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FUNDAMENTAL INDEXATION AND THE FAMA–FRENCH THREE FACTOR MODEL: RISK ASSIMILATION OR STOCK MISPRICING?

Xiaofeng Shi[a], *Mike Dempsey*[b,*] *and Laurence Irlicht*[c]

We confirm the outperformance of fundamental indexation (FI) portfolio returns as due to an exploitation of stock mispricing, while, simultaneously, largely explained in terms of the Fama–French three-factor (FF-3F) model. This leads us to conclude that rather than FI representing a repackaging of the book to market and small firm size effects as encountered in the FF-3F model, the impact of these factors in the FF-3F model is explained by their ability to differentiate on aggregate between over- and under-priced stocks.

This paper examines the extent to which the success of Fundamental Indexation (FI) as a strategy of portfolio formation is attributable to the exploitation of stock mispricing (as claimed by its protagonists) as opposed to a repackaging of the risk factors in the Fama–French three-factor (FF-3F) model (as argued by its critics). As the creators of FI, Arnott *et al.* (2005) and Hsu (2006) have argued that portfolios constructed following conventional market capital-weighted indexes must tend logically to overweight overvalued stocks and underweight undervalued stocks, leading, thereby, to what they call a "structural drag" on the performance of these portfolios. They argue that an FI strategy that avoids capital weighting in favor of a weighting of stocks in relation to such as firm book value, earnings, sales, cash flow and dividends (even number of employees) avoids the structural drag and provides an outperformance over a conventional capital market index. FI as promoted by Arnott and associates at *Research Affiliates* represents one of the most successful new investment products of the last decade, having attracted many billions of dollars in portfolio investment. And FI appears to

[a]Tutor, School of Banking and Finance, Monash University, Melbourne, Australia. E-mail: Terry.Shi@monash.edu
[b]Head of Finance Discipline, School of Economics, Finance and Marketing, RMIT University, Melbourne, Australia. E-mail: michael.dempsey@rmit.edu.au
[c]Investment Director, Listed Equities, IFM Investors, Melbourne, Australia. E-mail: Laurence.irlicht@ifminvestors.com
*Corresponding author.

have worked well. Arnott *et al.* (2005) report that over the 43-year period 1962–2004, a back-tested portfolio that weighted large stocks in terms of fundamental attributes such as revenue, earnings, dividends, and book value, outperformed capital-weighted indexation (CWI) portfolios, such as the S&P 500, by about 2 percentage points per year. Since 2005, a live FI portfolio has continued to outperform conventional capital-weighted indexes by the same margin.

A number of authors confirm that FI outperforms when benchmarked against the traditional capital asset pricing model (CAPM), but that FI does not outperform against the FF-3F model (FF, 1993, 1996), which has additional risk premiums for high book-equity-to-market-equity (B/M) and small-firm-size stocks (for example, Jun and Malkiel (2007), Blitz and Swinkels (2008), McQuarrie (2008) Malkiel and Jun (2009)). Since FI indexes, by construction, display a bias to high B/M and small firm stocks, it therefore appears possible to interpret FI's reported performances as a repackaging of the known "value" (high B/M) and "small firm size" effects. It has been pointed out that a long literature in empirical finance has isolated a value effect in asset pricing and that studies as far back as DeBondt and Thaler (1987) and Keim (1983) show that stocks selling at high B/M generate higher returns. Moreover, to the extent that FI attempts to underweight stocks with (temporarily) high market capitalizations, there will be a tendency for an FI portfolio to contain smaller-capitalization stocks compared with a cap-weighted index. Fama and French have argued steadfastly that the larger returns generated by stocks that either have high B/M or of small firms are compensation for risk. Jun and Malkiel (2008) quote Fama and French as stating that FI is a "triumph of marketing, and not of new ideas," and consider that FI is "simply a "repackaging" of ideas that have been in the academic literature for years". Perold (2007) and Kaplan (2008) both claim to have proved that market capital-weighting indexation does not lead to a "structural drag". Perold states, "even though individual stocks may have random pricing errors . . . capitalization weighting, in and of itself, does *not* create a performance drag" (our italics) (p. 36) and refers to such as Asness (2006), Bogle and Malkiel (2006) as having "explained eloquently how fundamental "indexing" is simply a particular packaging of quantitative value investing" (p. 35). Thus, for the critics of FI, there is nothing surprising about constructing an index that favors small-cap stocks or value stocks and then showing that such a model outperforms capital-weighted indexation (CWI).

The present paper is structured to first, establish whether FI outperformance can be attributed to an exploitation of stock mispricing, second, to confirm the interdependence of FI outperformance with the Fama–French value (B/M) and small firm size factors, and, finally, to provide evidence as to whether the outperformances of value and small firm size stocks in the FF-3F model are the outcome of stock mispricing as opposed to a reward for risk. Thus, in a first stage, we consider that smaller firms are more likely to be mispriced due to thin trading and fewer analysts and resources following the stock—and that FI portfolio formation should accordingly be more effective in outperforming alternative portfolio formation strategies—when applied to portfolios of increasingly smaller firm stocks. Similarly, we argue that FI portfolio formation should be more effective in outperforming alternative portfolio formation strategies in periods of high market volatility or crisis, than in more stable periods.

