	-0.0364	-0.0576
1996	-0.0568	-0.0666	-0.0950	-0.0238	-0.0425	-0.0455	-0.0618	-0.0263
1997	-0.1116	-0.1064	-0.1284	-0.0484	-0.0821	-0.0648	-0.0824	-0.0355
1998	-0.3534	-0.3934	-0.4927	-0.2521	-0.2783	-0.2955	-0.3585	-0.2514
1999	0.1203	0.1929	0.1588	0.1468	0.0840	0.1476	0.1201	-0.0002
2000	0.0390	0.0432	0.0291	-0.0164	0.0599	0.0533	0.0168	0.1741
2001	0.3601	0.4234	0.4661	0.1834	0.3446	0.4010	0.4324	0.2414
2002	0.0696	0.1068	0.2018	0.0345	0.0592	0.0937	0.1784	0.0345

Table 4.3

Descriptive statistics for the double-sorted portfolios

This table shows the descriptive statistics for the size and value sorted portfolios from the CRSP dataset. SL, SM, and SH are the portfolios that comprise of small stocks with low B/M, medium B/M, and high B/M ratios, respectively. BL, BM, and BH are the portfolios that comprise of large stocks with low B/M, medium B/M, and high B/M ratios, respectively. The return of the Small portfolio is the average return on the three value-sorted small-cap portfolios. The return of the Big portfolio is the average return on the three value-sorted large-cap portfolios. SMB is the difference between Small and Big portfolios. MK is the raw return of the CRSP market index.

Statistics	Period	SL	SM	SH	BL	BM	BH	Small	Big	SMB	MK
Arithmetric mean	196201-200212	0.0081	0.0126	0.0145	0.0086	0.0095	0.0113	0.0118	0.0098	0.0019	0.0088
Arithmetric mean	196201-197312	0.0037	0.0070	0.0098	0.0055	0.0047	0.0093	0.0069	0.0065	0.0004	0.0053
Arithmetric mean	197401-198312	0.0176	0.0204	0.0233	0.0079	0.0121	0.0142	0.0204	0.0114	0.0090	0.0107
Arithmetric mean	198401-200212	0.0060	0.0120	0.0129	0.0109	0.0112	0.0111	0.0103	0.0111	-0.0008	0.0099
Geometric mean	196201-200212	0.0312	0.4739	1.2022	0.0762	0.1377	0.3200	0.2767	0.1580	0.0041	0.0900
Geometric mean	196201-197312	0.0084	0.0152	0.0226	0.0135	0.0124	0.0231	0.0144	0.0159	0.0068	0.0133
Geometric mean	197401-198312	0.0501	0.0774	0.1066	0.0182	0.0314	0.0396	0.0754	0.0287	0.0233	0.0259
Geometric mean	198401-200212	0.0093	0.0503	0.0622	0.0386	0.0443	0.0438	0.0319	0.0433	0.0032	0.0328
Median	196201-200212	0.0091	0.0157	0.0191	0.0091	0.0112	0.0127	0.0141	0.0118	0.0007	0.0115
Max	196201-200212	0.2854	0.2682	0.3011	0.2126	0.1707	0.2103	0.2718	0.1625	0.2183	0.1656
Min	196201-200212	-0.3211	-0.2760	-0.2776	-0.2314	-0.2048	-0.1895	-0.2916	-0.2086	-0.1661	-0.2253
Range	196201-200212	0.6065	0.5442	0.5787	0.4440	0.3755	0.3998	0.5634	0.3711	0.3845	0.3909
Std Dev	196201-200212	0.0711	0.0540	0.0542	0.0487	0.0430	0.0449	0.0584	0.0430	0.0326	0.0453
Skewness	196201-200212	-0.2837	-0.4832	-0.2862	-0.2510	-0.2349	-0.0979	-0.4170	-0.2891	0.5553	-0.4424
Kurtosis	196201-200212	1.6970	3.2359	4.1671	1.6266	2.1077	1.8244	2.7431	1.7963	5.5659	1.8185

Figure 4.1

The returns of the Small and Big portfolios across time

The graph plots the 12-month moving average returns of the Small and Big portfolios. The dotted line represents the 12-month moving average returns of the Big portfolio, and the full line represents the 12-month moving average of the Small portfolio. The shaded areas indicate NBER recessionary periods.

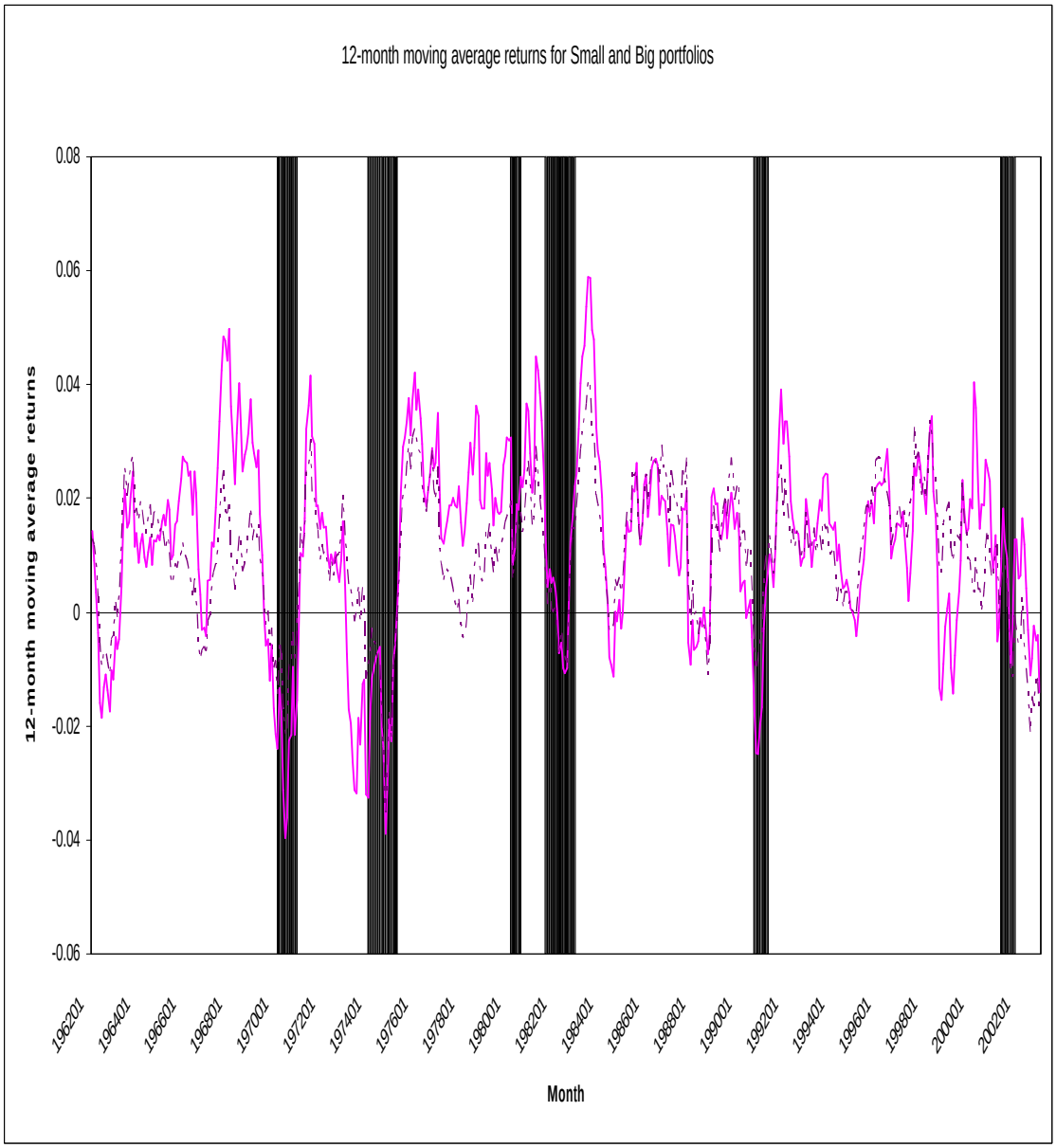


Figure 4.2

The returns of the SMB and market portfolios across time

The graph plots the 12-month moving average returns of the SMB and MK portfolios. The dotted line represents the 12-month moving average returns of the MK portfolio, and the full line represents the 12-month moving average of the SMB portfolio. The shaded areas indicate NBER recessionary periods.

