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NBIM DISCUSSION NOTE

A Survey of the Small-firm Effect

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The small-firm effect (SFE) refers to the long-term average excess returns that a portfolio of small-capitalisation stocks earns over a portfolio of large-capitalisation stocks. In this note, we review the extensive empirical evidence on the SFE and the various theoretical explanations that researchers have put forward for the effect.

Summary

- The outperformance of small-cap stocks over large-cap stocks is a well-documented observation in financial research. In the US, small-cap stocks outperformed large-cap stocks by three percent per annum over the period 1927-2011. Global small-cap stocks also tend to outperform global large-cap stocks over long time horizons. The positive relationship between firm size and stock returns is non-linear across firm size and is strongest for the smallest firms in the sample.

- The SFE varies significantly over time. Historically, the SFE has gone through periods of continued out- and underperformance. Most notably, in the two decades after 1981, the year when the SFE was first documented, small firms underperformed large firms in both the US and the UK. More recent evidence points towards a reversal of this trend. Due to the high riskiness of the SFE, an investment strategy attempting to exploit the effect may only pay off over relatively long periods of time.

- The SFE appears to vary with the stocks' book-to-market ratio. The effect is strong and positive for the stocks with relatively high book-to-market (value) and weak and even negative for the stocks with low book-to-market (growth). Unlike the SFE for growth stocks, the SFE for value and neutral stocks has persisted after 1981. In absolute terms, small growth stocks have been among the worst performers in the past three decades.

- The SFE in the US tends to concentrate in January. A popular explanation for this observed seasonality is the tax-selling hypothesis, the proposition that some investors sell securities at year-end to establish capital losses for income tax purposes, thereby putting downward pressure on security prices. Small-cap stocks, which are typically stocks that have recently diminished in market value, tend to be the first stocks to be sold. Alternative explanations include the window-dressing hypothesis, the proposition that institutional investors sell "loser" stocks at quarter-end to improve the appearance of their portfolios.

- The outperformance of small-cap stocks cannot be attributed solely to market risk. The CAPM's failure to explain the SFE and the related value effect has triggered an ongoing debate regarding the nature of these stock market regularities. Research suggests that the SFE may be (1) a proxy

for a non-diversifiable risk factor such as cash flow risk, business cycle risk or liquidity risk; (2) a statistical artefact resulting from measurement errors, data mining and various methodological biases; and (3) a result of irrational investor biases.

- Estimates of the SFE may be plagued by statistical inference biases arising from "data snooping" and from performing tests on pre-sorted portfolios. Some empirical evidence also suggests that the riskiness of small-cap stocks may be biased downward due to serial correlation in small-cap returns, while estimates of average small-cap returns may be biased upward due to a type of survivorship bias in commonly used data samples. Statistical issues, however, cannot fully explain the observed SFE in the data.

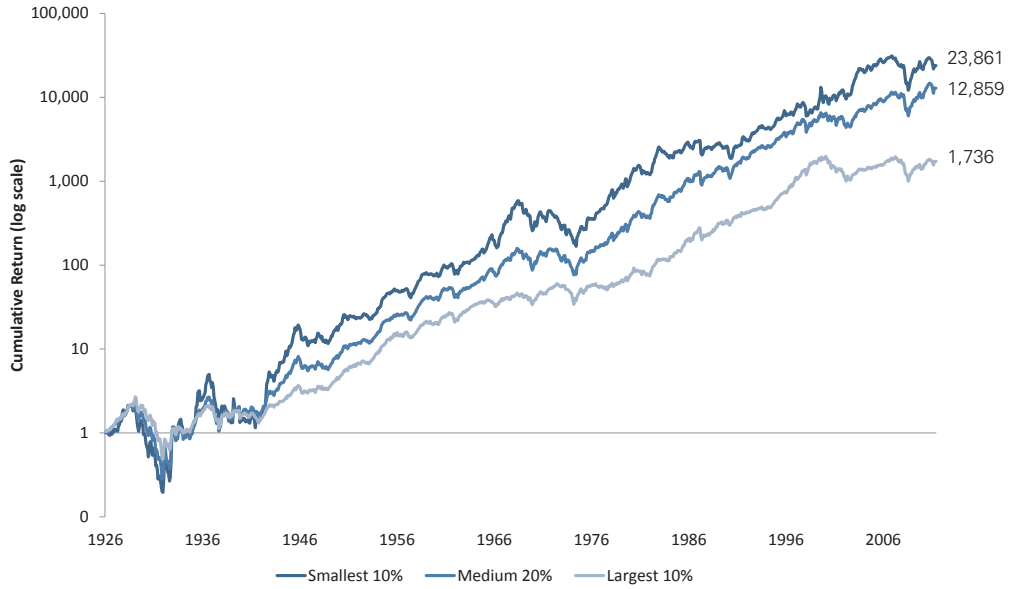
- Proponents of behavioural finance suggest that the SFE may be explained by investor biases. The SFE may represent market correction to an investor reaction that creates "losers" (stocks with low recent returns, typically small-cap stocks) and "winners" (stocks with high recent returns, typically large-cap stocks). Another theory holds that investors tend to overvalue small-cap stocks compared to large-cap stocks when investors are particularly bullish and undervalue them when they are bearish.

- Proponents of rational expectations favour risk-based explanations for the SFE. Firm size is viewed as a proxy for some non-diversifiable source of risk that drives the cross-section of expected returns. Some evidence suggests potential links between firm size and cash flow, bankruptcy and distress risk, as well as between size and various macroeconomic variables. Another theory holds that the lower liquidity of small-cap stocks is a source of risk leading to higher returns, and that temporal shifts toward greater liquidity in small-cap equity markets during the 1980s may account for the weak SFE between 1980 and 2000.

1. Introduction

In this note, we review the empirical evidence and theoretical explanations concerning one of the oldest empirical challenges to the Sharpe-Lintner-Black asset pricing model, the small-firm effect (SFE). The SFE refers to the empirical observation that stocks of small firms tend to outperform those of larger firms over the long run and that this outperformance cannot be attributed solely to differences in market risk. Chart 1 below shows the long-term performance since 1926 of the smallest ten percent of US stocks by market capitalisation (small-cap stocks), the middle 20 percent (mid-cap) and the largest ten percent (large-cap). A dollar invested in the smallest decile of stocks generated a return that is almost 14 times larger than the return on a dollar invested in the largest decile of stocks.

Chart 1: Cumulative performance of US small-, mid- and large-cap stocks (1926-2011)



Source: Kenneth French Data Library; NBIM calculations

The SFE first came to prominence in the US, where Rolf Banz (1981) showed that the smallest companies quoted on the New York Stock Exchange (NYSE) had provided the highest long-term returns from 1936 to the late 1970s in both absolute and market-risk-adjusted terms. Since 1981, the SFE has become one of the most prominent and well-researched regularities in stock market returns. A plethora of academic papers have attempted to extend and clarify the early findings, as well as to provide theoretical justifications for the observed patterns in small-firm returns. A forthcoming survey article on the SFE in the *Journal of Banking and Finance* lists nearly 100 peer-reviewed journal articles on the topic (van Dijk 2011).

The thinking about the SFE has changed dramatically over the past 30 years. Early research often referred to the SFE as a market anomaly because the excess returns on small-cap stocks could not be explained by the single-factor capital asset pricing model (CAPM), in which the asset's covariance with the market portfolio is the only relevant measure of risk. In a series of seminal papers, Fama and French (1992, 1993, 1996) advanced the theory that the SFE did not constitute an anomaly, but rather reflected the higher systematic risk of small-cap stocks. Small firms tended to carry higher distress risk than larger firms. Because of this additional source of risk, a factor based on firm size, along with factors based on the firm's book-to-market and the market portfolio, could better explain the cross-sectional variation in stock returns. Empirical support for the higher riskiness of small-cap stocks, however, proved to be mixed. Alternative theories emerged claiming that the SFE may be a result of data mining (Lo and MacKinlay 1990); seasonal tax effects (Keim 1983); transaction costs (Stoll and Whaley 1983); and relative illiquidity (Acharya and Pedersen 2005) among others. Yet another strand of research, behavioural finance, suggests that the SFE is consistent with investors being susceptible to certain irrational biases. The debate is still ongoing.

Since the 1990s, research on the SFE has been further complicated by the fact that the effect has largely diminished after it was first observed in 1981. Throughout the 1980s and the 1990s, small-cap stocks fared poorly relative to large-cap stocks, prompting a number of researchers and market observers to pronounce the SFE dead. However, as van Dijk (2011) argues, this may be a premature conclusion. The SFE had gone through long periods of underperformance even before 1980. Moreover, the effect reasserted itself after 2000 with small-cap stocks posting some of the highest returns in the post-2001 bull market. The strong variability of the SFE over time makes it difficult to establish whether the average SFE today is larger or smaller than it used to be even after decades of underperformance (van Dijk 2011).

In this note, we outline the main evidence on the SFE with a particular focus on the question of whether the SFE constitutes a systematic risk premium that a long-term investor may be able to capture. To this end, we (1) examine the extensive empirical evidence on the SFE; (2) describe the key characteristics of the SFE, including its persistence across equity markets, variability over time, seasonality and non-linearity across firm size and fundamental valuation; and (3) outline the various statistical, risk-based, behavioural and other explanations that have been put forward for its existence. Finally, we derive conclusions about the risk/return profile of the SFE and its place in a long-term investor's investment strategy. A number of issues that are important to investing in small-cap stocks are not addressed here. These issues include the investment capacity of global small-cap strategies and the large transaction costs inherent in trading small-cap stocks.