In a second stage, we proceed to determine the alpha outperformance of FI against the CAPM and FF-3F models. If FI portfolio formation provides positive alphas against the CAPM, but not against the FF-3F model, the implication is that

FI outperformance is largely absorbed by the B/M and firm size effects (which, as, we have noted, has led to the accusation that FI portfolio formation represents a repackaging of the B/M and possible firm size effects). But, in this case, provided that we have established that FI's success is due to mispricing (the first stage, above), at least on the face of it, the effectiveness of the B/M Fama–French factors can be related, inversely, to stock mispricing: portfolios of high (low) B/M stocks subsequently outperform because these stocks are on aggregate under- (over-)priced; and similarly for portfolios of stocks of small firm size. The evidence must then directly challenge the contention of Fama and French that the three-factor model factors are to be interpreted as proxies for risk undertaken by investors in the context of rational asset pricing.

Thus, in the third stage, we seek to distinguish between risk and mispricing as explanations of the FF-3F model by performing a series of diagnostic tests. If the B/M and firm size factors are capturing mispricing, we expect that portfolios of both very high and very low B/M and firm size will have higher variances of stock returns both in cross-section and through time—due to stocks in these portfolios, on aggregate, tending to be either over-priced (low B/M, high firm size) or under-priced (high B/M, low firm size). Additionally, if portfolios of either very high or very low B/M and firm size are capturing mispricing, we anticipate that FI will outperform cap-weighted portfolios for portfolios formed on either very high or very low B/M and firm size, but will be significantly less capable of doing so in portfolios of medium B/M and firm size.

The development of the paper as outlined above is organized as follows. Section 2 provides a brief background and review of the literature. Section 3 introduces the data and outlines the methodology. Section 4 reports our results and Section 5 concludes the paper.

1 Background and review of the literature

Subsequent to Arnott *et al.* (2005), which demonstrated that in certain circumstances, FI-based portfolios had produced higher monthly returns than traditional capital-weighted indexation (CWI) with similar or lower volatility, FI has been studied extensively in various settings, including markets outside the United States. Arnott and West (2006) argue for the superior performance of FI among small stocks (U.S. stocks ranked 1,000th to 3,000th). Hsu and Campollo (2006) discuss the superior performance of FI portfolios among 23 markets in relation to the MSCI and FTSE Developed World Indexes. FI has also been successful in Europe (Hemminki and Puttonen, 2008), as well as in Australia (Mar *et al.*, 2009).

Nevertheless, the explanation of FI performance in relation to risk-adjusted returns remains controversial. On the face of it, we have the possibility that the phenomenon of mispricing or "noise" as it underpins the strategy of FI is itself explanatory of the application of the Fama and French model. Going back to such as La Porta *et al.* (1997) and Skinner and Sloan (2002)—who propose that high B/M (value) and low B/M (growth) stocks are systematically mispriced due to market participants' under- and overestimation of future earnings—we have evidence of a correspondence between the B/M and small firm size factors and mispricing. Ali *et al.* (2003) also suggest a relation between mispricing and the factors in the FF-3F model by reporting that the B/M effect is greater for substantially mispriced stocks, while Daniel and Titman (2006) argue that the B/M effect in the FF-3F model is the result of market overreaction to intangible information. Schultz (2010) suggests that large value stocks are easier to analyze and cheaper to trade than small-growth stocks,

concluding that the former are less mispriced. Doukas *et al.* (2010) and Arnott *et al.* (2011) consider that both B/M and firm size are proxies for stock mispricing.

Evidence of stock mispricing more generally has been presented by such as Daniel *et al.* (1998), who suggest that stock market under and over reactions are caused by investor overconfidence in relation to private information and biased self-attribution—which lends support to the underlying contention of FI, namely that the stock market over or under reacts to information allowing for significant stock mispricing. Lo (2004, 2005) promotes an adaptive market hypothesis whereby market efficiency is influenced by individual behavior in adapting to a changing market condition. This accords with Lim *et al.* (2008) who report that most Asian stock markets were significantly less efficient during the Asian financial crisis. More recently, Todea and Lazăr (2012) suggest that the recent volatile financial environment has led to a decrease in market efficiency.

Nevertheless, FI has its critics. Asness (2006) and Perold (2007) contend that FI is actually an active management strategy with a value tilt (high B/M), the outcome of which is that FI is not necessarily superior to price-based strategies. Perold (2007) argues that avoidance of the performance drag is not possible without a knowledge of fair values and that market prices that deviate from fair values do not automatically generate a market capitalization-weighted indexation that overweights overvalued stocks. Kaplan (2008) argues that FI inappropriately assumes that fundamental weights are unbiased estimates of fair value weights that are statistically independent of market value. Kaplan (2008) demonstrates that a key feature of Hsu's (2006) model, the independence assumption that the "error in fundamental weighting is independent of market value", is internally inconsistent. Graham (2012) documents that FI does not consistently outperform CWI if fair values are observable and claims that CWI does not underperform because of performance drag. Bernstein (2006), Blitz and Swinkels (2008), and Jun and Malkiel (2008) have also argued that FI is actually a value strategy, whose superior returns can be explained by the FF-3F model. Thus, for the critics of FI, there is nothing surprising about constructing an index that favors value or small-cap stocks and then showing that such a model outperforms pure CWI.