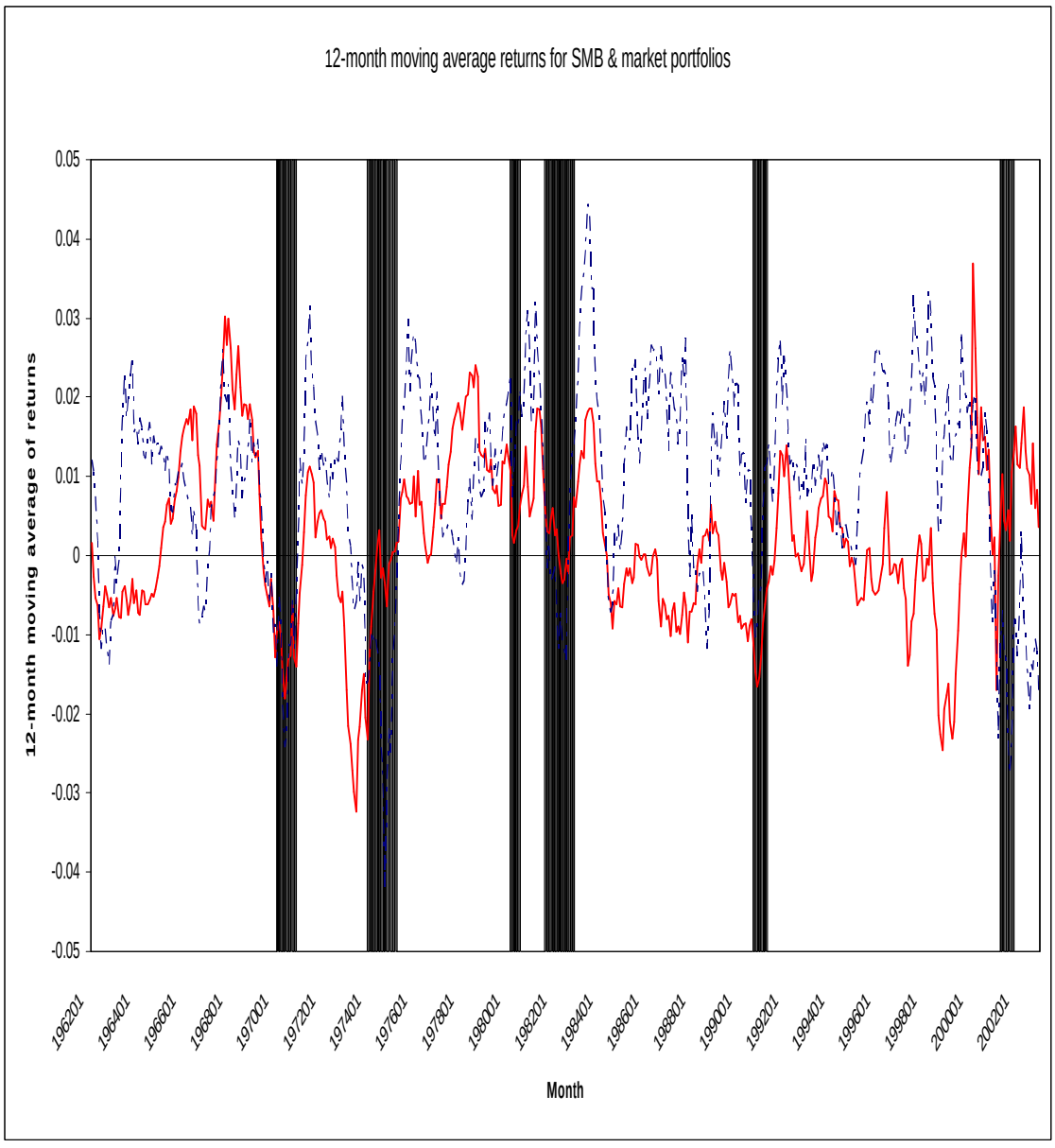


Table 4.4

Descriptive statistics for the diversified and enlarged equity fund portfolios

This table shows the descriptive statistics for the diversified and enlarged equity fund portfolios. ewret and vwret represent equally-weighted returns and value-weighted returns, respectively.

Statistics	Period	Diversified equity fund		Enlarged equity fund		MK	Small	Big
		ewret	vwret	ewret	vwret			
Arithmetric mean	196201-200212	0.00846	0.00881	0.00802	0.00864	0.00877	0.01176	0.00981
Arithmetric mean	196201-197312	0.00507	0.00517	0.00465	0.00479	0.00530	0.00687	0.00651
Arithmetric mean	197401-198312	0.01190	0.01122	0.01178	0.01114	0.01068	0.02043	0.01142
Arithmetric mean	198401-200212	0.00879	0.00985	0.00817	0.00975	0.00995	0.01029	0.01106
Geometric mean	196201-200212	0.07752	0.09465	0.06471	0.08956	0.09002	0.27673	0.15802
Geometric mean	196201-197312	0.01246	0.01285	0.01189	0.01237	0.01326	0.01438	0.01586
Geometric mean	197401-198312	0.03030	0.02793	0.03005	0.02782	0.02587	0.07539	0.02871
Geometric mean	198401-200212	0.02565	0.03293	0.02261	0.03250	0.03276	0.03188	0.04333
Median	196201-200212	0.01172	0.01160	0.01115	0.01146	0.01145	0.01405	0.01183
Max	196201-200212	0.14720	0.16642	0.14546	0.16180	0.16560	0.27180	0.16250
Min	196201-200212	-0.21652	-0.20950	-0.21497	-0.20714	-0.22530	-0.29157	-0.20857
Range	196201-200212	0.36372	0.37592	0.36043	0.36894	0.39090	0.56337	0.37107
Std Dev	196201-200212	0.04512	0.04405	0.04363	0.04256	0.04529	0.05837	0.04305
Skewness	196201-200212	-0.56379	-0.46022	-0.57478	-0.46749	-0.44244	-0.41698	-0.28911
Kurtosis	196201-200212	1.58401	1.54116	1.76085	1.68149	1.81854	2.74314	1.79628

Table 4.5

Correlations between equity fund portfolio returns with factors

The top table shows the cross-correlations of diversified equity fund returns with factors and the bottom table shows the cross-correlations of enlarged equity fund returns with factors.

Diversified	ewret	vwret	Small	Big	MK
ewret	1.0000	0.9931	0.9244	0.9455	0.9791
vwret	0.9931	1.0000	0.8906	0.9606	0.9903
Small	0.9244	0.8906	1.0000	0.8358	0.8785
Big	0.9455	0.9606	0.8358	1.0000	0.9721
MK	0.9791	0.9903	0.8785	0.9721	1.0000

Enlarged	ewret	vwret	Small	Big	MK
ewret	1.0000	0.9927	0.9243	0.9400	0.9786
vwret	0.9927	1.0000	0.8913	0.9551	0.9902
Small	0.9243	0.8913	1.0000	0.8348	0.8794
Big	0.9400	0.9551	0.8348	1.0000	0.9712
MK	0.9786	0.9902	0.8794	0.9712	1.0000

Table 4.6

Correlations between size- and double-sorted portfolios

The 5 tables below show the correlations between various size- and double-sorted portfolios used in the subsequent style analysis.

	Small	Big	SMB	MK
Small	1.0000	0.8358	0.6878	0.8785
Big	0.8358	1.0000	0.1764	0.9721
SMB	0.6878	0.1764	1.0000	0.2899
MK	0.8785	0.9721	0.2899	1.0000

	Qnt1	Qnt2	Qnt3	Qnt4	Qnt5
Qnt1	1.0000	0.9575	0.9135	0.8642	0.6987
Qnt2	0.9575	1.0000	0.9798	0.9434	0.7992
Qnt3	0.9135	0.9798	1.0000	0.9742	0.8572
Qnt4	0.8642	0.9434	0.9742	1.0000	0.9116
Qnt5	0.6987	0.7992	0.8572	0.9116	1.0000

	SL	SM	SH	BL	BM	BH
SL	1.0000	0.9404	0.8863	0.8164	0.7235	0.6946
SM	0.9404	1.0000	0.9726	0.7849	0.8027	0.8056
SH	0.8863	0.9726	1.0000	0.7317	0.7823	0.8292
BL	0.8164	0.7849	0.7317	1.0000	0.8533	0.7780
BM	0.7235	0.8027	0.7823	0.8533	1.0000	0.9026
BH	0.6946	0.8056	0.8292	0.7780	0.9026	1.0000

	Lo	Med	Hi
Lo	1.0000	0.9410	0.7577
Med	0.9410	1.0000	0.8878
Hi	0.7577	0.8878	1.0000

	Dec1	Dec2	Dec3	Dec4	Dec5	Dec6	Dec7	Dec8	Dec9	Dec10
Dec1	1.0000	0.9625	0.9355	0.9090	0.8811	0.8560	0.8347	0.8020	0.7489	0.6179
Dec2	0.9625	1.0000	0.9755	0.9626	0.9465	0.9247	0.9065	0.8840	0.8327	0.7080
Dec3	0.9355	0.9755	1.0000	0.9820	0.9723	0.9580	0.9380	0.9190	0.8771	0.7552
Dec4	0.9090	0.9626	0.9820	1.0000	0.9810	0.9688	0.9535	0.9321	0.8932	0.7699
Dec5	0.8811	0.9465	0.9723	0.9810	1.0000	0.9770	0.9642	0.9538	0.9175	0.8043
Dec6	0.8560	0.9247	0.9580	0.9688	0.9770	1.0000	0.9744	0.9640	0.9397	0.8364
Dec7	0.8347	0.9065	0.9380	0.9535	0.9642	0.9744	1.0000	0.9777	0.9587	0.8686
Dec8	0.8020	0.8840	0.9190	0.9321	0.9538	0.9640	0.9777	1.0000	0.9719	0.8869
Dec9	0.7489	0.8327	0.8771	0.8932	0.9175	0.9397	0.9587	0.9719	1.0000	0.9234
Dec10	0.6179	0.7080	0.7552	0.7699	0.8043	0.8364	0.8686	0.8869	0.9234	1.0000

Figure 4.3
Diversified equity fund's Small and Big style analysis

The graph below shows the estimated Big and Small loadings of the diversified equity fund. The dotted area represents the Small loadings, and the remaining area represents the Big loadings. The shaded bands represent NBER recessionary periods.