2. Empirical evidence on the SFE

In this section, we discuss alternative measures of the SFE and summarise the empirical evidence on the SFE both in the US, where the effect was first documented, and in global equity markets. The literature uses two principal methods of measuring the effect: (1) cross-sectional regressions to estimate the excess returns on a portfolio of small-cap stocks relative to the return predicted by a pre-specified asset pricing model such as CAPM; and (2) sorting stocks into size groups by market capitalisation and looking at the performance of portfolios that are long the small-cap stocks and short the large-cap stocks. The first method explicitly controls for potential differences in market risk between small- and large-cap stocks, whereas the second approach provides a simple and intuitive measure of the SFE that could also be used to construct investable strategies. We rely primarily on the second approach to illustrate the SFE's behaviour over time and its main empirical characteristics in Sections 2(c) and 2(f).

a. The SFE as a CAPM anomaly

Like many other stock return patterns, the SFE was discovered from testing empirically the capital asset pricing model of Sharpe (1964), Lintner (1965) and Black (1972). The CAPM postulates that the market portfolio of invested wealth is mean-variance-efficient, implying a linear relationship between the expected return on a financial asset and the asset's covariance with the market portfolio (β). In equilibrium, the asset's beta is the only factor that matters for pricing assets. According to this model, the asset's beta is the only relevant measure of risk and a sufficient variable to explain the cross-sectional variation in expected returns. From the familiar CAPM equation, the abnormal return on a portfolio of small-cap stocks is measured by Jensen's (1968) α_i:

$$\alpha_i := R_{it} - R^F_{it} - \beta_i (R^M_{it} - R^F_{it})$$

where:

R_{it} = return on a portfolio of small-cap stocks

R^F_{it} = the risk-free rate, typically proxied by the yield on Treasury bills

R^M_{it} = return on the market portfolio, typically proxied by a broad equity index

Using stock return data from 1936 to 1975 for a sample of NYSE-listed US stocks, Banz (1981) finds statistically significant abnormal returns of five percent per annum for the smallest 20 percent of

stocks by market capitalisation. The result is robust to the choice of market portfolio proxy, including market-cap- and equally-weighted equity indices and an index that includes government and corporate bonds. Even more dramatically, stocks of the smallest firms in the sample are found to outperform the largest ones by 19.8 percent per annum over the same period. Results of Fama-MacBeth regressions suggest a significant inverse relationship between stock returns and firm size. Banz concludes that firm size is likely an important pricing factor for equities, but does not offer any theoretical arguments whether the factor is size itself or some other state variable that is correlated with size.

A series of subsequent studies in the 1980s confirmed Banz's result using alternative data samples. Based on data for 566 NYSE and AMEX stocks between 1963 and 1977, Reinganum (1981) finds that stocks in the bottom decile by market capitalisation outperform the largest decile of stocks by 23.4 percent per annum. Moreover, Reinganum finds that the SFE accounts for nearly all of Basu's (1977) value effect, the empirical observation that high earnings-to-price (value) stocks tend to outperform low earnings-to-price (growth) stocks. Using Reinganum's dataset but an alternative estimation methodology, Brown, Kleidon and Marsh (1983) find a statistically significant negative relationship between log market capitalisation and stock returns in the cross-section of returns. Lamoureaux and Sanger (1989) report an SFE of 26.8 percent for the smallest fifth percentile of NASDAQ stocks and 22.4 percent for the smallest fifth percentile of NYSE/AMEX stocks over the period 1973-1985. In summary, all of these early studies of Banz's effect find large and economically significant premia for US small-cap stocks relative to the returns predicted by the CAPM.

Results of studies based on global equity data suggest that the SFE phenomenon is not unique to the US equity market. Annaert, Van Holle, Crombez and Spinel (2004) find a significant SFE of 1.5 percent per month in a sample of 2,866 European stocks between 1974 and 2000. This effect is found to be significant in explaining the cross-sectional variation in equity returns for the aggregate European market. Using data on 1,420 listed shares on the London Stock Exchange and a variety of econometric techniques, Leledakis, Davidson and Smith (2004) find a statistically significant SFE in the UK market. Similarly, studies by Beedles (1992) for Australian stocks between 1974 and 1987, Stehle (1997) for German stocks between 1954 and 1990, and Rouwenhorst (1999) for emerging-market stocks between 1975 and 1997 find large and economically significant small-cap premia. While some of the studies on the global SFE may be affected by survivorship and small sample biases, the SFE appears to be pervasive and consistent across countries.

The magnitude of the SFE found in the 1980s meant that the SFE became rapidly recognised as one of the pre-eminent stock market anomalies of the day. Throughout the 1980s and 1990s, many other peculiar patterns in average stock returns were uncovered. Most notably, ranking securities on variables such as book-to-market (Rosenberg, Reid and Lanstein 1985), price momentum (Jagadeesh and Titman 1993), leverage (Bhandari 1988) and dividend yield (Fama and French 1988) was observed to generate returns in excess of those predicted by the CAPM. The mounting evidence against the empirical validity of the CAPM suggested that these regularities may not necessarily constitute pricing anomalies but rather be an artefact of inadequate risk models. As Fama (1970) had noted, any test of market efficiency also jointly tests a maintained hypothesis about equilibrium asset returns. Thus, whenever someone discovers an abnormal pattern in asset returns – a finding that seemingly indicates market inefficiency – it may also indicate that the underlying asset pricing model is inadequate.

In a breakthrough study, Fama and French (1992) rejected the adequacy of the CAPM and showed that firm size and book-to-market equity provided a powerful characterisation of the cross-section of stock returns. Consistent with the earlier studies, Fama and French find that small-cap stocks outperform large in a sample of stocks listed on the NYSE, AMEX and NASDAQ between 1963 and 1990. When stock portfolios are sorted by size alone, there appears to be a positive relationship between firm size and CAPM betas. The CAPM betas of size portfolios, however, are almost perfectly correlated with size, so tests on size portfolios alone are insufficient to disentangle the effects of beta and firm size on average returns. When Fama and French sort the stocks by market beta within each size portfolio, they find no relation between average returns and beta, but a strong relation between average returns and size. These findings suggest that firm size may be a priced risk factor for stocks in addition to the market factor.

b. Mimicking portfolios as a measure of the SFE

To measure the magnitude of the SFE and the value effect (the observed outperformance of high book-to-market stocks relative to low book-to-market stocks), Fama and French (1993) construct two factor-mimicking portfolios based on book-to-market and firm size. At the end of June of each year starting in 1926, the CRSP universe of US stocks is sorted based on each stock's market capitalisation (size) and book-to-market.[1] The ranking based on book-to-market defines three sub-universes of stocks: the 30 percent of stocks with the highest book-to-market (value stocks), the 30 percent with the lowest book-to-market (growth stocks) and the remaining 40 percent (neutral). A long-short portfolio mimicking the small-cap premium (called "small minus big", or SMB) is then constructed by going long the smallest 30 percent of stocks and going short the largest 30 percent of stocks in each of the three book-to-market universes. The long and short positions are weighted equally across valuation buckets. The value factor ("high minus low", or HML) is constructed analogously. Fama and French use double sorts across size and valuation in order to reduce any value bias in the small-cap factor and any small-cap bias in the value factor.

In addition to an SMB factor for US stocks, Fama and French construct small-cap factors for Europe, Japan, Asia Pacific ex Japan, and North America, as well as a global aggregate factor for the developed world. The construction methodology is similar, but the breakpoints for small and large stocks are different. Large-cap stocks are those in the top 90 percent of June market cap sorts for each region, and small-cap stocks are those in the bottom ten percent. For the global portfolio, Fama and French use global size breakpoints and region-specific book-to-market breakpoints to allocate the stocks of these regions to the global portfolio. The SMB is again defined as an equally weighted long position in the small-cap stocks and an equally weighted short position in the large-cap stocks in the three book-to-market buckets (value, growth and neutral).

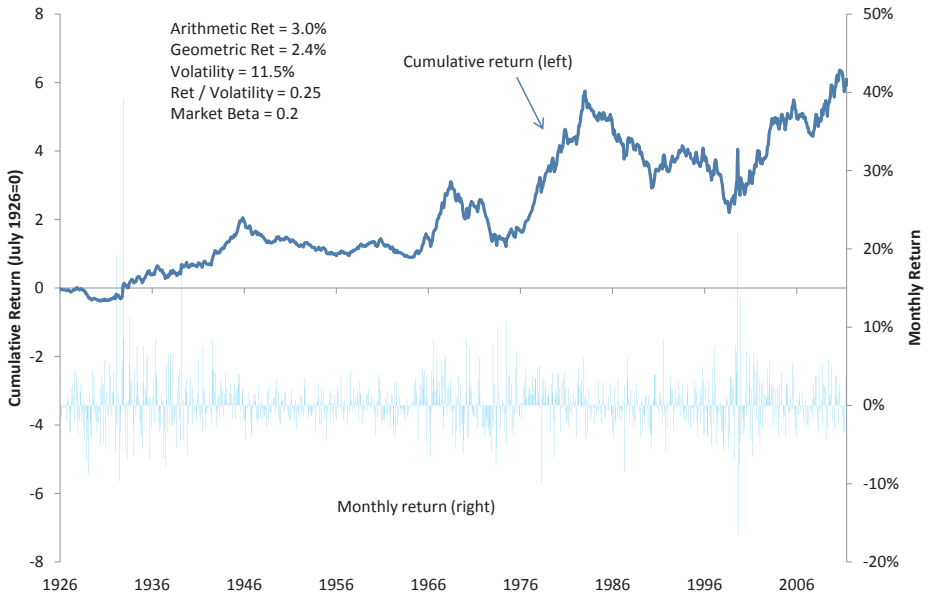
Much of the research on the SFE since the early 1990s has used the Fama-French SMB or similarly constructed size factors. The SMB, however, is a theoretical construct whose returns are almost impossible to replicate in practice. Fama-French's universe of stocks consists of effectively all stocks in the market, some of which may be in extreme distress or practically impossible to trade. Transaction costs and trading restrictions faced by many investment managers are not taken into account in constructing the SMB (Huij and Verbeek 2007). Moreover, the SMB factor does not control for any industry tilts resulting from the value and size sorts, which may be substantial if certain industries tend to consist predominantly of small companies or companies with a high book-to-market. Commercial index providers such as FTSE, MSCI and Russell have attempted to address some of these practical issues by designing investable factor-mimicking portfolios that take into consideration the portfolio's liquidity, turnover and inadvertent industry tilts.[2]

Chart 2 below summarises the performance of the Fama-French theoretical SMB factor for the US from 1926 through to the present. The average return on the SMB is three percent per annum, confirming that US small-cap stocks have outperformed large-cap stocks on average over the long term. Capturing the small-cap premium, however, entails substantial risk, as suggested by the factor's volatility of 11.5 percent per annum. The performance of the factor is also strongly time-varying and exhibits long periods of positive and negative performance. Most notably, the SMB performed exceptionally well from 1975 to 1980 (cumulative return = 125 percent) and poorly between 1981 and 2000 (cumulative return = -26 percent). Over its entire history, the SMB has generated a risk-adjusted return of 0.25 with a relatively low but positive exposure to market risk (market beta = 0.20).

