The size effect in value and momentum factors: Implications for the cross-section of international stock returns

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Abstract

Small stocks mimic common risks on equity markets. To reach this conclusion, we distinguish between different size dimensions of traditional risk factors in the Fama and French (1993) and Carhart (1997) multifactor models. We find that the small stock component of value and momentum factors explains differences in returns on regional and global size, value and momentum portfolios. This result does not hold for the big stock component of common risk factors. Models featuring the size effect in value and momentum factors perform far better than conventional benchmark models in finance. In addition, we complement the market integration analysis of Fama and French (2012). In contrast to their time series evidence, our cross-sectional asset pricing tests indicate a considerable degree of integration on international stock markets.

JEL: G11; G12

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1. Introduction

Firm-level characteristics such as market capitalization, the ratio of book equity to market equity and the short-term history of past returns are important determinants of stock returns.[1] Small stocks tend to offer higher returns than big stocks. Stocks of companies with high book-to-market equity ratios (value stocks) generally outperform stocks with low respective ratios (growth stocks). High stock returns over the past year typically signal high returns in the near future and vice versa (momentum). Returns on stock portfolios sorted according to size, value, and momentum characteristics cannot be explained by empirical approximations of the Sharpe (1964) and Lintner (1965) capital asset pricing model (CAPM). Differences in the sensitivity to the market return—the only risk factor in the CAPM—have proved to be insufficient to account for the return differentials between small and big (size premium), value and growth (value premium) as well as past winner and past loser stocks (momentum premium). Augmenting the market return with additional factors related to firm-specific characteristics goes a long way towards explaining these anomalies (Fama and French (1993) and Carhart (1997)). Such models typically reveal high explanatory power for time series variation of stock portfolio returns. In cross-sectional regressions, however, they leave substantial room for improvements.

It is the goal of this paper to enhance the multifactor asset pricing models for common stock equity returns in the cross-sectional dimension. We show that the cross-sectional performance of the conventional benchmark models in finance can be considerably

[1] See for instance, Banz (1981), Reinganum (1981), Fama and French (1992, 1996, 1998), Jegadeesh and Titman (1993), and Carhart (1997).

improved by explicitly taking into account the different size dimensions in the common risk factors.

The starting point of our analysis is Fama and French (1993). The authors argue that the size and value effects reflect compensation for systematic risks that are not captured by the standard CAPM. To address this shortcoming, they introduce a three-factor model that links returns on common stocks to their sensitivities to the excess market return, a factor mimicking an aggregate size premium (SMB)—measured by the difference between the returns on small stocks and the returns on big stocks—and one related to the value (HML) effect—proxied by the difference between the returns on value stocks and the returns on growth stocks. Despite its strong success in rationalizing the value premium, this model fails severely in capturing the momentum in stock returns (Fama and French, 1996). Against this backdrop, Carhart (1997) extends the three-factor Fama-French model with a winner-minus-loser (WML) momentum factor—computed as a difference between the returns on past winner stocks and past loser stocks. More than 90% of time series variation in stock portfolio returns can be explained by Fama and French (1993) and Carhart (1997) models. Yet, these so-called benchmark or workhorse models in finance provide a substantially lower fit in cross-sectional analyses.

We argue that the size effect in value and momentum factors is the key to explain the cross section of global and regional size, value and momentum sorted portfolio returns. To reach this conclusion, we distinguish between two size dimensions in the HML and WML factors, respectively. One captures the value, respectively, momentum effect in small stocks. Another captures the value, respectively, momentum effect in big stocks.

Our findings indicate that cross-sectional differences in value and growth portfolio returns are explained by differences in their sensitivities to a value factor in small stocks. This result does not hold for the value factor in big stocks. A similar reasoning applies to momentum stock portfolios. Differences in winner and loser portfolio returns reflect differences in their sensitivities to a momentum factor in small stocks. This result does not hold for the momentum factor in big stocks. Parsimonious modifications of the Fama and French (1993) and Carhart (1997) models that take explicitly into account the size effect in value and momentum factors improve substantially the cross-sectional performance of the benchmark models in finance: Modified multifactor models provide considerably higher measures of fit and substantially lower pricing errors than the original model versions for the cross section of global and regional size, value, and momentum sorted portfolios in four major regions around the world: North America, Europe, Japan and Asia Pacific (excluding Japan).

From a mechanical point of view, our results echo Reinganum (1981) who documents that the value effect is strongly related to factors associated with size. Our insight is underscored by recent findings on the declining pattern in value and momentum returns from small to big stocks in Fama and French (2012). De Moor and Sercu (2012) also relate the moderate cross-sectional fit of conventional multifactor models to the ignorance of tiny, microcap stocks. Furthermore, Banz (1981) emphasizes that the size effect is mainly driven by very small stocks. Our results—obtained on the basis of the Fama and French (2012) dataset which explicitly includes very small microcap stocks—reinforce that small stocks mimic common systematic risks on equity markets.