2 Data and methodology

2.1 Data and variable description

Monthly data for the 24-year sample period January 1987 to December 2010 were obtained from Russell Investments. The monthly based data for stock prices (database variable code PRC; if PRC data not available, then ALTPRCA), numbers of stocks outstanding (database variable code SHROUT), and stock returns (database variable code RET) are available from the Center for Research in Security Prices (CRSP) database. Stock returns recorded as greater than 300% per month are ignored. Stock market capitalization values are calculated as the multiple of the stock price and the number of stocks outstanding. The accounting variables (book value, cash flow, sales, and dividends) are available from the CRSP–Compustat merged database and include dividends (database variable code DVT), book value per share (database variable code BKVLPS), sales (database variable code SALE), depreciation (database variable code DP), and earnings before interest and tax (database variable code EBIT). Cash flow is calculated as the sum of depreciation (database variable code DP) and earnings before interest and tax (database variable code EBIT). Book value is calculated as the

multiple of the book value per share (database variable code BKVLPS) and number of shares outstanding (database variable code SHROUT). The data for the FF-3F model (i.e., small minus big (SMB), high minus low (HML), risk-free rates, and market returns) are available from Kenneth French's data library (2010).

2.2 Methodology

2.2.1 Stage one: Stock mispricing and portfolio performance

Portfolio construction: Stock selection

At the *first* stage, we consider that due to thinner trading and lower market analysis, stocks of smaller firms are more likely to be mispriced. Accordingly, we compare FI portfolio performance with the performance of market-price based index strategies as a function of market capitalization, which is taken as an inverse proxy for mispricing. In forming the portfolios, we consider that a portfolio manager following a "large cap stocks" portfolio will naturally select first the largest cap stocks and proceed to include the next largest stocks in accordance with a chosen portfolio breadth of stocks. Similarly, a portfolio manager following a "small cap stocks" portfolio will select stocks from the opposite direction of small cap stocks. Thus, for each month we construct 182 portfolios with the following numbers of stocks: The first portfolio comprises the 100 stocks with the largest market capitalization from the Russell 1000 Index; the second portfolio comprises the 110 stocks with the largest market capitalization (i.e., the 100 stocks retained from the first portfolio plus the subsequent 10 stocks with the largest market capitalization); the third portfolio comprises the 120 stocks with the largest market capitalization (i.e., the 100 stocks retained from the first portfolio plus the 10 stocks subsequently added to the second portfolio plus the subsequent 10 stocks with the largest market capitalization). As a result, the 91st portfolio comprises all stocks in the Russell 1000 Index. The 92nd to 182nd portfolios are constructed by removing the largest stocks from the previous portfolio, 10 stocks at a time. The 92nd portfolio is identical to the 91st portfolio. The 93rd portfolio comprises the 990 stocks with the smallest market capitalization from the Russell 1000 Index (i.e., 1,000 stocks from the 92nd portfolio minus the 10 stocks with the largest market capitalization). The 94th portfolio comprises the 980 stocks with the smallest market capitalization (i.e., the 990 stocks retained from the 92nd portfolio minus the 10 stocks with the largest market capitalization that are excluded in the 93rd portfolio). As a result, the 182nd portfolio comprises the 100 stocks with the smallest market capitalization from the Russell 1000 Index.

Portfolio construction: Stock weighting

We consider three benchmark indexation techniques against which to benchmark FI: capitalization-weighted indexation (CWI), price-weighted indexation (PWI), and equally weighted indexation (EWI). PWI is interpreted as representing a milder version of CWI, for which mispricing of share value is amplified by the number of shares outstanding. If the performance drag is substantially destructive to price-based portfolio performance, as claimed by the protagonists of FI, it is reasonable to expect FI to outperform both CWI and PWI techniques. The EWI technique is adopted as the most conceptually straightforward price-indifferent strategy. Each month, the weight for each stock is calculated for each indexation strategy. The weights are then used to calculate the monthly return generated for each of the portfolios.

Our FI composite index incorporates four fundamental variables: book value, cash flow, sales, and dividends. The FI portfolios are constructed each month based on the method of Arnott *et al.*

(2005), who find that the composite index outperforms alternative versions of FI. With the exception of book value, five-year trailing average figures are calculated for the remaining factors (cash flow, sales, and dividends). The weights for each of the four fundamental factors are calculated separately and aggregated to produce the target weights of the FI portfolio. An individual stock's target weight is the average of the weights calculated based on each of the four fundamental factors. The fundamental variables are available on a quarterly basis. Nevertheless, we rebalance all portfolios (FI plus the three benchmarks) to their target weights on a monthly basis to ensure that the portfolio structure is not significantly altered by variation in stock market capitalization values and that the monthly rebalancing approach is applied consistently to all four indexation strategies. The weighting based on dividends excludes non-dividend-paying companies. Hence the FI portfolio target weights for these companies are the average of the weights from the other three fundamental factors (i.e., book value, trailing five-year average cash flow, and trailing five-year average sales). The monthly CWI and PWI portfolios are constructed, respectively, by weighting each stock by its one-month-lagged market capitalization value and by its one-month-lagged stock price. The portfolio weighted average returns for each month allow for the comparison of portfolio performances for each formation strategy (CWI, EWI, PWI) across portfolio sizes within the 24-year period.