1 The Center for Research in Security Prices (CRSP) database provides daily and monthly market and corporate action data for securities with primary listings on the NYSE, NYSE MKT (AMEX), NASDAQ and Arca exchanges and include CRSP broad market indices. Data cover the period 1926 to the present.

2 For a more thorough discussion of constructing factor-mimicking portfolios, see NBIM Discussion Note 8-2012 "Capturing Systematic Risk Premia" of 30 March 2012.

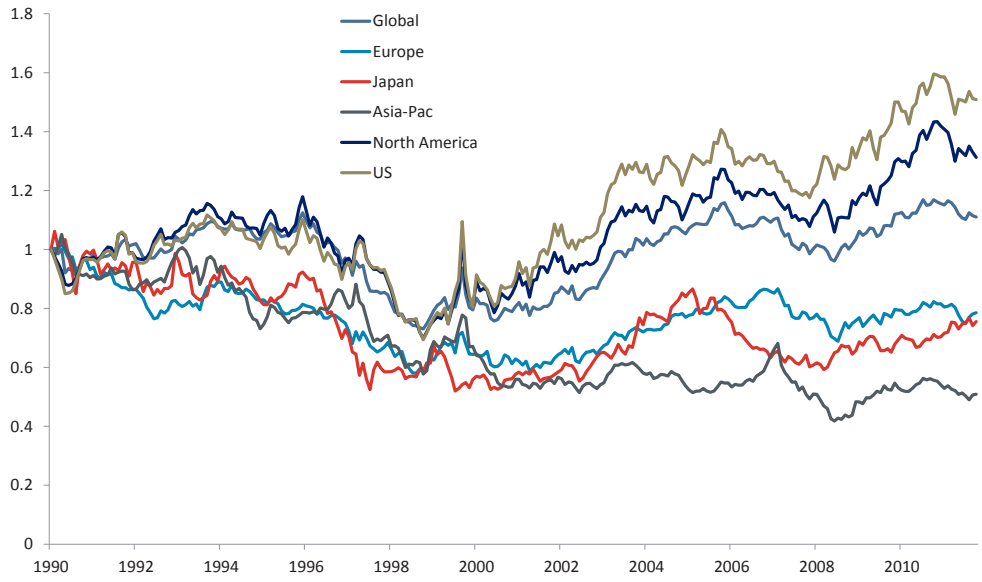
Chart 2: Performance of the US SMB factor (1926-2011)



Source: Kenneth French Data Library, NBIM calculations

Over the period 1990-2011 for which data on global SMB factors are available, the US SMB factor outperformed those in other developed markets. As Chart 3 shows, the cumulative performance of the US SMB was 51 percent, compared to -49 percent in Asia Pacific ex Japan, -24 percent in Japan and -21 percent in Europe. Except in North America, small-cap stocks fared poorly relative to large-cap stocks over the period. The differential performance of small-cap stocks across regions was particularly prominent in the 2001-2010 period, as evidenced by the decoupling of the five SMB series after 2001.

Chart 3: Performance of global SMB factors (1990-2011)



Source: Kenneth French Data Library, NBIM calculations

Table 1 below summarises the risk/return profiles of the Fama-French SMB factors for the five regions as well as those of factors based on the MSCI World style indices. The period covered is 1997 to March

2012 due to MSCI data availability. The MSCI SMB factor for each region represents the difference in returns between a long position in the regional MSCI small-cap index and a short position in the corresponding MSCI large-cap index. The results show important differences in performance and risk across regions. US small-cap stocks performed best over this period in both absolute and risk-adjusted terms. The SMB factors in Asia and Japan had negative exposure to market risk as measured by their betas to the global MSCI World portfolio. Moreover, the MSCI style portfolios generated significantly higher Ret/Vol ratios over this particular period, highlighting the importance of the choice of portfolio construction methodology.

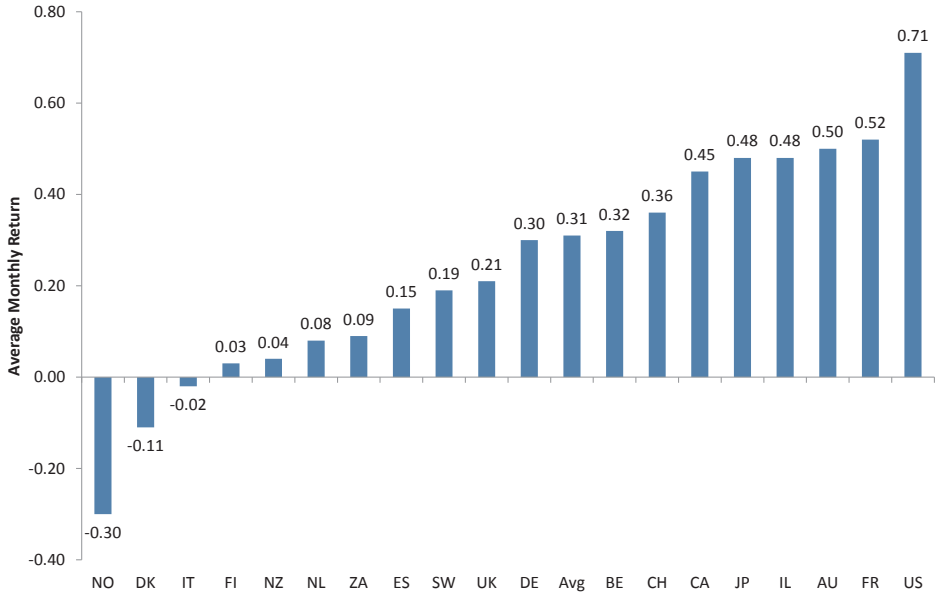
Table 1: Small-cap premiums in different regions (1997 to March 2012)

	Ret	Vol	Ret/Vol	Beta
Theoretical Benchmarks (Fama-French)				
United States	4,2%	13,1%	0,32	0,20
Global	3,0%	8,0%	0,37	-0,02
North America	3,6%	12,1%	0,30	0,20
Europe	2,3%	8,6%	0,26	-0,11
Japan	3,2%	11,6%	0,28	-0,17
Pacific ex Japan	-0,6%	11,2%	-0,05	0,04
MSCI Style Indices (Large cap minus Small cap)				
United States	5,7%	31,8%	0,18	0,19
Global	6,0%	9,2%	0,65	0,08
North America	3,0%	13,4%	0,22	0,18
Europe	-2,3%	9,8%	-0,23	0,06
Japan	-4,1%	15,2%	-0,27	-0,19
Pacific ex Japan	-5,4%	11,1%	-0,49	0,13

Source: FactSet; NBIM calculations

Over longer time horizons, the SFE tends to be positive for the majority of developed countries. Chart 4 below, taken from the Credit Suisse Global Investment Returns Sourcebook 2012, compares the average monthly return differential for 19 developed markets based on MSCI equity data. The period covered is the longest possible for each country, ranging from 12 years for Norway to 81 years for the USA. The small-cap premium is positive in 17 of the 19 countries, ranging from -0.30 percent for Norway to 0.71 percent for the USA. The US SFE is again the largest among all countries. The average effect is 0.31 percent per year – positive but significantly smaller than the premia found in the early research literature on the SFE. Overall, these results confirm the pervasiveness of the SFE across countries, but also highlight the variability of the effect across countries and its sensitivity to the time period considered.

Chart 4: Small-cap premiums in 19 countries (periods ending December 2011)



Source: Dimson, Marsh and Staunton, "Credit Suisse Global Investment Return Sourcebook 2012", p. 44.

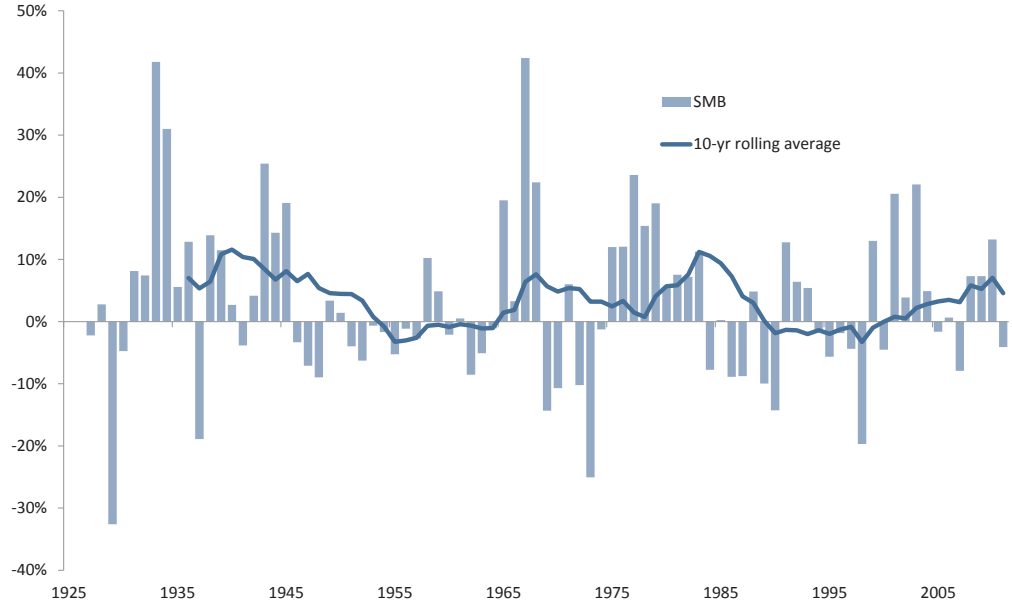
c. The robustness of the SFE over time

As the factor-mimicking portfolios showed, the SFE exhibits large swings in performance. A number of authors have studied the robustness of the SFE over time. Brown, Kleidon and Marsh (1983) demonstrate that the ex-ante excess return attributable to size is highly unstable over time. Based on ten size-sorted portfolios in a sample of 566 NYSE and AMEX stocks, they find that excess risk-adjusted returns and size are positively related over the period 1967-79, but that the magnitude and sign of the relationship are not constant. They measure an annualised small-firm excess return of -7.0 percent for 1967-1975 and 37.3 percent for 1976-1979. Results of econometric tests reject the hypothesis that the SFE is stable over time, implying that estimates of the SFE are highly sensitive to the time period studied.