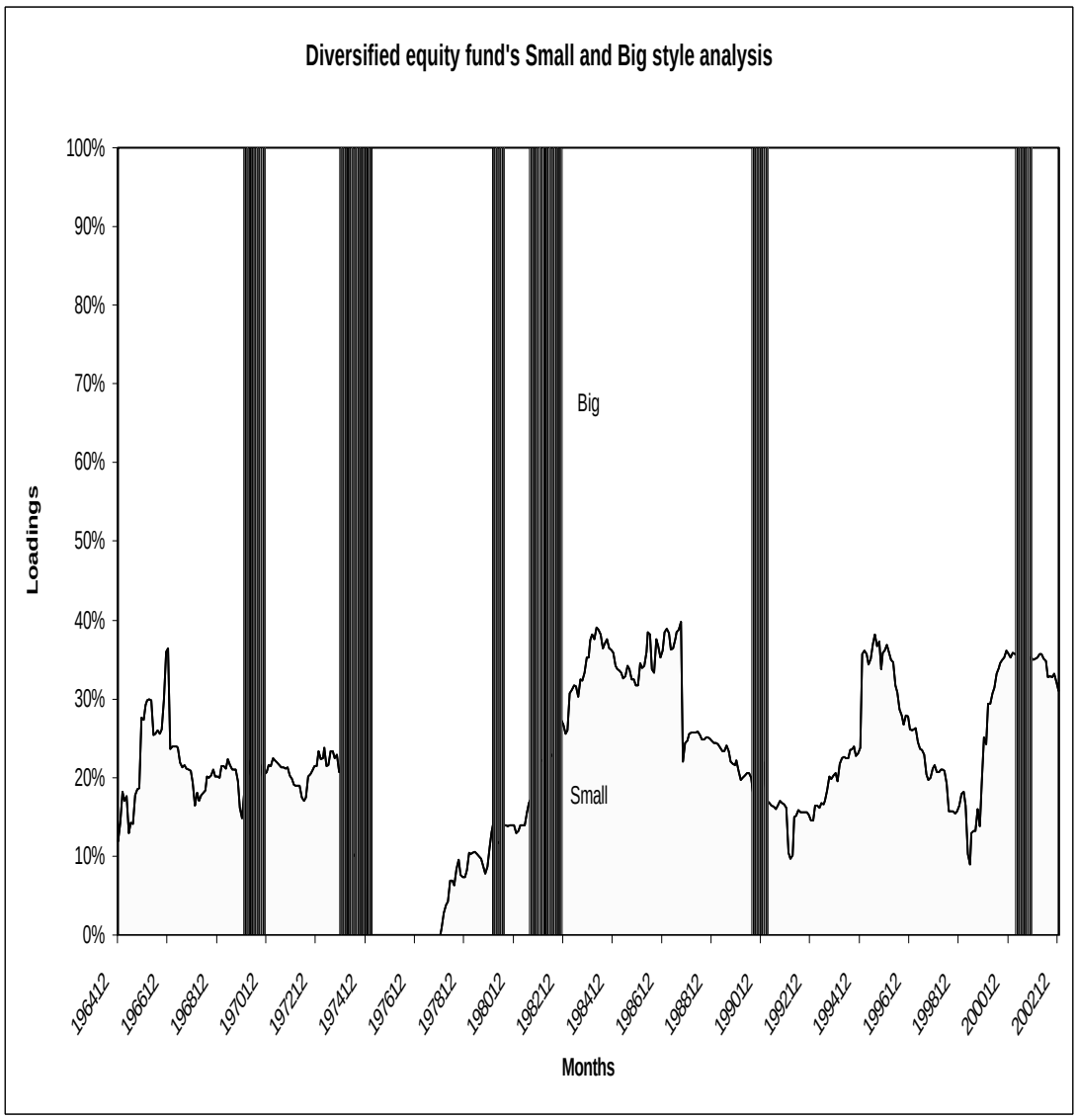


Figure 4.4
Diversified equity fund's double-sorted style analysis

The graph below shows the estimated SL, SM, SH, BL, BM, and BH loadings of the diversified equity fund. The area filled with dots, horizontal lines, and zig-zag lines represents the SL, SM, and SH loadings (equivalent to the Small loadings), and the remaining area represents the BL, BM, and BH loadings (equivalent to the Big loadings). The shaded bands represent NBER recessionary periods.

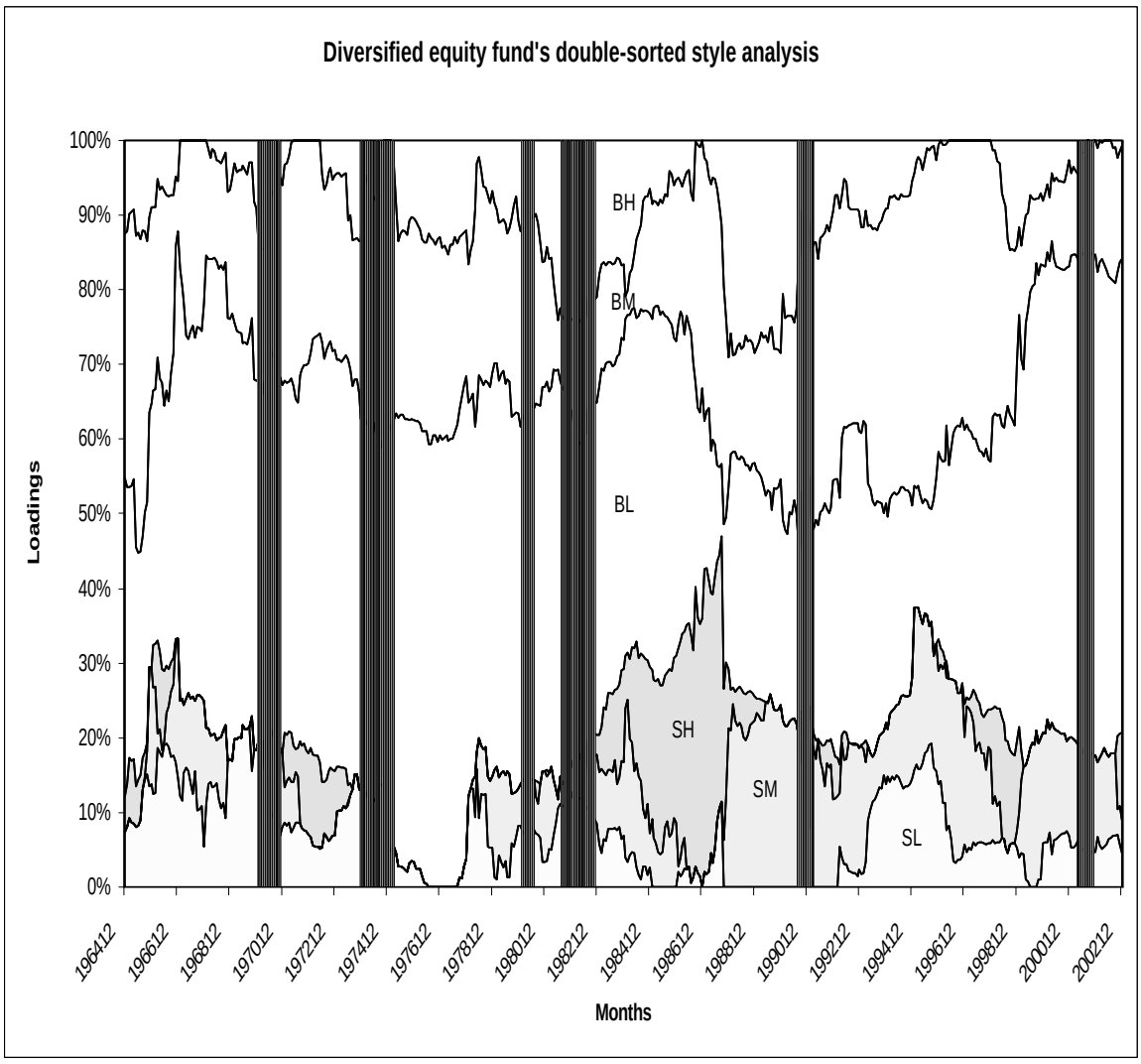


Figure 4.5
Diversified equity fund's Lo, Med, and Hi style analysis

The graph below shows the estimated Lo, Med, and Hi loadings of the diversified equity fund. The dotted area represents the Lo loadings, the area filled with horizontal lines represents the Med loadings, and the remaining area represents the Hi loadings. The shaded bands represent NBER recessionary periods.