Performance comparisons

In addition, we allow for a distinction between crisis and non-crisis periods. We identify four crisis periods during the sample period: Black Monday, between the start of 1987 and the end of 1988; the Asian financial crisis, between the start of 1997 and the end of 1998; the dot-com crash, between the start of 2000 and the end of 2002; and the global financial crisis, between the start of 2008 and the end of 2010. The periods between the start of 1989 and the end of 1996 and the between the start of 2003 and the end of 2007 are identified as non-crisis periods. On this basis, we calculate arithmetic and geometric mean returns, standard deviations, and Sharpe ratios. Student *t*-tests are performed to test the comparison of performances between the FI portfolio and benchmark portfolios (CWI, EWI, and PWI).

2.2.2 *Stage two*: *Stock mispricing and the CAPM and FF models*

In the *second* stage of analysis, we compare FI strategy performances with performances of the other benchmark indexes in relation to both the CAPM and FF-3F models. To this end, the monthly portfolio returns $R_{i,t}$ for portfolio i in month t are regressed on

(1) the CAPM:

$$(R_{i,t} - R_{f,t}) = a_i + b_i(R_{M,t} - R_{f,t}) + e_t, \tag{1}$$

where $R_{f,t}$ = the risk-free rate, and $R_{M,t}$ = the market return, and b_i is the estimated coefficient of the regression, a_i is the intercept, and e_t is the error term of the regression, and

(2) the FF-3F model:

$$(R_{i,t} - R_{f,t}) = a_i + b_i(R_{M,t} - R_{f,t}) + s_i SMB_t + h_i HML_t + e_t, \tag{2}$$

where the terms are as in Equation (1) and for each month t, SMB_t and HML_t, respectively, are the small firm size minus big firm size and high B/M minus low B/M factors, and s_i, and h_i are the coefficients of the regression. The market premium $R_{M,t}$, SMB_t and HML_t factors and risk-free rate $R_{f,t}$ are taken from Kenneth French's data

library (2010). Student t-tests are performed to compare the cross-sectional averaged estimated coefficients between benchmark and FI portfolios.

2.2.3 *Stage three*: *Stock mispricing and size and value effects*

In the *third* stage of our analysis we seek to determine in a series of diagnostic tests whether the value factor (represented by the stock's B/M) and the small firm size factor (represented by the inverse of a stock's market capitalization value) are indicative of risk factors or of mispricing. If portfolios of either very high or low B/M and firm size are indicative of stock mispricing, we anticipate that such portfolios will both (1) have stocks of higher volatility and (2) be more volatile through time. Thus, we (1) calculate each month, for each portfolio, the cross-sectional standard deviation of stock returns in that portfolio (weighted in accordance with the index strategy) and (2) calculate the idiosyncratic volatility of the portfolio through time as the standard deviation of the error term e_t in the CAPM regression as Equation (1).

Additionally, we form a 5 × 5 portfolio matrix on the interaction of B/M and firm size by categorizing the stocks, first, into five groups based on the book-to-market ratio, and, secondly, categorizing each quintile into a further quintile based on stock size. Thus, for each month, 25 groups are created, with approximately 40 stocks in each group. When we construct portfolios for each group, we anticipate one of three general outcomes. (1) Because the outperformance of FI is essentially due to leaning toward higher book-to-market and lower-capitalization stocks and not due to stock mispricing, there should be no outperformance of FI over CWI when we control for the two effects. (2) Because the outperformance of FI is due to an exploitation of stock mispricing, but has no association with the book-to-market and small firm size factors, FI should more or less uniformly outperform CWI across the partitioned B/M and firm size portfolios. (3) Allowing that the outperformance of FI is due to its ability to exploit stock mispricing, and that portfolios with very high (low) book-to-market ratios represent stocks that are generally under- (over-)priced, FI will outperform CWI with these portfolios, but *fail* to outperform with those portfolios that have few mispriced stocks (i.e., with middle-range book-to-market ratios). In addition, FI will outperform CWI in portfolios of small-cap stocks—which are assumed to be subject to higher stock mispricing—although this effect may be muted in the present sample since none of our stocks lie outside the Russell 1000.

3 Results

Stage one: *Stock mispricing and portfolio performance*

As explained in the methodology section, we build from a base of the largest 100 stocks, progressively including the next 10 largest stocks. Thus, in Figure 1, the left half of each graph summarizes the performances for the indexes encompassing stocks of increasingly smaller firms as the portfolio increases in the number of stocks from 100 to 1,000. The right-hand side of each graph is formed as we successively remove the remaining 10 largest stocks from the portfolio.