Studies written in the late 1990s and early 2000s find that the SFE largely diminished after 1981. Dichev (1998) shows that the SFE was virtually non-existent in US equity markets during the period 1981 to 1998. The difference in monthly returns between small-cap and large-cap stock portfolios is negative for both samples of stocks traded on the NYSE/AMEX and stocks traded on NASDAQ. Results of Fama-MacBeth cross-sectional regressions that relate stock returns to the probability of bankruptcy of a firm, the firm's market value, and the firm's book-to-market indicate no statistically significant relationship between stock returns and firm size. Similarly, Chan, Karceski and Lakonishok (2000) find no sizable SFE in US equity market data for the period 1984-1998. In a comprehensive study of the SFE, Horowitz, Loughran and Savin (2000) report no consistent relationship between size and realised returns over the period 1980-1996 using three alternative methodologies. Based on a comprehensive sample of all NYSE, AMEX and NASDAQ firms listed on the CRSP daily tapes from 1980 to 1996, the authors show that (1) the smallest decile of stocks by market capitalisation underperformed the largest decile of stocks by 1.18 percent on average; (2) there is no statistically significant relationship between realised stock returns and log market capitalisation; and (3) linear spline analysis indicates no significant relationship between firm size and expected stock returns.

Chart 5 below shows the performance of the Fama-French SMB factor in every year from 1927 to 2011. The SMB is positive in 47 of the 85 years considered. It is especially large in the early 1930s, the early 1940s, the late 1970s and most recently between 2001 and 2005. Small-cap stocks, however, significantly underperformed large-cap stocks over the periods 1968-1974, 1984-1990 and 1994-1998. As suggested by the ten-year rolling average line, the average SFE decreased after its discovery in 1981 before reversing its course after 2000.

Chart 5: Annual SMB return over time (1927-2011)



Source: Kenneth French data library; NBIM calculations

Pekkala (2005) notes that the SFE was particularly large during the period 1975-1980. We illustrate this result by reporting in Table 2 summary statistics for the US SMB and the market portfolio as measured by the CRSP market-value-weighted index over the full sample 1927-2011 and over three non-overlapping sub-samples: 1926-1974, 1975-1980 and 1981-2011. As shown in Panel A, while small-cap stocks outperformed large-cap stocks by 3.0 percent per year between 1927 and 2011 (t-stat = 2.4), the level of outperformance varied substantially from period to period. The SFE was large prior to 1974, extremely large between 1975 and 1980, and significantly smaller after 1980. Although the overall stock market also did particularly well during the 1975-1980 period, we observe no significant difference in the average market return prior to 1974 and after 1980. Furthermore, the SFE appears to perform particularly well during periods of economic expansion. As shown in Panels B and C, the SFE averaged -0.4 percent during economic contractions and 3.8 percent during economic expansions. We discuss the potential association between the SFE and various macroeconomic factors in Section 3(b).

Table 2: Summary statistics for the SMB and the market portfolio

Panel A: All years

	1926-2011		1926-1974		1975-1980		1981-2011	
	SMB	Market	SMB	Market	SMB	Market	SMB	Market
Mean Return	3,0%	10,9%	2,4%	9,7%	14,1%	20,0%	1,7%	11,0%
Buy and Hold Return	2,4%	9,5%	1,8%	7,8%	14,4%	20,4%	1,1%	10,2%
Volatility	11,5%	18,9%	12,0%	20,9%	10,1%	16,2%	10,9%	15,9%
t-stat for Mean Ret	2,38	5,33	1,41	3,23	3,40	3,02	0,85	3,86

Panel B: NBER Recessions

	1926-2011		1926-1974		1975-1980		1981-2011	
	SMB	Market	SMB	Market	SMB	Market	SMB	Market
Mean Return	-0,4%	-3,1%	-3,6%	-6,1%	20,4%	47,5%	4,7%	-4,4%
Buy and Hold Return	-1,0%	-6,8%	-4,2%	-10,1%	21,2%	55,7%	4,2%	-6,6%
Volatility	11,9%	28,0%	12,1%	30,0%	15,4%	23,1%	10,3%	22,1%
t-stat for Mean Ret	-0,13	-0,47	-1,04	-0,72	1,21	1,88	0,96	-0,42

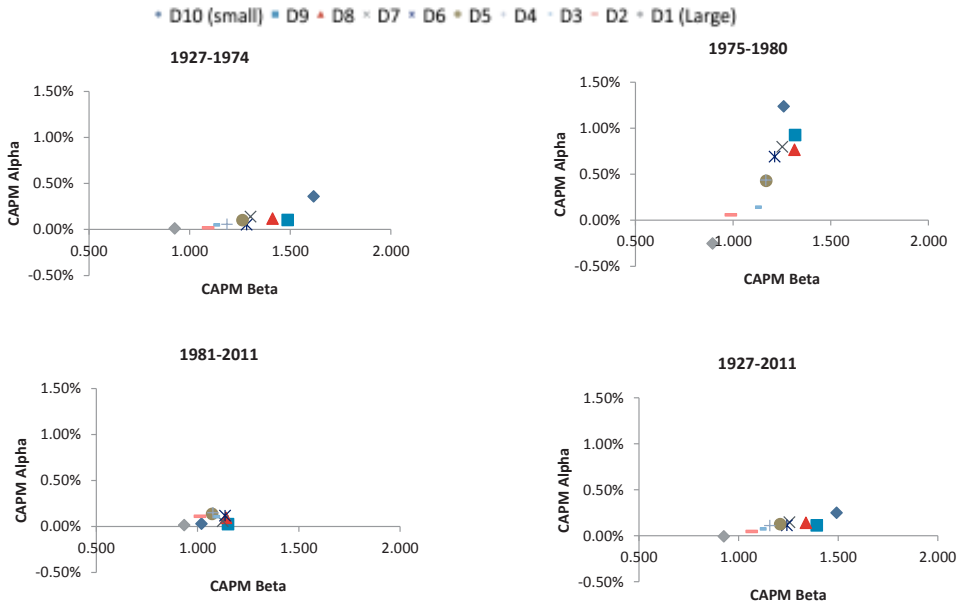
Panel B: NBER Booms

	1926-2011		1926-1974		1975-1980		1981-2011	
	SMB	Market	SMB	Market	SMB	Market	SMB	Market
Mean Return	3,8%	14,6%	4,5%	15,2%	13,0%	15,5%	1,1%	13,7%
Buy and Hold Return	3,3%	14,3%	3,9%	14,8%	13,4%	15,5%	0,6%	13,3%
Volatility	11,4%	15,5%	11,9%	16,4%	9,1%	14,6%	11,0%	14,5%
t-stat for Mean Ret	2,77	7,72	2,27	5,54	3,24	2,41	0,54	4,83

Source: Pekkala (2005); Kenneth French data library; NBER; NBIM calculations

CAPM-based measures of the SFE also suggest that the SFE attenuated after 1981. Similar to Pekkala's Figure 1, we estimate CAPM alphas and betas for the ten size-sorted portfolios in the CRSP universe over the three non-overlapping subsamples in Table 2. Chart 6 below provides scatter plots of the CAPM alpha vs beta estimates. CAPM betas tend to be correlated with size in all time periods. In the 1927-1974 subsample, the smallest-decile portfolio has a positive CAPM alpha, whereas the larger-firm stocks earn returns that are largely consistent with the CAPM. Over the period 1975-1980, however, we observe a strong SFE for all size-sorted portfolios, as indicated by the strong positive relationship between CAPM alphas and betas. Small-firm alphas are especially large during this period, exceeding one percent per month for the smallest-decile portfolio. After 1980, no statistically significant abnormal returns for small stocks are observed.

Chart 6: The evolution of the SFE – CAPM alphas vs CAPM betas



Source: Pekkala (2005); Kenneth French data library; NBER; NBIM calculations

Like the US SFE, the SFE in international markets appears to have diminished in recent years. Fama and French (2011) find no statistically significant SFE in any of four regions (North America, Asia Pacific ex Japan, Europe and Japan) based on stock return data from 23 different countries from November 1990 to March 2011. The average SFE in Europe, Asia Pacific and Japan is slightly negative over the period, whereas the average global SFE is 0.1 percent per month and indistinguishable from zero (t-stat = 0.69). Dimson and Marsh (1999) contend that the average SFE in the UK not only diminished but also reversed its course after the early 1980s. They compare the performance of the smallest tenth of UK companies by market capitalisation (the HGSC index) with that of an all-share equity portfolio during the period 1955-1997. The arithmetic average return for the HGSC index was 24.5 percent over the period 1955-1986, compared to 18.3 percent for the all-share portfolio, implying an average SFE of 6.2 percent per annum (t-stat = 2.46). During the following decade, however, the HGSC earned an average return of less than 10.6 percent, compared to 17.1 percent for the all-share portfolio. The negative SFE of 6.5 percent is found to be statistically significant at the 90 percent confidence level.

While admitting that the SFE appears to have diminished since the early 1980s, van Dijk (2011) argues that it is premature to conclude that the SFE has completely disappeared as many others have suggested. Stock returns are noisy, and standard errors around estimates of the SFE are necessarily large, making it difficult to draw conclusions about the true size of the SFE from short samples. And, as the author shows, the average SFE was 11.3 percent per year over the period 2001-2010, indicating a possible reversal in the SFE trend from the prior decade. Moreover, as realised stock returns are only a noisy proxy of expected returns, they can deviate from expected returns for extended periods of time. Thus, the decline in the realised SFE since the 1980s may be only a temporary phenomenon driven by information surprises that made realised returns deviate from expected returns, rather than a true shift in expected returns. It may still be the case that small-cap stocks have higher expected returns going forward (van Dijk 2011).

To test formally whether the SFE declined after 1981 and then reversed its course in 2000, we estimate CAPM equations that include time period dummies and perform a Chow test for structural breaks on the estimated alphas. Results from models based on US monthly returns are reported in Table 3. Overall, the results suggest that the SFE declined after 1981 but reversed its course sharply in 2000. Within the pre-2000 sample, the SFE was lower after 1981 as indicated by the negative coefficient for the post-1981 alpha. The SFE in 1981-2000 averaged -22 bps per month, or 39 bps lower than in 1927-1981. While the coefficient is only marginally statistically significant, the Chow test suggests that 1981 brought a structural break in the data. Similarly, the test indicates a statistically significant break in the SFE in 2000. The SFE turned positive after 2000, as indicated by the positive and statistically significant coefficient for the post-2000 alpha and positive pre- and post-2000 alpha differential. Even

though the SFE was markedly lower in the two decades after 1981, we cannot conclude that the average SFE is necessarily dead as many have argued.