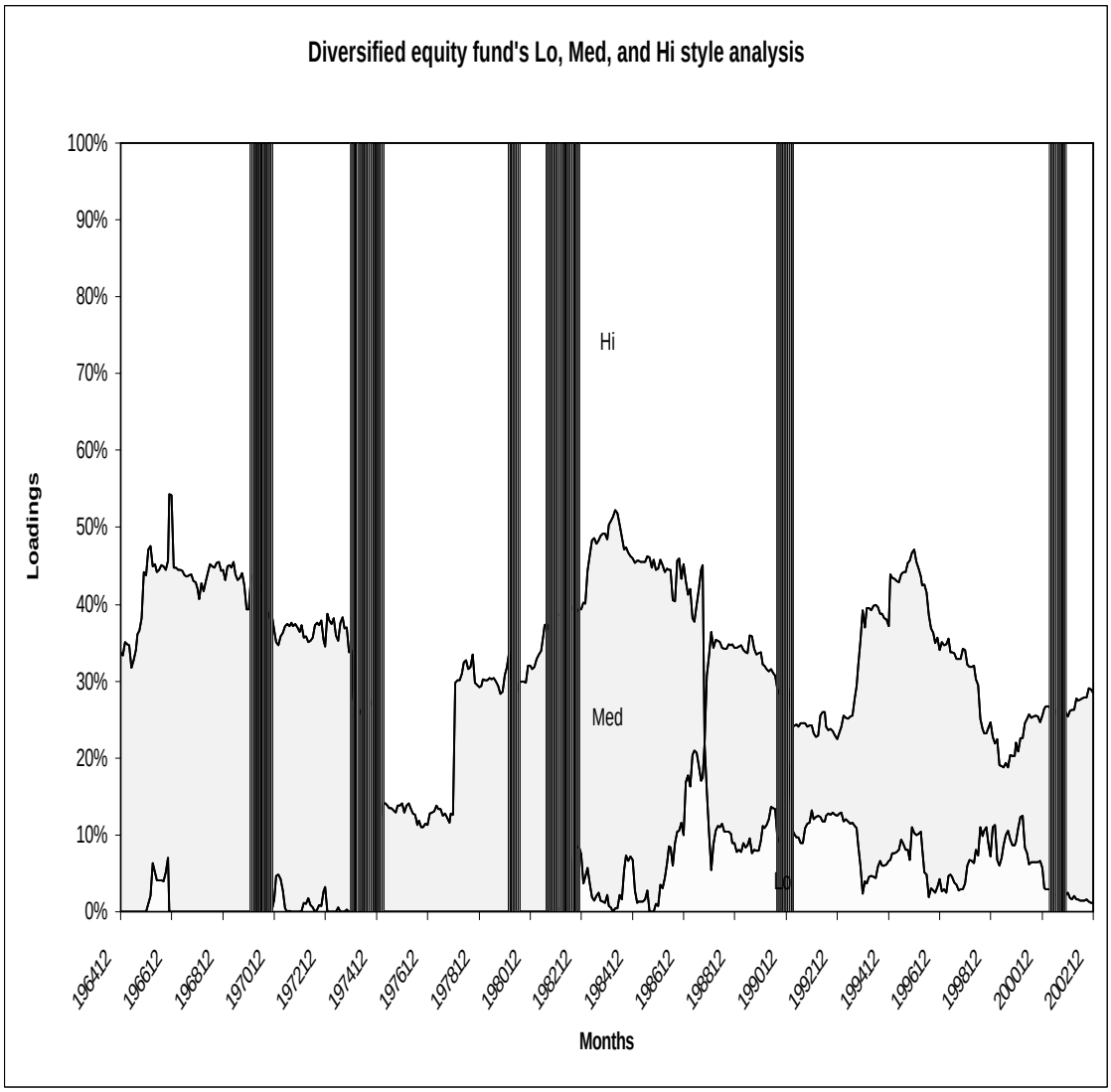


Figure 4.6
Diversified equity fund's deciles style analysis

The graph below shows the estimated decile loadings of the diversified equity fund. The dotted area represents the loadings of Deciles 1 - 3, the area filled with horizontal lines represents the loadings of Deciles 4 - 5, and the remaining area represents the loadings of Deciles 6 - 10. The shaded bands represent NBER recessionary periods.

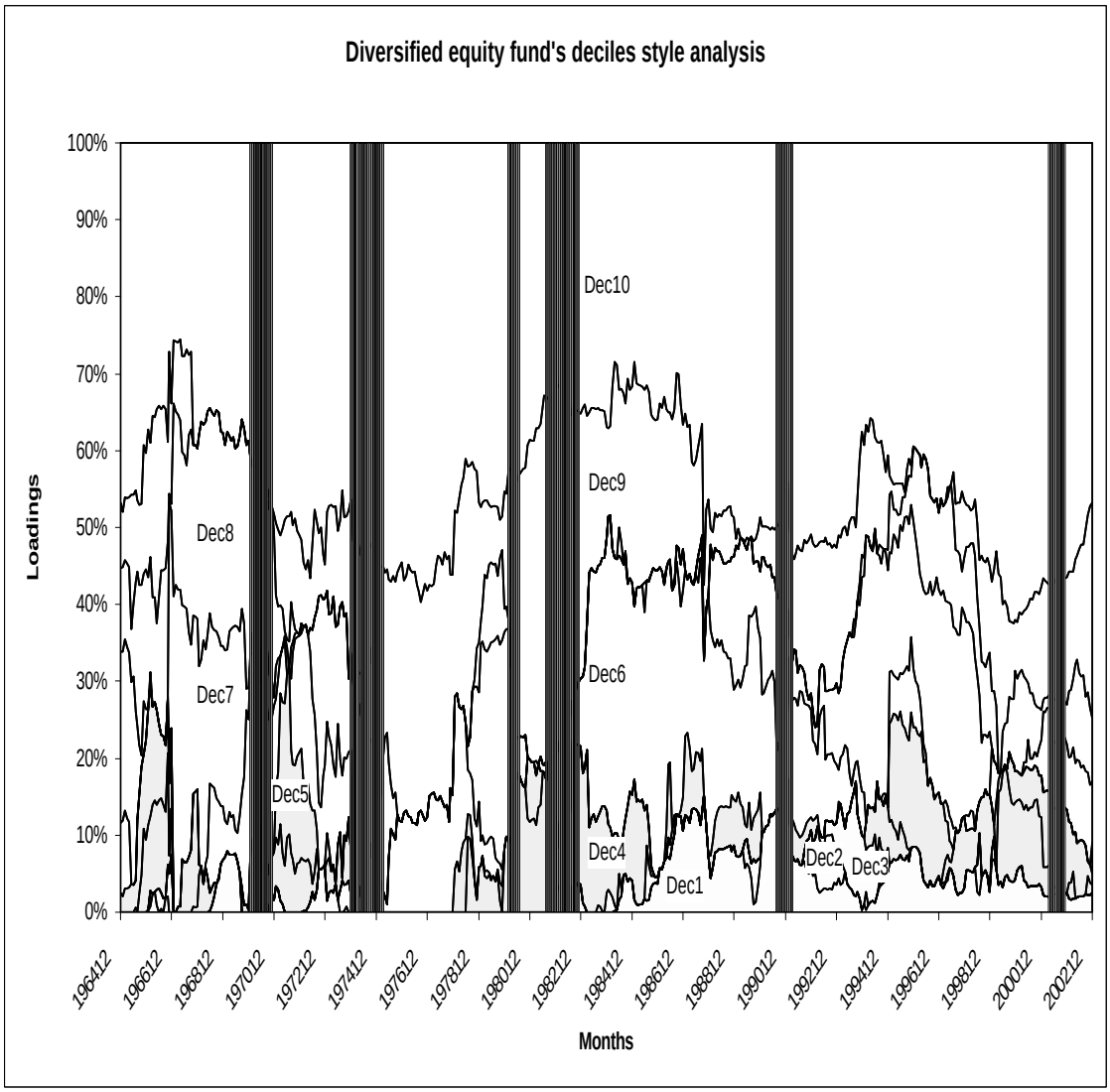


Figure 4.7
Diversified equity fund's quintiles style analysis

The graph below shows the estimated quintile loadings of the diversified equity fund. The area filled with grids, vertical lines, dots, and horizontal lines represents the loadings of Quintile 1, Quintile 2, Quintile 3, and Quintile 4, respectively. The remaining area represents the loadings of Quintile 5. The shaded bands represent NBER recessionary periods.