In Figure 1, we display the average monthly outcomes for the portfolio in relation to arithmetic and geometric mean returns, the variance of monthly returns, and the portfolio Sharpe ratio. With portfolios of increasingly small firm size, stock returns and volatility increase for each of the index strategies. We observe that for portfolios dominated by stocks of larger firms (left-hand side of each figure) EWI somewhat outperforms FI, but that with portfolios dominated by smaller

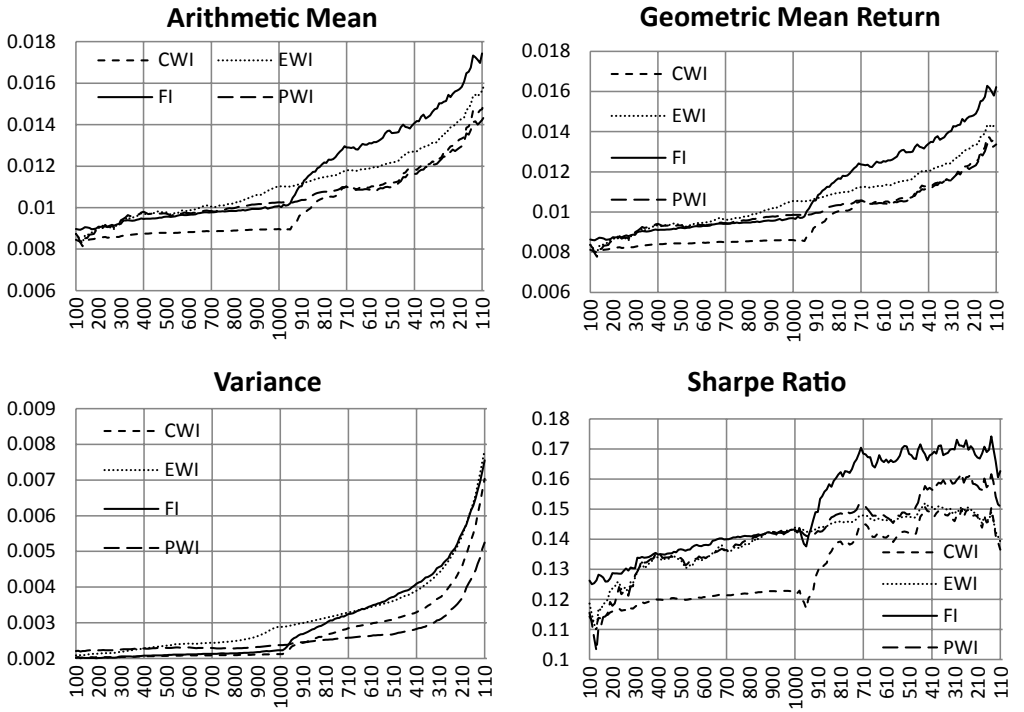

Figure 1 Performance comparisons for indexation strategies (PI, EWI, CWI, PWI) as a function of portfolio firm size, 1987–2010.

firms (right-hand side of each figure), FI markedly outperforms EWI as well as the other indexes. We note, also, that small-cap stocks contribute positively to the risk-return relation as measured by the Sharpe ratio and that on this measure FI portfolios outperform the alternative benchmark portfolios on a risk-adjusted basis.

Figures 2 and 3 display the variation of the key performance indicators for each of the four indexation techniques during crisis and non-crisis periods, respectively. The performance indicators across the four indexation techniques do not differ significantly during the non-crisis periods, but do differ significantly in the crisis periods, when FI in particular, but also EWI, are able to exploit stock performances more effectively than either PWI or CWI. Thus, we interpret the evidence as again supporting the argument that non-market price indexes (FI and EWI) are able to outperform market-price indexes (CWI and PWI) due to the ability of the former to more effectively exploit stock pricing.

Stage two: *Stock mispricing and the CAPM and FF models*

Confirming previous studies, the FF-3F model explains the FI portfolio performances with lower alpha, higher R^2, and lower root mean square error than the CAPM (not reported here). Neither small nor large capitalization-dominated portfolios produce significant alpha in the FF-3F model. Figure 4 summarizes the variation of alpha and idiosyncratic risk measured as the root mean square error or standard deviation of the regression residuals e_t in Equations (1) and (2). The figure highlights, in particular, that the intercept (alpha) in the CAPM regression is significantly reduced in the FF-3F model regression. This is consistent with the hypothesis that the outperformance of FI is, at least in part, captured by the FF-3F size and value factors.