Table 3: Structural breaks in the SFE (US data, 1927-2011)

Pre-2000 (1927-1999)	Estimate	t-stat	Post-1981 (1981-2011)	Estimate	t-stat
Alpha pre-1981	0,17	1,39	Alpha pre-2000	-0,20	-0,96
Alpha post-1981	-0,22	-1,29	Alpha post-2000	0,84	1,82
Difference	-0,39	-1,67	Difference	0,64	1,98
Structural break in 1981?	Yes		*Structural break in 2000?*	No	
Chow test F-statistic	3,73		Chow test F-statistic	3,55	
p-value	0,02		p-value	0,03	

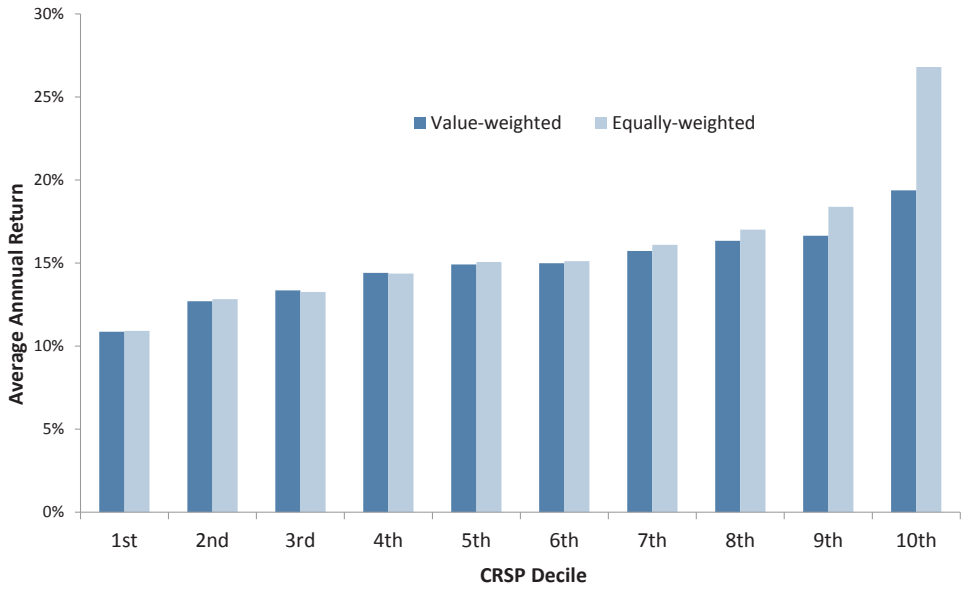
Source: Kenneth French Data Library; NBIM calculations

d. Concentration among the smallest firms

A number of studies find that the SFE is non-linear across firm size and is particularly pronounced for the smallest firms in the sample. As Chart 7 illustrates, stocks in the bottom ten percent of the CRSP universe (stocks with a market capitalisation of 87 million dollars or less as at December 2011) outperform the largest decile of stocks by six percent on average when the stocks are weighted by market cap in each decile. However, the outperformance is almost twice as large when the stocks in the tenth decile are equally weighted. The smallest stocks in this decile earn the highest returns on average. Smaller firms in deciles one to eight, however, do not appear to earn above-average returns. This result suggests that the SFE is not linear across firm size.

A study by Horowitz, Loughran and Savin (2000) finds a statistically significant size effect for US stocks over the period 1963-1997, but no such effect when they remove firms with a market capitalisation of five million dollars or less. Micro-caps appear to be the driving force behind the effect. In a similar vein, Knez and Ready (1997) find no evidence for the SFE after correcting for outliers in the stock return data. Using a robust regression estimator that trims the one percent most extreme observations in the CRSP data series each month, the authors find no significant relationship between stock returns and market capitalisation over the period 1963-1990. Their analysis suggests that the SFE is likely driven by the very small stocks in the sample rather than being a universal small-cap phenomenon.

Chart 7: Performance of portfolios formed on size (1927-2011)



Source: Kenneth French Data Library; NBIM calculations

e. Interaction between the SFE and the value effect

The SFE in the US tends to concentrate not only in the smallest firms in the sample but also in the stocks with relatively high book-to-market ratios (value stocks). Table 4 below reports the average performance of 25 portfolios formed on size and book-to-market over the periods 1926-2011, 1981-2000 and 2001-2011. The portfolios are the intersections of five size portfolios sorted from small- to large-cap stocks and five book-to-market portfolios sorted from low book-to-market (growth) to high book-to-market (value).[3] We also report the CAPM alphas and betas for the five "small" portfolios that represent the smallest 20 percent of firms within each book-to-market quintile.

Over the full sample period from 1926 to 2011, the small value portfolio had the highest average annual return (16.2 percent) and the small growth portfolio had the lowest (0.7 percent). Whereas for value stocks we observe the expected negative relationship between size and stock returns, we observe no such effect for the growth stocks in the sample. In fact, we find a statistically significant negative SFE for growth stocks (alpha=-57 bps per month). The long-term SFE appears to be driven by the value stocks in the sample (the fourth and fifth book-to-market quintiles) as indicated by the positive and statistically significant alphas for these stocks. There is a negative link between the SFE and fundamental company valuation and a negative SFE for the extreme growth stocks in the sample.

Chen and Zhao (2009) argue that the weak SFE in the US after 1981 may be largely attributed to the underperformance of small growth stocks vis-à-vis large growth stocks in the post-1981 period. The authors find no statistically significant SFE for the period 1981-2006. However, when they remove the growth stocks from the sample, they find a positive and significant SFE of 0.27 percent per month. This "no-growth" size premium is comparable to the "no-growth" premium found in the pre-1981 data suggesting that the SFE has remained a persistent phenomenon among value and neutral stocks since 1926. Small value and neutral stocks have continued to generate returns in excess of their beta risk.

We illustrate Chen and Zhao's point in Panels B and C of Table 4. Over the period 1981-2000, we find a negative average annual return for small growth stocks of -0.5 percent and a large and statistically significant alpha of -119 bps per month. In contrast, the alphas for the small value stocks (the fourth and fifth quintiles by book-to-market) are positive and marginally statistically significant. Thus, the weak SFE from 1981 to 2000 was largely driven by the poor performance of small growth stocks over this period.

3 The portfolios were taken from Kenneth French's website http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

During the 2000s, small growth stocks continued to perform poorly. The small growth portfolio generated an average annual return of -1.4 percent (Panel C) and a negative (but not statistically significant) alpha of -21 bps per month. In contrast, small value and neutral stocks generated positive and statistically significant alphas of 57 to 88 bps per month. Moreover, small value and neutral stocks performed well relative to similarly-valued large-cap stocks during this period. In fact, the SFE during this period appears to have been more driven by the poor performance of large-cap stocks than by any exceptional performance of small-caps. Relative to their respective historical averages since 1926, small-caps performed on par or slightly below average; large-caps, on the other hand, performed significantly below average.

Table 4: Interaction between value and size (US data)

Average annual returns for 25 portfolios sorted on size and book-to-market

CAPM regressions for the five book-to-market portfolios within the smallest quintile of stocks (the five "Small" portfolios in the leftmost column)

Panel A: 1926 - 2011

							Alpha		Beta		
	Small →				Big		Est.	t-stat	Est.	t-stat	R-Sqr
Growth	0,7%	6,8%	8,4%	9,7%	9,1%	Growth	-0,57 %	-2,15	1,63	33,74	0,53
↑	7,6%	11,8%	11,9%	10,5%	9,4%	↑	-0,11 %	-0,48	1,46	36,47	0,57
	11,4%	13,6%	13,2%	11,7%	9,7%		0,15 %	0,91	1,38	45,31	0,67
	14,1%	13,8%	13,4%	12,6%	9,4%		0,35 %	2,25	1,30	45,40	0,67
Value	16,2%	14,3%	13,6%	12,0%	11,8%	Value	0,51 %	2,78	1,39	41,39	0,63

Panel B: 1981 - 2000

							Alpha		Beta		
	Small →				Big		Est.	t-stat	Est.	t-stat	R-Sqr
Growth	-0,5%	6,3%	9,7%	13,8%	15,9%	Growth	-1,19 %	-3,39	1,33	16,86	0,54
↑	13,1%	13,1%	16,0%	14,0%	15,4%	↑	-0,05 %	-0,18	1,11	15,95	0,52
	15,9%	17,7%	15,9%	15,8%	14,0%		0,17 %	0,75	0,97	19,16	0,61
	18,5%	18,9%	17,3%	18,0%	16,2%		0,40 %	1,94	0,88	18,81	0,60
Value	18,1%	17,8%	20,7%	19,1%	17,6%	Value	0,39 %	1,85	0,85	17,95	0,58

Panel C: 2001 - 2011

							Alpha		Beta		
	Small →				Big		Est.	t-stat	Est.	t-stat	R-Sqr
Growth	-1,4%	4,2%	4,0%	5,4%	0,8%	Growth	-0,21 %	-0,57	1,40	19,03	0,74
↑	7,7%	8,2%	7,5%	7,2%	4,5%	↑	0,46 %	1,65	1,21	21,19	0,78
	9,3%	10,9%	9,8%	4,9%	2,6%		0,57 %	2,16	1,04	19,65	0,75
	10,8%	8,3%	8,1%	7,1%	1,4%		0,69 %	2,37	0,98	16,56	0,68
Value	12,8%	8,3%	12,5%	4,6%	0,4%	Value	0,88 %	2,61	1,18	17,28	0,70