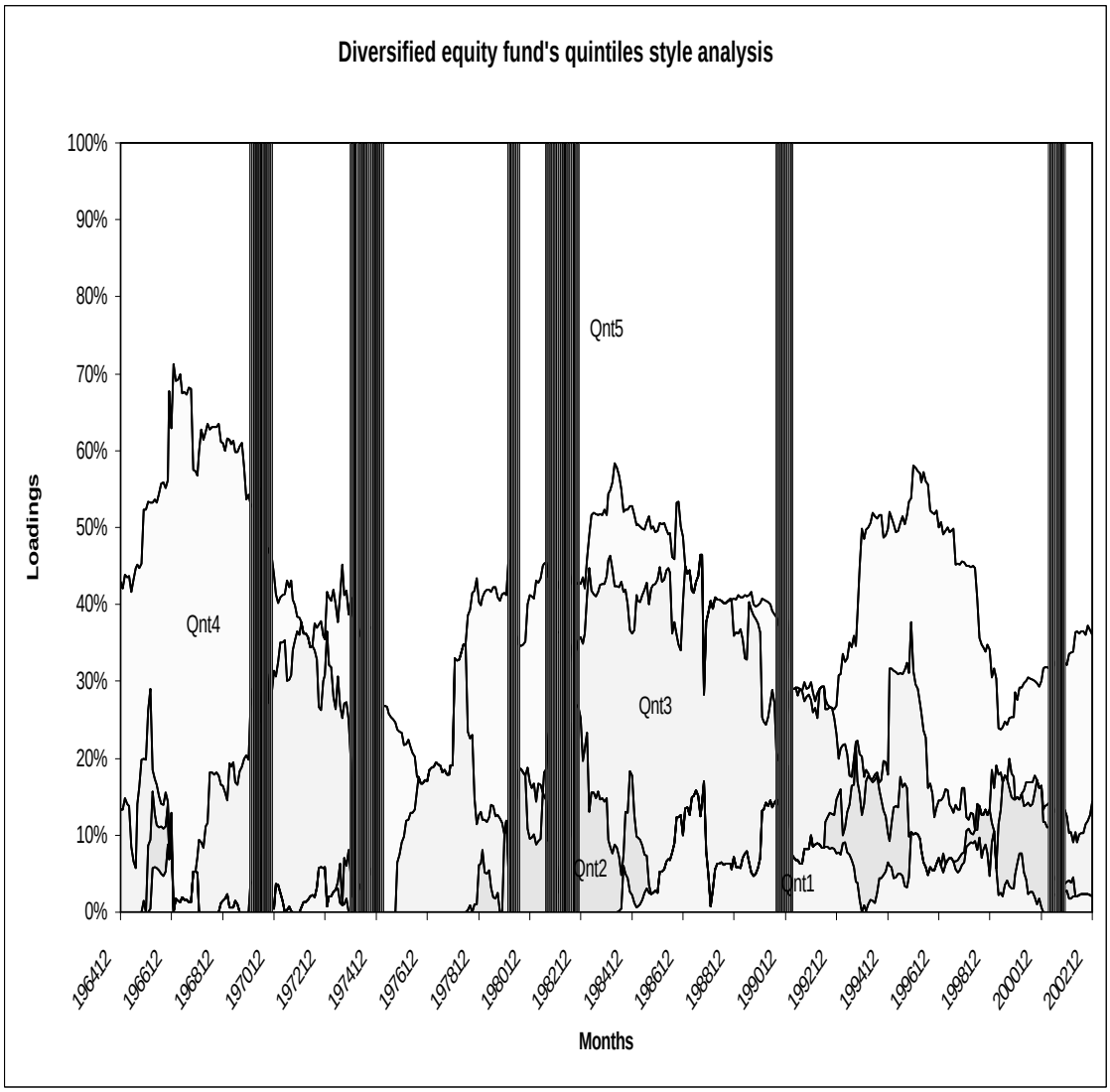


Figure 4.8
Enlarged equity fund's Small and Big style analysis

The graph below shows the estimated Big and Small loadings of the enlarged equity fund. The dotted area represents the Small loadings, and the remaining area represents the Big loadings. The shaded bands represent NBER recessionary periods.

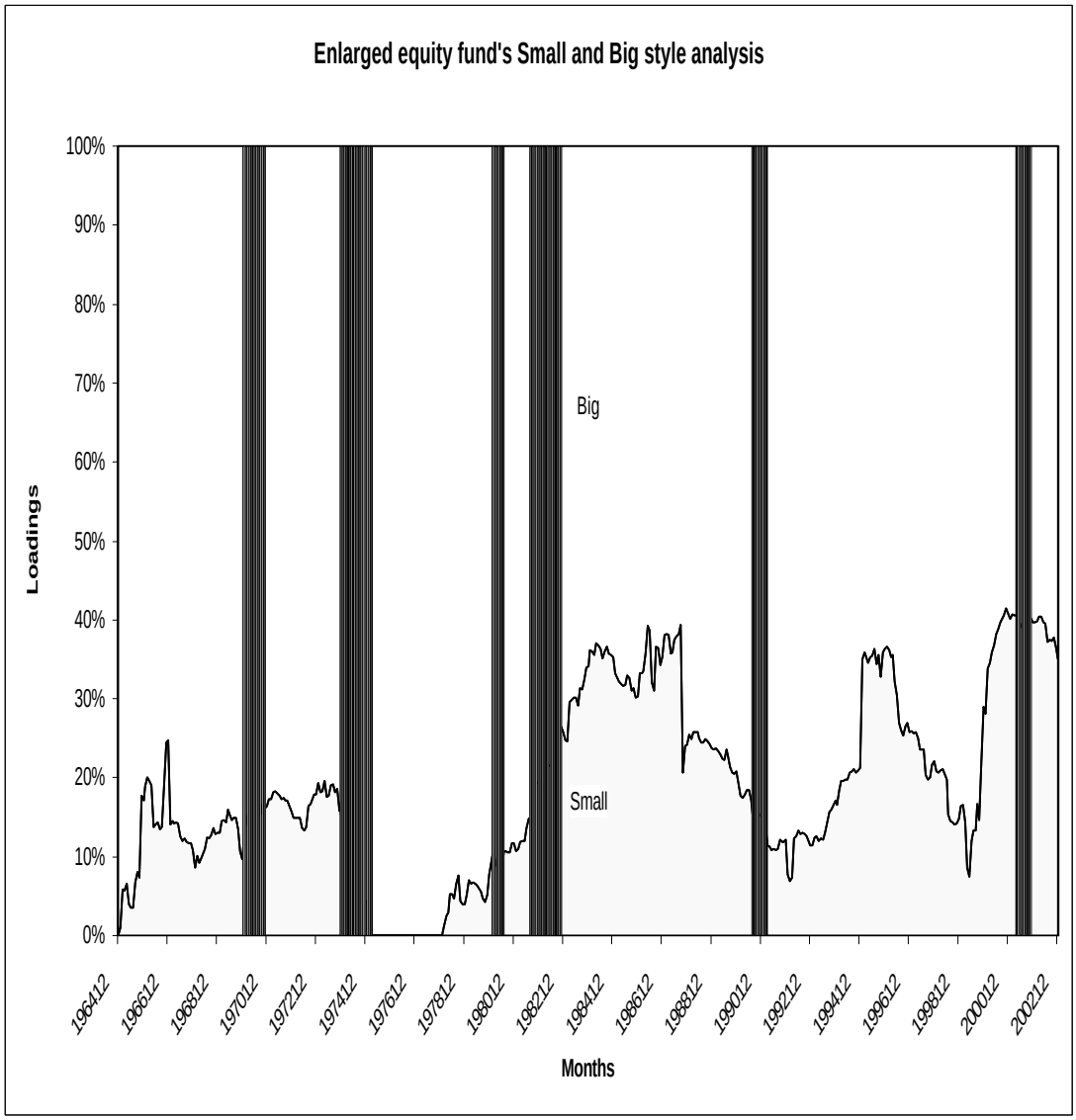


Figure 4.9
Enlarged equity fund's double-sorted style analysis

The graph below shows the estimated SL, SM, SH, BL, BM, and BH loadings of the enlarged equity fund. The area filled with dots, horizontal lines, and zig-zag lines represents the SL, SM, and SH loadings (equivalent to the Small loadings), and the remaining area represents the BL, BM, and BH loadings (equivalent to the Big loadings). The shaded bands represent NBER recessionary periods.