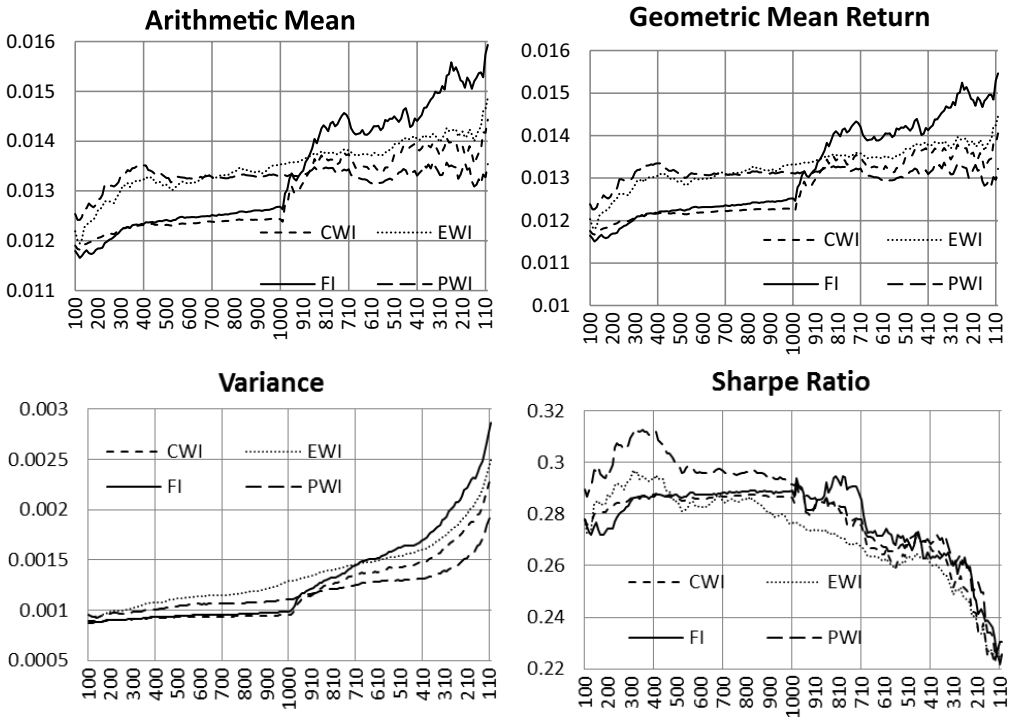

Figure 2 Performance comparisons for indexation strategies (PI, EWI, CWI, PWI) as a function of portfolio firm size, non-crisis periods.

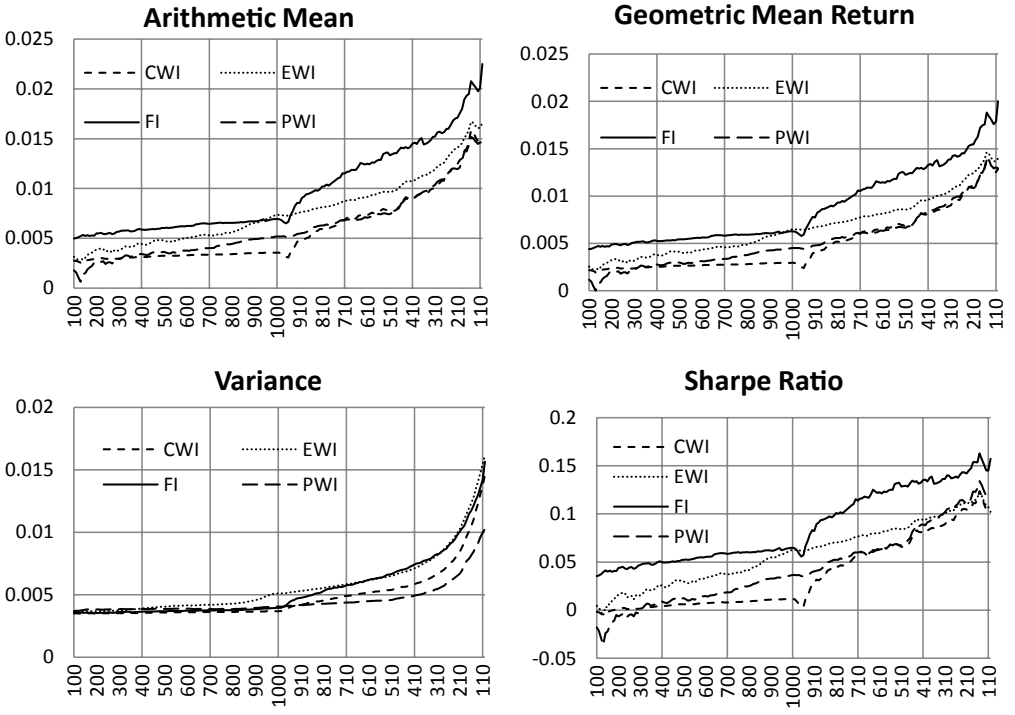

Figure 3 Performance comparisons for indexation strategies (PI, EWI, CWI, PWI) as a function of portfolio firm size, crisis periods.