Source: Kenneth French data library; NBIM calculations

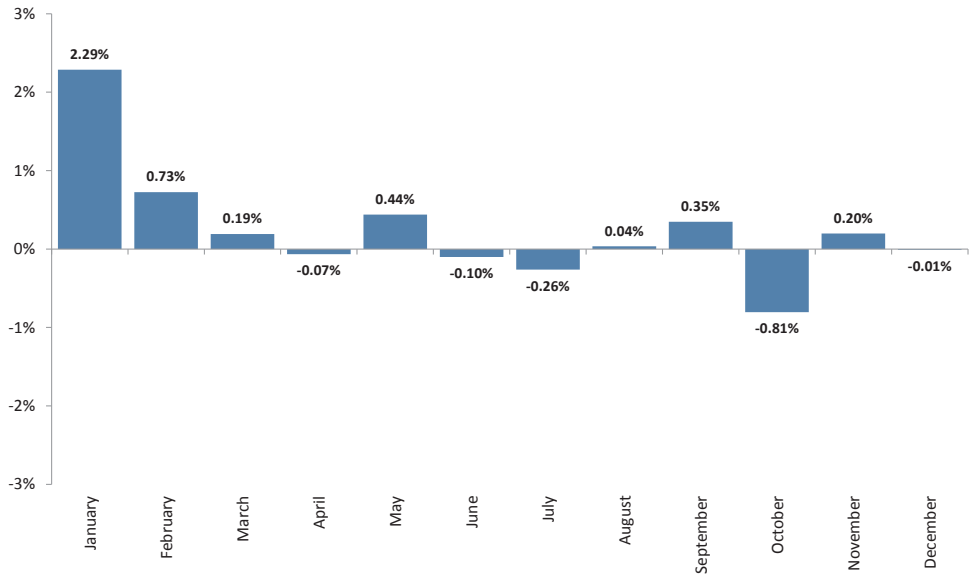
f. Seasonality

The SFE tends to perform extraordinarily well during the month of January in every year, an empirical observation known as the "January effect". Keim (1983) shows that nearly 50 percent of the average SFE (measured relative to the CAPM) over the period 1963-1979 is due to abnormal returns in January. Moreover, Keim observes that 26 percent of the abnormal returns are earned during the first week of January and 11 percent on the first trading day of January. The first day's difference between the smallest- and largest-market-value portfolios is positive in every year and the average difference is statistically significant at the one percent level. Similarly, studies by Lamoureax and Sanger (1989)

and Daniel and Titman (1997) confirm that much of the SFE can be attributed to the extraordinary performance of small-cap stocks in January.

Chart 8 below illustrates the January effect for the US stocks in the CRSP database. The SFE as measured by the Fama-French SMB factor is exceptionally large in the month of January and averages almost zero during the remaining 11 months. Nearly all of the average SFE over the period 1927-2011 can be attributed to the January effect. In contrast to the average annual SFE, the January anomaly did not disappear between 1981 and 2000, as shown in Table 5 where we report estimates of the January alpha coefficients for different time periods and results of tests for structural breaks similar to those in Table 3. While the January SFE declined by 212 bps after 1981, it remained positive on average over the period. The Chow test also suggests that 1981 brought a break in the January return patterns. The year 2000, however, does not appear to be of any particular significance. The January SFE is generally higher after 2000 but not in any statistically significant manner. We conclude that the January seasonal effect declined after 1981 but has remained a persistent feature of the SFE.

Chart 8: The January effect – average US SMB performance by month (1927-2011)



Source: Kenneth French Data Library; NBIM calculations

Table 5: The January effect (1927-2011)

	Jan, pre-2000 (1927-1999) Estimate	t-stat		Jan, post-1981 (1981-2011) Estimate	t-stat
Alpha pre-1981	2,75	6,71	Alpha pre-2000	0,40	0,56
Alpha post-1981	0,63	0,87	Alpha post-2000	1,48	1,10
Difference	-2,12	-3,45	Difference	1,08	0,95
Structural break in 1981?	Yes		*Structural break in 2000?*	No	
Chow test F-statistic	7,48		Chow test F-statistic	2,26	
p-value	0,00		p-value	0,12	

Source: Kenneth French Data Library; NBIM calculations

3. Explanations for the SFE

Having outlined the main empirical evidence on the SFE, we turn next to discussing the various studies that have attempted to explain the effect. We group these studies into three broad categories: (1) studies that look for an explanation in measurement and statistical estimation errors; (2) studies that provide an economic or risk-based explanation for the SFE; and (3) studies that propose behavioural and institutional factors that may account for the effect. We also discuss what factors may account for the observed variation in the SFE over time, the SFE's poor performance from 1981 to 2000 and its strong seasonality.

a. The SFE as a statistical artefact

Several authors suggest that the SFE may be nothing more than a statistical artefact resulting from measurement errors, data mining and various methodological biases. A potentially serious "data snooping" problem arises when many researchers use the same dataset to uncover pricing anomalies (Lo and MacKinlay 1990; Black 1993). Authors in search of interesting research test hundreds of different hypotheses but only publish the most interesting and surprising results. The statistical significance of these results is questionable because it depends on the number of tests performed to derive the particular result. Every once in a while an interesting pattern is bound to emerge simply by chance. The observed anomaly, however, will not continue to exist out of sample. Black (1993) argues that the SFE fits this description because it largely diminished after its discovery in 1981. In a recent study, however, McLean and Pontiff (2012) study the out-of-sample and post-publication decay in return predictability for 77 characteristics linked to patterns in average returns, including firm size, and show that a discrete drop in predictive ability of only 30 percent occurs after publication. This result speaks to the extent to which academic findings may not be simply the result of data mining and the extent to which active management may not completely arbitrage away return predictability.

Estimates of the SFE may be also plagued by statistical inference issues arising from sorting stocks into size portfolios. Lo and MacKinlay (1990) note that there are serious inferential biases associated with testing financial asset pricing models like the CAPM when tests are performed on the returns of portfolios sorted on a common characteristic like firm size. Briefly stated, Lo and MacKinlay argue that on an ex-post basis one can always find statistically significant deviations from the CAPM. These deviations, however, are not real but a direct result of grouping stocks with common disturbance terms. So long as the grouping of stocks is based on a variable that is only known to be empirically correlated with returns or based on a variable measured within the sample, the test will contain such a data snooping bias. The authors provide evidence that, under reasonable assumptions, this kind of bias may lead to rejecting the null hypothesis (that the CAPM alpha is 0) with probability one even when the null hypothesis is actually true.

Similarly, Berk (2000) shows that sorting stocks into groups using an attribute of the data can lead to a significant bias toward rejecting the model when asset pricing tests are implemented within the groups. According to Berk (2000), when a researcher sorts by a variable that is known to be cross-sectionally correlated with returns (e.g. firm size), the average returns of each group will reflect this correlation. As a consequence, the return variation across groups will be "too high" and the return variation within groups will be "too low". The explanatory power of even a correct pricing model will then be smaller within the group than in the entire sample. Thus the sorting procedure introduces a bias toward rejecting the asset pricing model.

Another general criticism of the SFE relates to Roll's (1977) critique of the CAPM. Empirical tests of the CAPM suggesting the existence of the SFE examine the relationship between equity returns and beta relative to proxies for the market portfolio like a broad-based equity index. However, as Roll demonstrates, the market in the theoretical CAPM should include all wealth, both tangible assets like property, bonds and art, and intangible assets like human capital. Because the true market portfolio is unobservable, tests of the CAPM are in effect testing whether a particular proxy of the market portfolio lies on the minimum variance frontier rather than testing the model itself. Within any sample, however, one can always find a mean-variance portfolio. Hence finding evidence against the efficiency of a given portfolio tells us little about whether or not the CAPM is correct. However, this may not be such a serious problem in the case of the SFE as Banz (1981) shows that the SFE is very robust to the choice of market proxies. More generally, Kandel and Stambaugh (1987) and Shanken (1987)

show that common proxies of the market portfolio should be highly correlated with the true market, thereby reducing the severity of the proxy problem.

Several authors have attempted to explain the SFE by showing that: (1) measures of the riskiness of small-cap stocks are biased downward, and (2) measures of the average returns of small-cap stocks are biased upward. Roll (1981) argues that the riskiness of small-cap firms is understated due to serial correlation in small-cap returns. Returns on small-firm portfolios tend to be serially correlated because their constituent stocks are less frequently traded. As a result, risk measures estimated from short-interval return data such as daily returns significantly understate the true systematic risk (beta) of small-stock portfolios. In Roll's view, the observed large SFE reflects the true higher systematic riskiness of small stocks rather than a significant economic and empirical anomaly. Reinganum (1982) agrees with Roll's conjecture that security betas for small-cap firms may be somewhat biased downward, but shows that the magnitude of the bias is too small to explain the SFE effect. The excess small-cap returns not explained by the misassessment of small-firm risk are still greater than 20 percent per year over the period 1964-1978.

Average returns on small-cap stocks may be overstated due to survivorship bias in commonly used equity return databases such as the CRSP. Shumway and Warther (1999) provide evidence that the bias introduced by delisting stocks from the NASDAQ index may account for nearly all of the documented SFE among NASDAQ stocks. They observe that delistings due to poor performance are most frequent among the smallest NASDAQ stocks, thereby biasing the average returns for these stocks upward. Using over-the-counter return data from pink sheets for the delisted NASDAQ stocks, the authors estimate the return for the delisted stocks to be -55 percent on average. When both the surviving and delisted stocks are included in the SFE calculation, no evidence of the SFE is found over the period 1972-1995. This result, however, does not appear to hold for the stocks listed on the NYSE and AMEX exchanges. Adjusting for the delisting bias for the NYSE and AMEX does not completely eliminate the SFE.