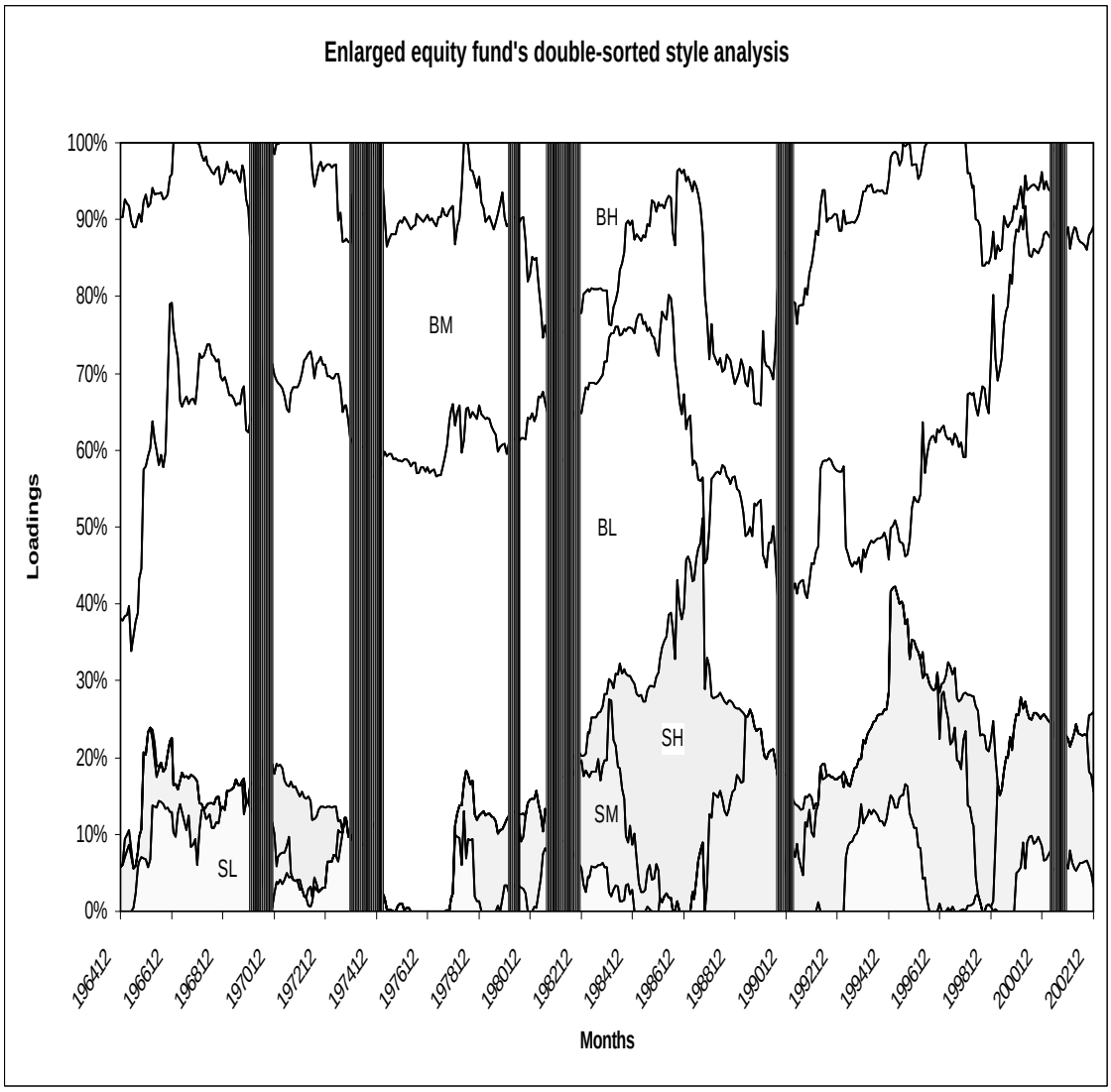


Figure 4.10
Enlarged equity fund's Lo, Med, and Hi style analysis

The graph below shows the estimated Lo, Med, and Hi loadings of the enlarged equity fund. The dotted area represents the Lo loadings, the area filled with horizontal lines represents the Med loadings, and the remaining area represents the Hi loadings. The shaded bands represent NBER recessionary periods.

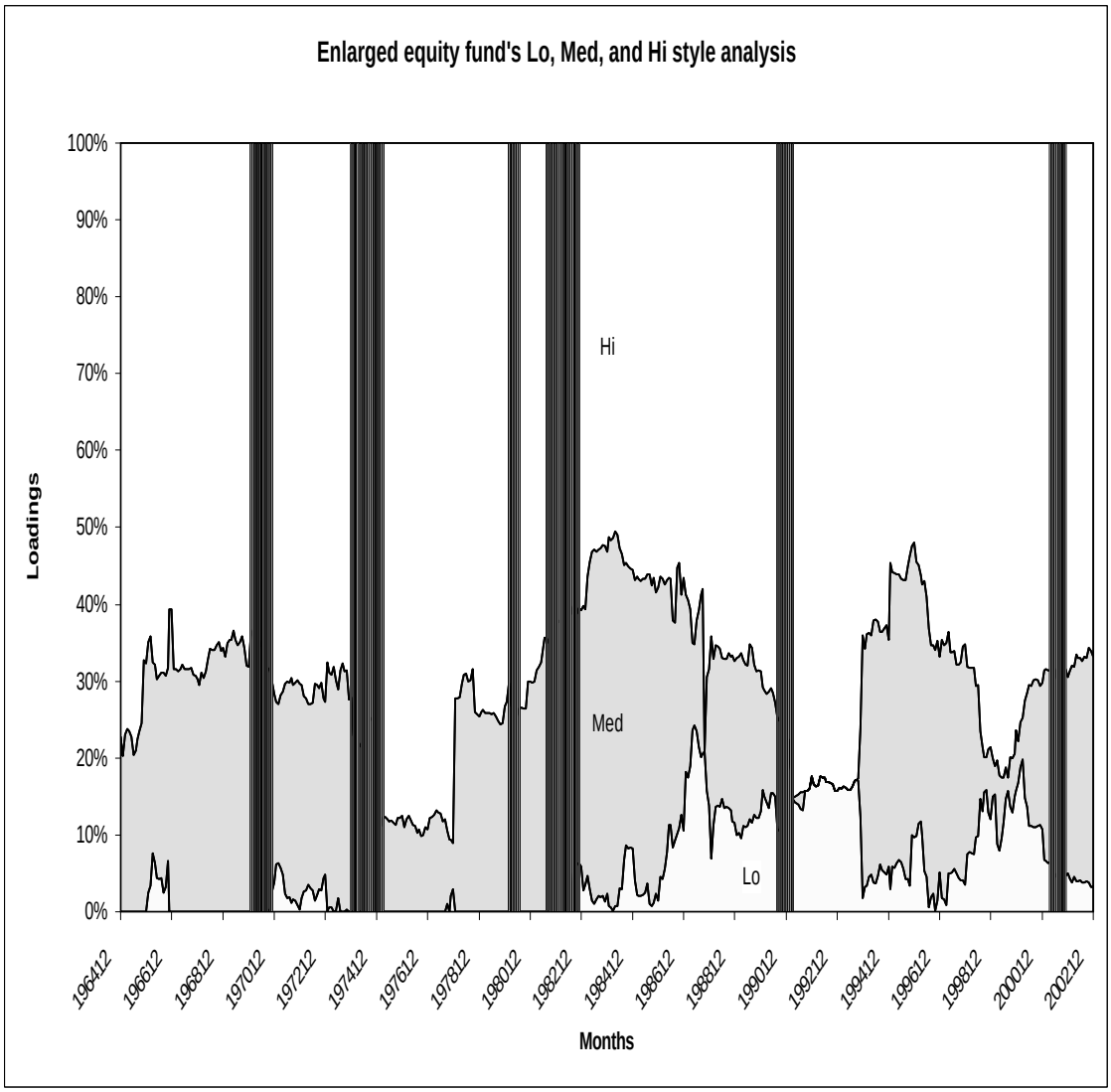


Figure 4.11
Enlarged equity fund's deciles style analysis

The graph below shows the estimated decile loadings of the enlarged equity fund. The dotted area represents the loadings of Deciles 1 - 3, the area filled with horizontal lines represents the loadings of Deciles 4 - 5, and the remaining area represents the loadings of Deciles 6 - 10. The shaded bands represent NBER recessionary periods.

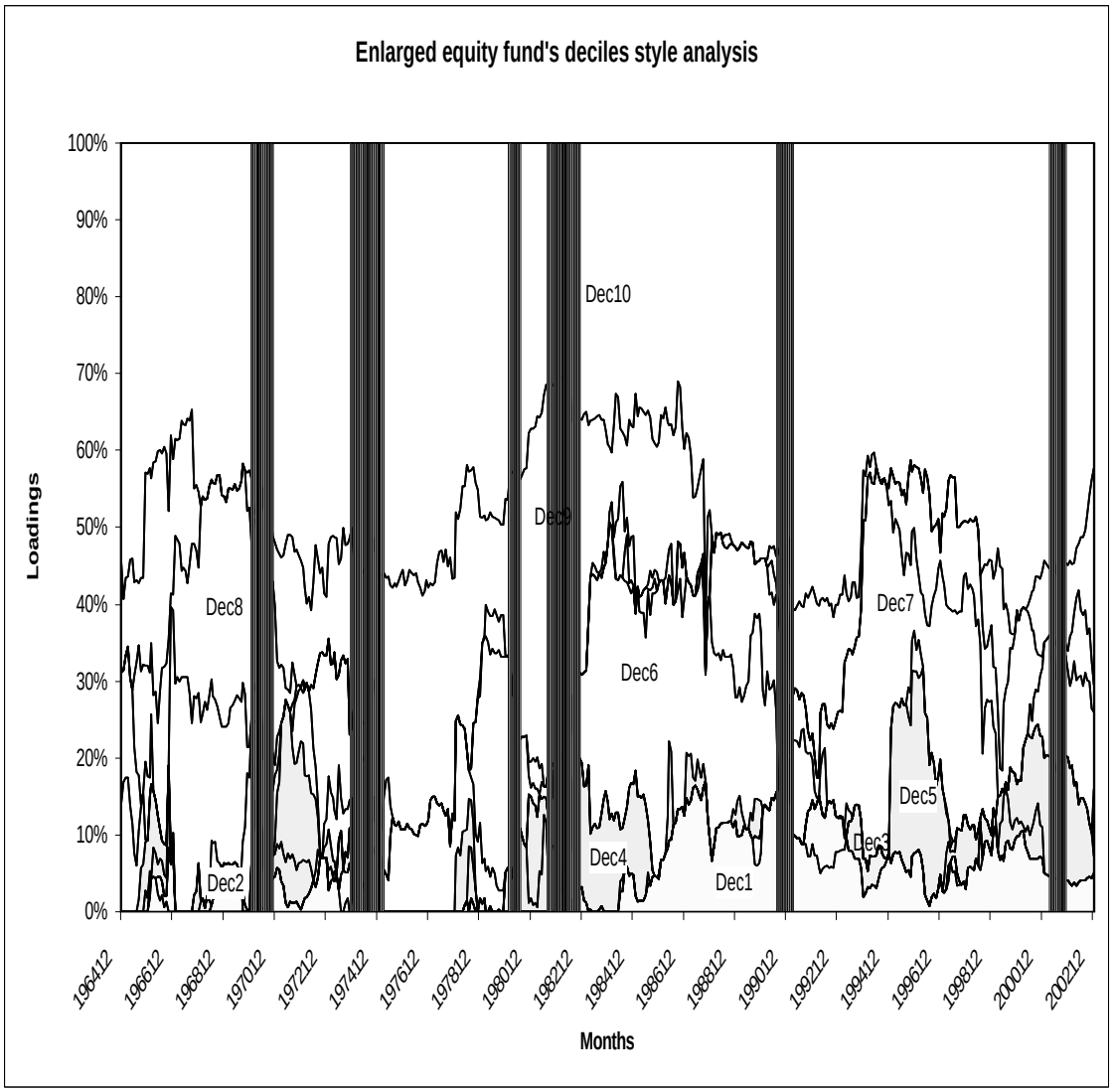


Figure 4.12
Enlarged equity fund's quintiles style analysis

The graph below shows the estimated quintile loadings of the enlarged equity fund. The area filled with grids, vertical lines, dots, and horizontal lines represents the loadings of Quintile 1, Quintile 2, Quintile 3, and Quintile 4, respectively. The remaining area represents the loadings of Quintile 5. The shaded bands represent NBER recessionary periods.