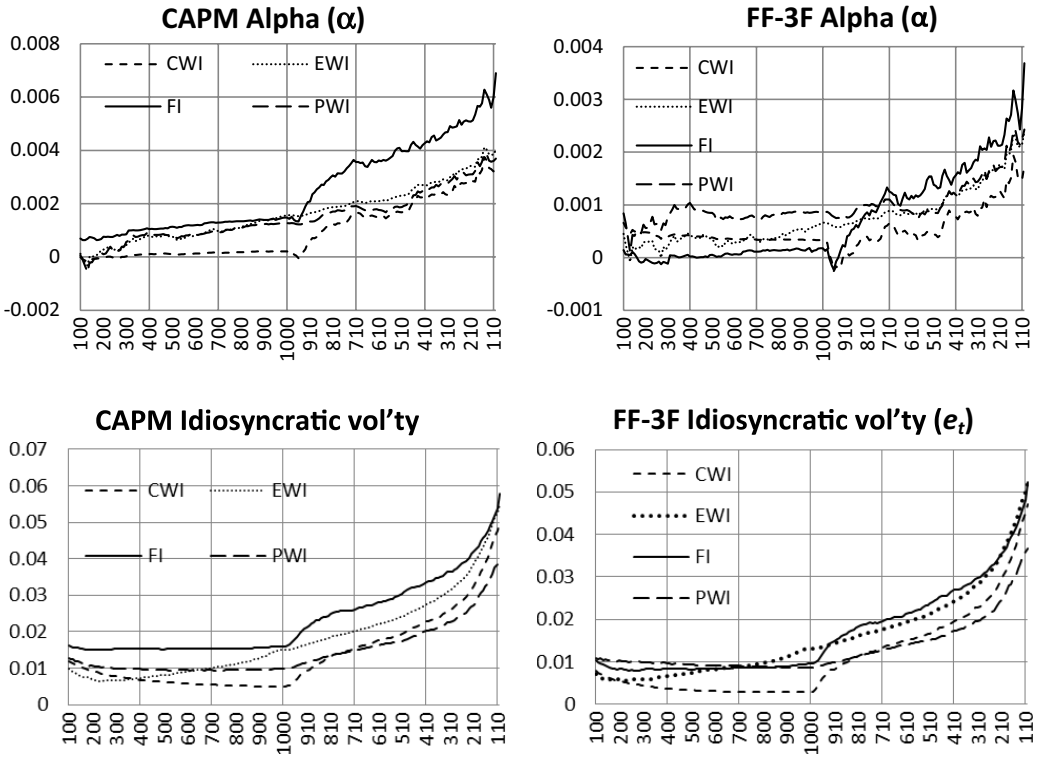

Figure 4 Performance comparisons for indexation strategies (PI, EWI, CWI, PWI) as a function of portfolio firm size, 1987–2010.

Stage three: *Stock mispricing and size and value effects*

The first graph in Figure 5 displays the *Return Spread*—the average cross-sectional standard deviation of individual stock returns in each indexation strategy (weighted consistent with the index strategy)—for each of the B/M portfolios. The adjacent graph displays the *CAPM Idiosyn'ic vol'ty*—the standard deviation of the portfolio error term e_t from the CAPM regression through time (Equation (1)), which is to say, the idiosyncratic or non-market volatility of the portfolio through time. Panel B reports the outcomes for *Return Spread* and *CAPM Idiosyn'ic vol'ty* for the portfolios on firm size. It is noteworthy that portfolios of either very high or very low B/M tend to have high stock volatilities, which, again, would appear to be unaccountable in relation to B/M as a risk proxy, but conforms with the interpretation of high (low) B/M as capturing stocks that are more highly under- (over-)priced. Similarly, the adjacent graphs *CAPM Idiosyn'ic vol'ty* display how the standard deviation of the portfolio error term from the CAPM regression through time, which is to say, the idiosyncratic or non-market volatility of the portfolio through time, is again higher for portfolios of both very high and low B/M. In a similar manner Panel B displays the performances for portfolios formed on firm size (from low firm size to high). For stocks of small firm size, the graphs reveal a similar story as for B/M.

We seek to control for B/M and firm size by categorizing stocks in 5 × 5 portfolios on the interaction of the book-to-market and firm size of stocks. The portfolios are constructed by categorizing the stocks in the Russell 1000 Index into