In summary, a number of studies claim that the SFE may be nothing more than a statistical artefact. However, the fact that the SFE has been documented in a variety of international stock samples suggests that this may not be entirely true. While the magnitude of the SFE may be affected by a number of statistical issues, none of the papers has been able to completely explain the strong evidence for the SFE over the long-term.

b. Systematic risk

Firm size may be a proxy for some unidentified macroeconomic or other non-diversifiable risk factor that drives the variation in expected asset returns. Because small-cap stocks have relatively higher exposure to this size-related systematic risk factor than large-cap stocks, they earn higher returns in equilibrium. If so, the observed SFE represents investors' compensation for the exposure to risk rather than an anomalous event. Fama and French (1992, 1993, 1996) are proponents of this risk-based explanation. They show that a three-factor model, which includes factors representing a company's size (SMB) and equity valuation (HML) in addition to the CAPM market factor, has more explanatory power for equity returns than the CAPM alone. Using US stock return data from 1963 to 1991, Fama and French (1992) provide strong empirical evidence that the SMB and HML factors have been the most significant common return factors, other than market risk, for capturing the variation in realised stock returns. Their analysis points towards an economic risk explanation for the SFE and the related value anomaly.

i. Firm distress

While Fama and French do not develop a comprehensive theory for what the underlying systematic risk factors in their model represent, they surmise that SMB and HML may act as proxies for firm characteristics such as profitability or relative distress risk. Controlling for book-to-market, small stocks tend to have lower earnings on assets than big firms, especially after 1981. The observation that small-cap stocks have gone through a period of depressed earnings indicates, according to Fama and French (1995), a surprise to expected future profitability after the early 1980s. The relative profitability of firms as reflected by the SMB may, therefore, be the source of the common risk. In a similar vein, Chan and Chen (1991) present some evidence that small firms may be riskier than large firms because small firms tend to be what the authors call marginal firms – firms with low production efficiency, high leverage and high sensitivity of cash flows to adverse economic developments. Based on stock

return and accounting data for US firms from 1956 to 1985, the authors construct two size-matched return indices designed to mimic the return behaviour of marginal firms and find that these indices can explain the variation in equity returns of small and large-cap firms. This result suggests that differences in relative distress between small and large-cap firms may account for the SFE. The hypothesis of SMB and HML reflecting relative distress has been also supported by Chen and Zhang (1998). In addition, Vassalou and Xing (2004), using US stock return data from 1971 to 1999, find that the SFE is statistically significant only for the quintile of stocks with the highest default risk, suggesting that the SMB factor may reflect default-related information.

A number of authors, however, have presented evidence against the relative distress argument. Dichev (1998) demonstrates that bankruptcy risk, a proxy for firm distress, is not rewarded with higher returns. On the contrary, firms with a high probability of distress are found to underperform lower-risk firms over the period 1980-1995, suggesting that firm distress is unlikely to constitute a true systematic risk factor. Similarly, Campbell, Hilscher and Szilagyi (2008) show that stocks with a high risk of bankruptcy tend to deliver low average returns. The authors form portfolios on 12-month-ahead estimates of failure risk, calculated from a model that uses point–in-time data, and show that distressed portfolios have low average returns, high volatility, high market betas and large loadings on the HML and SMB factors. These results present a significant challenge to the conjecture that the Fama-French factors are proxies for a financial distress premium.

ii. Conditional models

A number of authors have attempted to explain the SFE by introducing time variation in the covariance of asset returns with the market return (conditional CAPM) or with consumption growth (conditional consumption CAPM). In these models, the asset's beta is not constant as in the classical CAPM but varies in response to changes in a pre-specified conditioning variable. The economic rationale behind a conditional model for the SFE is that small and large-cap stocks may have different sensitivities to systematic risk in good and bad times. Lettau and Ludvigson (2001) use the log–consumption-to-wealth ratio as a conditioning variable to show that conditional models perform better than unconditional specifications and about as well as the Fama-French three-factor model in explaining the cross-section of average returns. Moreover, the authors find that value stocks are riskier than growth stocks because value stock returns are more correlated with consumption growth when the agents' risk aversion is high. Once the conditioning information provided by the log-consumption-to-wealth ratio is included in the model, no residual SFE remains in the data. Similarly, Santos and Varonesi (2006) show that using the fraction of total income produced by wages as a conditioning variable in the CAPM explains the cross-section of 25 Fama-French portfolios sorted on value and size. Small stocks are shown to be riskier in bad times, exhibiting higher betas in market downturns.

Campbell and Vuolteenaho (2004) provide strong empirical evidence that small stocks' outperformance may be due to higher cash flow risk. The authors explain the SFE using an economically motivated two-beta model in which they break the CAPM beta of a stock into two components: one reflecting news about the company's future cash flows and one reflecting news about the discount rate. Intertemporal asset pricing theory suggests that risk-averse investors dislike cash flow risk (the "bad beta") more than discount rate risk (the "good beta"). As a result, the price of cash flow risk is higher than the price of the "good" discount rate risk. In equilibrium, the ratio of the two prices must equal the risk aversion coefficient that makes an investor content to hold the aggregate market. Empirically, the authors find that small stocks have considerably higher cash flow betas than large stocks, and that this can explain their higher average returns in the cross-section. The implication of the two-beta model is that investors with lower risk aversion and a longer horizon should overweight these stocks relative to the average investor in the market.

iii. Macroeconomic factors

Several authors suggest that SMB may be a proxy for various macroeconomic risk factors related to consumption and investment. Liew and Vassalou (2000) test whether the performance of the Fama-French factors, as well as Carhart's momentum factor, can be linked to the future GDP growth of ten countries between 1978 and 1996. The authors demonstrate that the SMB contains significant information about future GDP growth independent of the information contained in the market factor. Even after including popular business cycle variables like the slope of the yield curve in the model, SMB retains its ability to predict future economic growth in six of the ten countries examined. Zhang, Hopkins, Satchell and Schwob (2009) also find a positive relationship between the SMB factor and

future GDP growth and a negative relationship between SMB and unexpected inflation. Small-cap stocks are also found to perform better than large-cap stocks when the short-term rates are low and the term spread is high.

To illustrate the relationship between the SFE and various macroeconomic factors, we summarise in Table 6 the average performance of the Fama-French SMB factor under different economic regimes. The definitions of macroeconomic factors follow closely those in Zhang, Hopkins, Satchell and Schwob (2009). Performance is measured both in absolute and market-risk-adjusted terms (CAPM alpha). In absolute terms, the SMB performs significantly better during periods of economic expansion, decreasing unexpected inflation, decreasing short-term interest rates, and widening term and credit spreads. Controlling for market risk decreases but does not eliminate the differentials. Only one of the alpha differentials (term spread) is statistically significant. Overall, these results suggest that SMB may be related to innovations in macroeconomic variables that indicate decreased risk in the economy or expanded investment opportunities.

Table 6: SMB's performance under different economic regimes

Macro Indicator	Description	Time Period	State of Economy	SMB's Performance	
				Absolute	Market Risk-Adjusted (CAPM Alpha)
NBER Recessions	1 if recession as defined by NBER; 0 otherwise	1927-2011	Expansions	3,8%	1,5%
			Recessions	-0,4%	1,0%
			Difference	4,2%	0,5%
			t-stat	4,60	0,18
"Surprise" in next quarter GDP growth	Next quarter annualized real GDP growth minus average GDP growth in last 4 quarters	1948-2011	Positive	3,7%	0,5%
			Negative	0,9%	0,1%
			Difference	2,8%	0,4%
			t-stat	2,16	0,46
Unexpected inflation	Realized monthly inflation minus expected inflation as proxied by the difference between the current T-Bill rate and its 12 month moving average (Fama & Gibbons, 1984)	1948-2011	Positive	2,1%	1,1%
			Negative	6,5%	3,0%
			Difference	-4,5%	-1,9%
			t-stat	-3,68	-0,43
Risk free rate	3-month T-Bill rate; high if current rate greater than 5-year moving average; low otherwise	1938-2011	High	1,5%	0,3%
			Low	4,2%	2,0%
			Difference	-2,8%	-1,7%
			t-stat	-4,07	-0,76
Term spread	Difference between the 10-year and 3-month Treasury rates; high if current spread higher than 3-year moving average; low otherwise	1956-2011	High	7,5%	5,7%
			Low	-1,4%	-2,0%
			Difference	8,8%	7,7%
			t-stat	10,99	2,90
Credit spread	Difference between Moody's Baa Corporate Bond Index yield and 10-year Treasury rate; high if current spread higher than 3-year moving average; low otherwise	1956-2011	High	5,1%	3,4%
			Low	0,6%	0,0%
			Difference	4,5%	3,5%
			t-stat	5,58	1,30

Source: Kenneth French Data Library; FRED; FactSet; NBIM calculations; Zhang, Hopkins, Satchell and Schwob (2009)

A number of additional state variables have been linked to the SMB factor. Petkova (2006) suggests that HML and SMB may be related to innovations in state variables that predict excess market returns. Petkova's model, which relates average stock returns to changes in aggregate dividend yield, default spread and short-term Treasury bills, explains the cross-sectional variation in equity returns better than the Fama-French model. When loadings on the innovations in the predictive variables are included in the model, loadings on HML and SMB lose their explanatory power, suggesting a strong correlation between HML and SMB on the one hand, and default and term spreads on the other.

Piazzesi, Schneider and Tuzel (2007) suggest that excess returns on value and small-cap stocks may be driven by fluctuations in the relative share of housing in the consumption basket of investors (composition risk). Because the housing share moves slowly, a concern with composition risk may induce low-frequency movements in equity prices not driven by news about cash flows. This new factor appears to be predictive of excess returns.

iv. Liquidity

Another strand of research has attempted to link the SFE to liquidity risk. In an early contribution, Amihud and Mendelson (1986) test the hypothesis that stock returns increase with bid-ask spreads. Using data for the period 1961-1980, they find evidence that average portfolio-risk-adjusted returns increase with their bid-ask spread, and the slope of the return-spread relationship decreases with the spread. The spread effect appears to persist when firm size is added as an explanatory variable in the regression equation. This result indicates that at least part of the SFE may be attributed to liquidity effects. Similarly, Stoll and Whaley (1983) provide some empirical evidence that transaction costs may account for a part of the SFE. However, Chen and Kan (1995), who re-examine Amihud and Mendelson's evidence under alternative and arguably more robust econometric specifications, find no clear relation between stock returns and transaction costs as measured by bid-ask spreads. Results of Fama-MacBeth regressions, seemingly unrelated regressions, and models that allow for a stochastic beta indicate that the relationship between CAPM risk-adjusted returns and bid-ask spreads is indistinguishable from zero. The authors question the hypothesis that the cross-sectional variation in the bid-ask spread may account for the SFE.