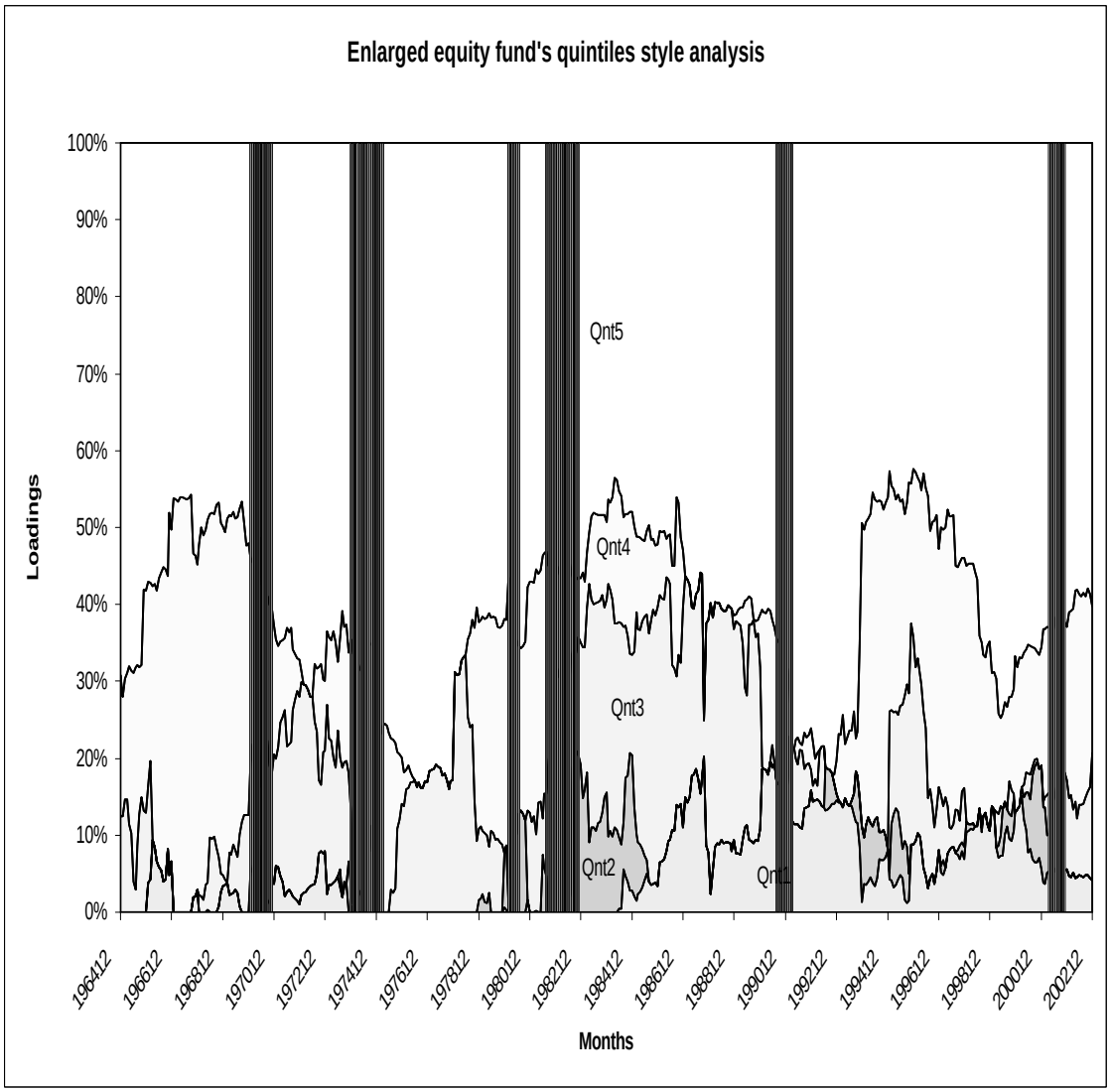
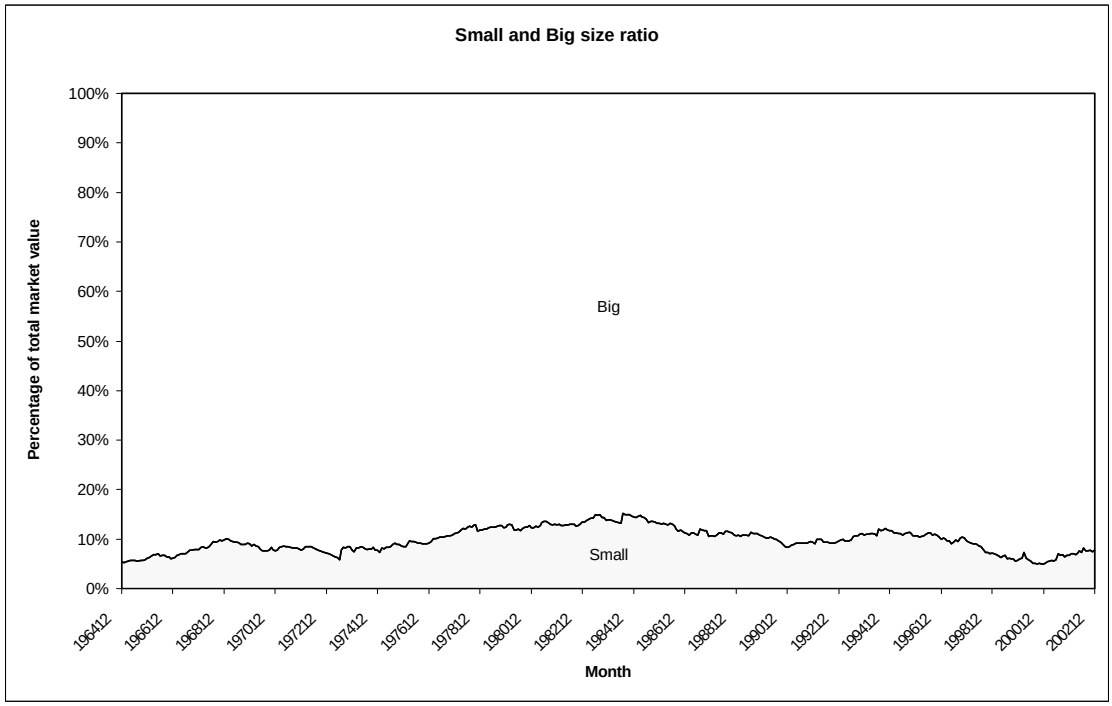
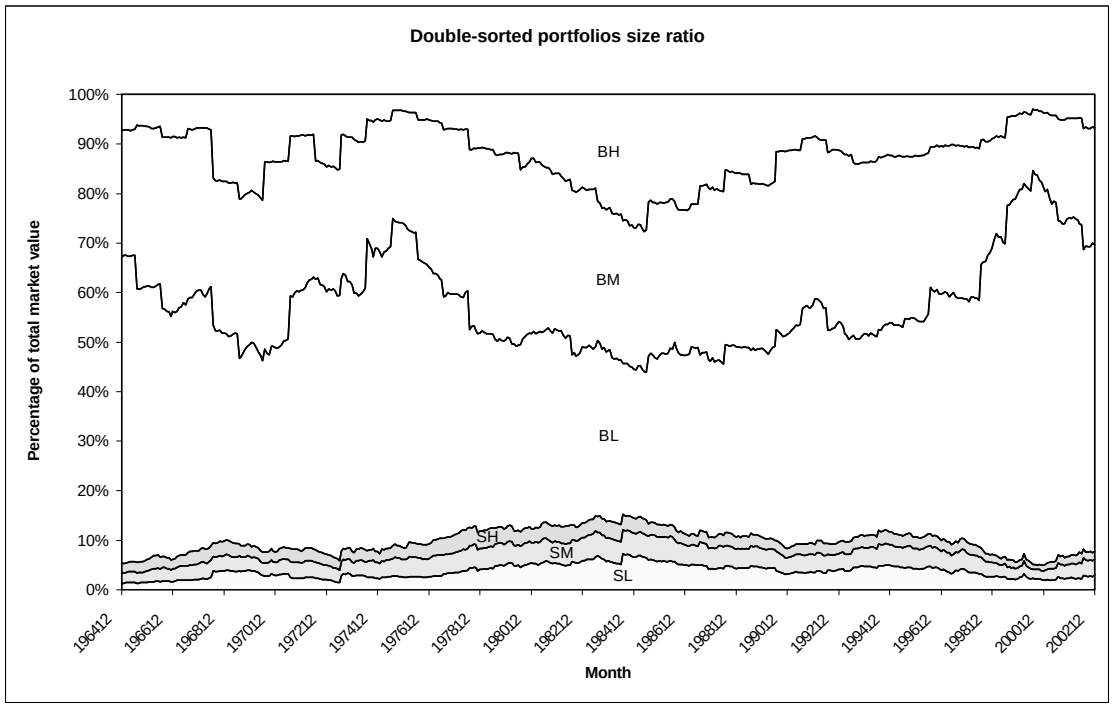
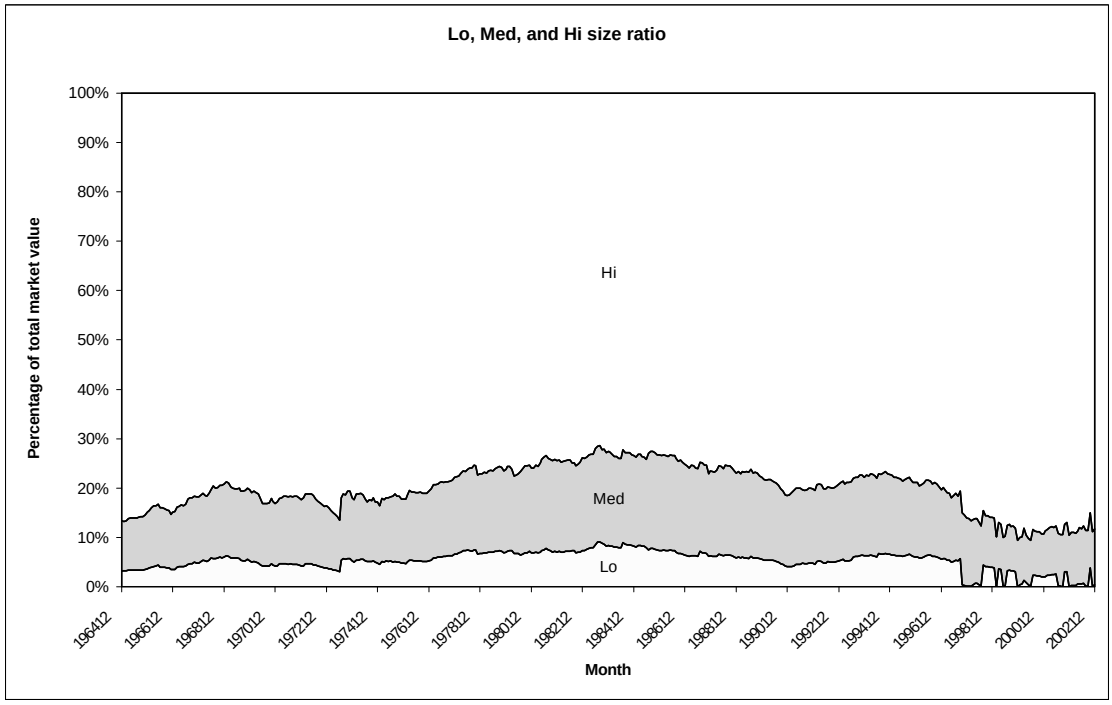