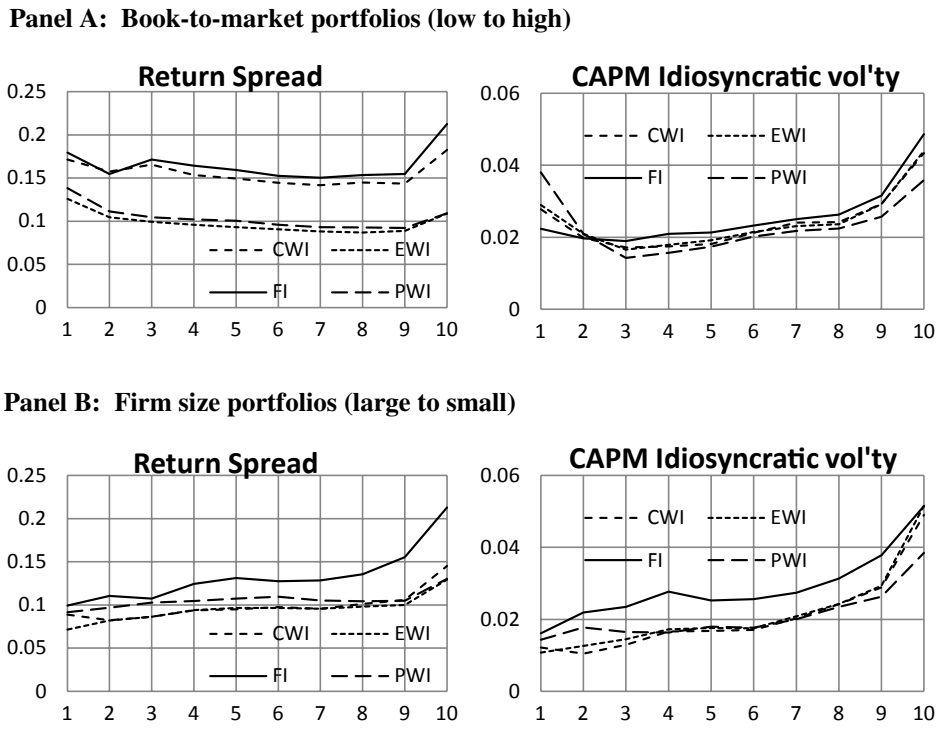

Figure 5 Volatility comparisons for indexation strategies (PI, EWI, CWI, PWI) as a function of (i) firm book-to-market and (ii) firm capitalization.

In panel A, the dectile classifications on the *x*-axis are for portfolios with stocks of lowest book-to-market (portfolio 1) to stocks of highest book-to-market ratio (portfolio 10), and for panel B, the *x*-axis is for portfolios with stocks of largest firm capitalization (portfolio 1) to stocks of smallest firm capitalization (portfolio 10). The sample period is 1987–2010. Return Spread is the cross-sectional standard deviation of stock returns within the portfolio; CAPM Idiosyncratic vol'ty is idiosyncratic volatility as the mean square error, which is the standard deviation, of the portfolio error term e_t in the CAPM regression in Equation (1).

five groups based on book-to-market ratio (BM). Thereafter, stocks from each of the five groups are categorized into five sub-groups based on stock size.

The stocks in each sub-group are weighted based on FI and CWI to allow the calculation of performance indicators. Panel A of Table 1 shows the performance of FI portfolios, Panel B shows the performance of CWI portfolios, and Panel C directly compares the performance between FI and CWI portfolios. A positive figure in Panel C indicates that the FI portfolio produces a higher arithmetic mean return than the corresponding CWI portfolio.

To the extent that FI represents essentially a tilt to either stocks of high B/M or small firm size, FI portfolios should not be able to systematically outperform CWI when we control for these factors. Table 1 is therefore noteworthy. Not only are the differences generally positive for FI (FI outperforms CWI in 20 out of the 25 portfolios, and in only one portfolio does it under perform by more than 2.5%), emphasizing the ability of FI portfolios to outperform controlling for B/M and firm size, but when we focus on differences greater than 6% as in Panel C, we observe the striking outperformance of FI for *both* very high and very low B/M values (i.e., columns 1 and 5) as well as for a combination of small

Table 1 Arithmetic mean returns for the 5 × 5 matrix portfolios, controlling for book-to-market and market capitalization.

	High BM				Low BM
Panel A: Fundamental indexed portfolios					
Large stocks	1.1	1.0	0.9	0.95	0.8
	1.7	1.0	1.0	0.7	0.8
	1.6	1.0	0.9	0.8	1.1
	1.7	1.2	0.9	0.9	0.95
Small stocks	2.3	1.3	0.95	1.0	1.0
Panel B: Capital-weighted portfolios					
Large stocks	0.95	0.95	0.85	0.9	0.8
	1.4	1.0	0.9	0.8	0.75
	1.4	1.0	0.8	0.8	1.1
	1.7	1.2	0.8	0.9	0.9
Small stocks	2.1	1.3	0.9	0.8	0.8
Panel C: Percentage differences between Panels A and B					
Large stocks	18.5%	7.0%	—	—	—
	20.5%	—	—	—	8.0%
	11.5%	—	9.0%	—	10.2%
	—	—	8.0%	—	10.9%
Small stocks	9.7%	—	—	30.0%	21.9%

We control for B/M and firm size by categorizing stocks in 5 × 5 portfolios on the interaction of the book-to-market and firm size of stocks. For each month, 25 groups are created, with approximately 40 stocks in each group. The groups and sub-groups are both sorted in descending order. We construct portfolios by weighting the stocks in each sub-group based on FI and CWI. Panel A reports the arithmetic mean returns when portfolio stocks are weighted based on FI. Panel B reports the arithmetic mean returns when portfolio stocks are weighted based on CWI. Panel C reports the percentage differences between the arithmetic mean returns reported in Panels A and B. For clarity, percentage changes less than 6% have been omitted in Panel C.

firm size and low B/M (5th row, 4th column). These are the portfolios that are assumed to be most mispriced. Thus, the evidence supports the conjecture of mispricing rather than investor risk awareness.

4 Conclusion

This paper has provided evidence that FI's outperformance is linked to its ability to exploit stock mispricing, while confirming a close linkage between FI portfolio returns and the FF-3F model. However, rather than confirming that FI represents a repackaging of the FF-3F book-to-market and firm size factors, the weight of our evidence supports the interpretation that these factors are themselves the outcome of stock mispricing.

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