In a more recent study, Amihud (2002) shows that expected market illiquidity positively affects the ex-ante stock excess return, suggesting that the excess return on small-cap stocks represents an illiquidity premium. Amihud measures liquidity (ILLIQ) as the ratio of a stock's absolute daily return to its daily dollar volume, averaged over a pre-specified period. Across stocks listed on the NYSE during 1964-1997, ILLIQ has a positive and statistically significant effect on expected returns. Moreover, the effect of illiquidity on stock returns is stronger for small stock portfolios, suggesting that excess returns on small-cap stocks may be partially attributed to variations in market liquidity. The results of Pastor and Stambough (2003) and Acharya and Pedersen (2005) also indicate that liquidity may be a priced source of risk. Using alternative liquidity measures, these authors find economically significant market-wide liquidity premia. Small-cap stocks tend to have relatively high loadings on these liquidity factors. These authors, however, do not measure explicitly to what extent liquidity effects may account for the SFE.

v. Neglected firm risk

Results of a number of studies suggest that there may be additional risk associated with investing in small-cap stocks because information on these stocks is relatively scarce and costly to come by. Neglected firms may be riskier because (1) fewer institutions monitor those firms, which increases the likelihood that insiders might appropriate shareholder value, and (2) there is greater uncertainty regarding firm value due to scarce information. Arbel and Strebel (1982) find evidence that stocks of firms that receive least attention from stock analysts earn a premium on a CAPM risk–adjusted basis over more widely followed stocks. This effect is found to be stronger for the small firms in the sample, but also to exist beyond the effect associated with size. Carvell and Strebel (1987) argue that the SFE is entirely a proxy for the neglected firm effect. More recent studies, however, have questioned the robustness of the neglected firm effect and its link to the SFE. Studies by Brennan, Chorida and Subrahmanyam (1997) and Beard and Sias (1997) find that risk-adjusted stock returns are not related to the degree of analyst coverage over the periods 1978-89 and 1982-1995, respectively.

Overall, risk-based theories for the SFE have produced mixed empirical results. The effect may be related to firm distress, although this appears to be a firm-specific factor that investors should be able to diversify away. Liquidity appears to be a promising factor, but changes in market liquidity have been found to account for only a portion of the SFE. A problem with all of the risk-based theories is that they cannot explain well the time variation of the SFE and the SFE's seasonality.

c. Behavioural finance

In contrast to Fama and French (1993), a number of authors argue that the SFE may not be directly linked to systematic risk. Rather, the SFE may be driven by factors outside the classic asset pricing paradigm such as investor behaviour, market frictions and institutional constraints.

Proponents of behavioural finance argue that investors have a tendency to depart from the assumed rational behaviour underlying the efficient market hypothesis, thereby leading to pricing anomalies. One behavioural explanation for the SFE is based on De Bondt and Thaler's (1985) overreaction effect. De Bondt and Thaler argue that investors tend to overreact to unexpected earnings news, thereby making stock prices somewhat predictable. With stock prices initially biased by excessive optimism or pessimism, prior "loser" stocks should outperform prior "winners" when the overreaction effect eventually reverses. To test their overreaction hypothesis, the authors track the performance of two portfolios formed on three- and five-year past returns, one comprised of the prior "winners" and one of the prior "losers". Past "losers" are found to significantly outperform the past "winners". As small-cap stocks tend to be recent "losers" and large-cap stocks recent "winners", the SFE may represent a market correction to De Bondt and Thaler's overreaction effect. Moreover, the overreaction effect concentrates in January, an indication that the overreaction effect may be linked to the SFE.

Lemmon & Portniaguina (2006) find a negative relationship between investor sentiment and the variation in excess returns on small stocks since 1977. When investor confidence increases, excess returns on smaller firm stocks decrease even after controlling for a number of macroeconomic factors related to the business cycle. According to the authors, investors tend to overvalue small-cap stocks compared to large-cap stocks when investors are particularly bullish and undervalue them when they are bearish. Sentiment has a disproportionately large impact on small-cap stock valuations because small firms are typically held by individual traders and individual traders are more likely to be affected by sentiment. However, the authors find no relationship between investor sentiment and small-cap returns prior to 1977, and no explanation why the SFE weakened after 1981.

d. The weak SFE after 1981

Several studies claim that the weak SFE after 1981 may be explained by investor clientele effects. Gompers and Metrick (2001) argue that asset pricing is driven by investor demand for risky assets and that institutional investors tend to prefer large-cap stocks to small-cap stocks. The growth of the professional money management industry after 1980 increased the demand for liquid large-cap stocks such as those included in the S&P 500 index, which in turn diminished the relative performance of small-cap stocks over the period 1980-1996. The preferences of institutional investors are thus responsible for the differential performance between small and large-cap stocks after 1980.

Cochrane (2001) argues that increased institutional investment in small-firm stocks after 1980 improved the sharing of small-firm risks in the aggregate market, and as a result the marginal investor no longer required a premium for holding volatile small-cap stocks. Briefly stated, poor investor diversification prior to 1980 explains the existence of the SFE, and improved diversification after 1980 explains the disappearance of the SFE. Consistent with the poor diversification hypothesis, Pekkala (2005) provides empirical evidence that volatility, which matters to undiversified investors, was an important explanatory variable for the cross-sectional variation in stock returns prior to 1980 but became largely unimportant after 1980. This result supports the finding of Xu and Malkiel (2004) that the SFE and idiosyncratic risk are positively correlated. Moreover, Pekkala (2005) argues and presents some empirical evidence that small firm risk-sharing began to improve even prior to 1980 when the US Employee Retirement Income Security Act (ERISA) was enacted in 1974. ERISA eliminated outdated prudent-man rules that largely prohibited pension funds from investing in risky securities such as small-cap stocks. Instead, ERISA encouraged pension funds to evaluate securities in the context of their overall portfolios and promoted diversification to minimise risk. As Pekkala (2005) shows, pension funds' small-firm equity holdings increased substantially after 1974, supporting the argument that institutional changes may have played a significant role in eliminating the small firm effect.

Hou and van Dijk (2010) attribute the disappearance of the SFE to differences in profitability shocks that small and large firms have experienced in the past two decades. The authors find that from 1963 to 1983 both small and large firms had close to zero profitability shocks, as measured by the difference between predicted earnings from a VAR model that includes lagged earnings, book value of assets and dividend payments to book equity as explanatory variables and actual earnings. In contrast, after 1984, small firms experienced significant negative profitability shocks and large firms experienced positive shocks. After adjusting the stock return series for the impact of these shocks, the authors find a statistically significant SFE of ten percent per annum from 1984 to 2005. They hypothesise that the SFE may not be "dead" as many others have proclaimed. Rather, the realised SFE from

1984-2005 was a poor proxy for the true expected SFE over the period due to significant differences in cash flow shocks after 1984.

e. The January seasonal effect

A number of authors have attempted to explain the January effect via tax-motivated investor behaviour. If investors sell securities at year-end to realise capital losses, stock prices become artificially depressed at the end of the year. Returns during the first few trading days of the next year are thus artificially high. The effect can be especially strong for small-cap stocks because they tend to be stocks that have declined in value. Reinganum (1983) examines how much of the January effect may be attributed to the tax-selling hypothesis and finds that the size of the price increase in the first week of January is positively related to the amount of short-term losses realised at the end of the prior year. However, Reinganum also finds that average returns on stocks are high even for stocks that show capital gains over the previous year and that small-cap stocks tend to outperform large-cap stocks during the entire month of January not just during the first few trading days. These findings suggest that tax selling may not be the whole story. Moreover, evidence from international markets suggests that the January effect is present even in countries where the tax year ends in a different month (Brown, Keim, Kleidon and Marsh 1983 for Australia; Kato and Schallheim 1985 for Japan).

More recent evidence on the tax-selling hypothesis, however, indicates that tax-selling may still be important in explaining the January effect. Poterba and Weisbenner (2001) find that changes in capital gains tax rules affect the magnitude of the seasonality in stock returns. Kang, Pekkala, Polk and Ribeiro (2011) present evidence that the magnitude of mispricing at the turn of the year is related to the level of interest rates, which in turn affect investors' decision on whether to realise tax losses at year-end or defer them to the following year. Interest rates are found to explain the variation in US and UK stock prices and selling behaviour at the turn of the tax year.

An alternative behavioural explanation for the January effect is the window-dressing hypothesis of Lakonishok, Shleifer, Thaler and Vishny (1991). The authors argue that fund managers sell stocks with large losses and purchase stocks with recent gains near the end of the year in order to improve the appearance of their portfolios before presenting them to clients or sponsors. Using equity portfolio holdings data for 769 US pension funds from 1985 to 1989, they find that the average pension fund sells poorly performing stocks disproportionately to the fund's holding and the pace of selling accelerates in the fourth quarter of the year. This suggests that the window-dressing hypothesis may contribute to the January effect.

4. Conclusion

Since Banz's (1981) empirical deduction that small-cap stocks earned higher average returns, a large body of literature has emerged on the SFE. Numerous studies have examined the validity and persistence of the SFE across different equity markets and proposed explanations for the observed outperformance of small-cap stocks over the long term.

While the US SFE has been positive on average over the long term, it exhibits great variation across small-cap stock characteristics and over time. First, the SFE tends to concentrate among the very small firms in the sample. As these stocks are particularly illiquid and difficult to trade, investors may find it costly to capture the full SFE in practice. Second, the SFE is most prominent for the value stocks in the small-cap universe. Indeed, we observe no long-term SFE within the small growth stocks. Third, the SFE exhibits strong time-varying properties with long periods of underperformance. Some even claim that the SFE disappeared after its discovery in 1981. This may be a premature conclusion, however, as the SFE has been persistently positive in the past decade. It is likely that the SFE is a risky strategy that pays off only over long time horizons. If so, a long-term investor can utilise the comparative advantage of its long investment horizon to benefit from the SFE over the long term.

Whether the SFE constitutes a systematic risk premium, however, is subject to debate. Some empirical evidence exists that excess returns on small-cap stocks represent a payment for risk. Researchers do not claim that firm size per se is the source of the risk driving expected returns, but that size is a proxy for one or more underlying risk factors linked to smaller firms. Links have been found between the

SFE and default, bankruptcy and distress risk, as well as between the SFE and various macroeconomic variables. None of these links, however, has been found to be robust. Another theory holds that the lower liquidity of small-cap stocks is a source of risk leading to higher returns, and that temporal shifts toward greater liquidity in small-cap equity markets during the 1980s may account for the smaller SFE between 1981 and 2001.

A strong challenge to any risk-based explanation for the SFE is the strong observed seasonal increase in the SFE each January. Even though a risk-driven SFE predicts variation across market states, it is not consistent with variation across months of the year. Many authors use the tax-selling hypothesis to explain the January effect. Others attribute the effect to market inefficiency and irrational biases. While the January effect has subsided somewhat over the past two decades, it has not completely disappeared from the returns on US stocks.

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