Figure 4.13
The size ratio for size- and double-sorted portfolios

The five graphs below show the market capitalization of the size- and double-sorted portfolios as a percentage of the total market capitalization.






Lo, Med, and Hi size ratio
Percentage of total market value
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Hi
Med
Lo
196412
196612
196812
197012
197212
197412
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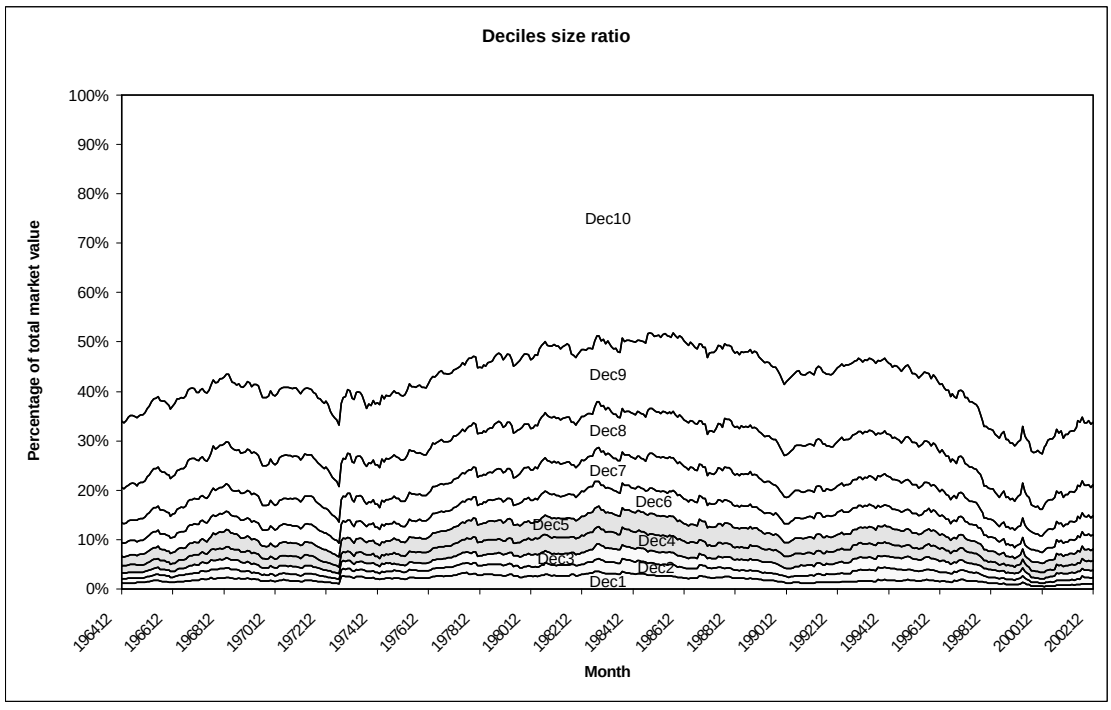
199812
200012
200212
Month


Deciles size ratio
Percentage of total market value
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Dec10
Dec9
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Dec7
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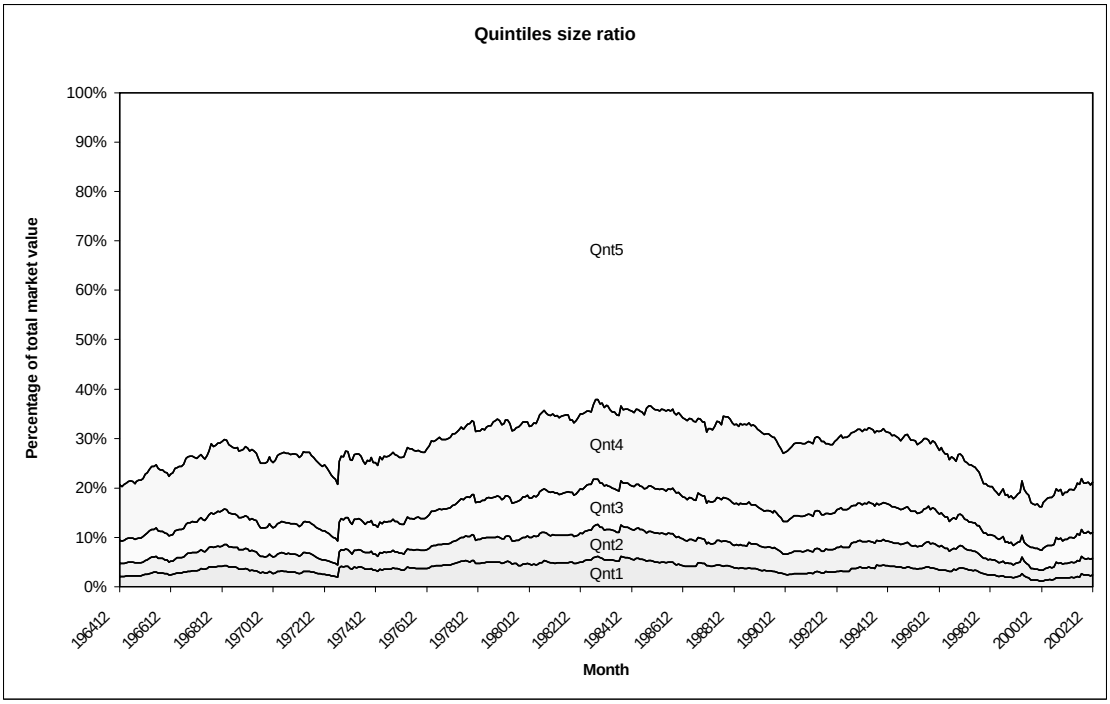
Month


Quintiles size ratio
Percentage of total market value
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Qnt5
Qnt4
Qnt3
Qnt2
Qnt1
196412
196612
196812
197012
197212
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198812
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200212
Month