From an economic perspective, our results reflect the view that value effect captures business cycle related risk (e.g. Fama and French (1993, 1995), Lettau and Ludvigson (2001), and Yogo (2006)). For instance, Fama and French (1995) find that the value effect proxies relative distress risk. Heaton and Lucas (2000) note that a typical market participant owns a small, privately held business. Her income is particularly sensitive to financial events which cause distress among small firms and distressed value firms. In this vein, small and big stocks' HML components accommodate differences in structural characteristics that lead firms of different size react differently to economic news. Chan and Chen (1991) argue that small firms are more likely to suffer strongly from economic contractions than large stocks. This argument is reinforced for small stocks with high book-to-market equity ratios subject to most unfavourable economic risks.

Interestingly, we obtain similar results for a model that features a small stock momentum factor. This finding emphasizes that small stocks convey important information about common risks in the economy. Sensitivity to these risks is the key to explain returns on portfolios with various formation characteristics.

Based on strong performance of models which feature the small and big stocks' components of common risk factors, we ask whether the cross-sectional dispersion in regional size, value, and momentum returns is better explained by regional or global versions of the modified multifactor models. This exercise complements the time series regressions by Fama and French (2012) who conclude that regional factors generate a better fit of the regional stock portfolio data than global factors. Griffin (2002) similarly argues that country-specific versions of the three-factor Fama-French (1993) model are a better description of international stock returns as compared to a global version of the model. This finding is consistent with a notion of a low degree of international stock market integration. Interestingly, our augmented models which feature the size effect in common risk factors provide a less clear-cut picture in this respect. In particular, the cross section of size and book-to-market ratio sorted portfolios indicates that regional factors strongly outperform the global factors only in case of Asia Pacific (excluding Japan). For North America, Europe, and Japan, regional and global factors do about equally well. The cross section of size and momentum sorted portfolios is captured similarly well by regional and global factors. Hence, compared with Fama and French (2012), this study provides stronger support in favour of the notion of international stock market integration. This difference in outcomes primarily reflects the fact that tests of asset market integration always imply tests of the underlying asset pricing models (Fama and French (2012) and Nitschka (2010)).

The remainder is organized is follows. Section 2 presents the methodology and motivates the modified Fama-French and Carhart models. Section 3 describes the data set of regional and global stock portfolios sorted on (i) size and book-to-market equity and (ii) size and momentum. Section 4 discusses our main empirical results on the size effect in value and momentum factors and studies its implications for the cross section of stock returns. Finally, Section 5 summarizes several robustness tests and Section 6 concludes.

2. Theoretical and empirical framework

In this section, we briefly present the general theoretical framework our empirical analysis is based on. We then describe the by far most standard empirical pricing models for stock returns that are commonly used as benchmarks in the asset pricing literature. Subsequently, we introduce and motivate our preferred alternatives.

2.1 General framework

Cross-sectional asset pricing tests presented in this paper follow from the basic pricing equation for excess returns

$$0 = E(mR^{i,e}), \quad (1)$$

where m is the stochastic discount factor (SDF), $R^{i,e}$ the excess return on stock portfolio *i*, and *E* the expectation operator. Here and later we skip the time indices for simplicity of notation. One can show that for a linear SDF of the form $m = 1 - b'f$, where f is the vector of pricing factors and *b* the vector of corresponding factor loadings, there exists a beta representation of Equation (1), $E(R^{i,e}) = \lambda'\beta^i$, which states that the expected excess return on asset *i* equals the factor prices λ times the asset specific exposure to the factors measured by β^i.

Our tests rely on the two-stage regression approach of Fama and MacBeth (1973). The first stage is a time-series regression of portfolio returns on the risk factors to obtain the estimates of β^i. The second stage is a cross-sectional regression of average excess returns on their betas to calculate the risk prices of the factors λ. We do not include a constant in the second stage equation as we deal with excess returns. To correct for the bias in standard errors of risk prices due to the use of generated regressors, we employ the Shanken (1992) correction.

2.2 Standard benchmark pricing models

The first benchmark model we consider is the plain vanilla capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) which postulates that an asset return's comovement with the market portfolio return should be the only determinant of average returns:

$$E\left(R^{i,e}\right) = \lambda_M \beta_M^i , \tag{2}$$

where β_M^i measures the sensitivity of asset i to fluctuations in the market portfolio return and λ_M is the market risk premium.

Despite its intuitive appeal, the CAPM fails to explain the patterns in returns on common stocks. Fama and French (1993) argue that portfolios constructed to mimic risk factors related to size—proxied by market equity (ME)—and value—proxied by the ratio of book-to-market equity (BE/ME)—add substantially to the explanatory ability of the CAPM market beta:

$$E\left(R^{i,e}\right) = \lambda_M \beta_M^i + \lambda_{SMB} \beta_{SMB}^i + \lambda_{HML} \beta_{HML}^i . \tag{3}$$

The factors in this model are constructed using six value-weight portfolios formed independently on size and BE/ME:

	Low BE/ME (**G**rowth)	Middle BE/ME (**N**eutral)	High BE/ME (**V**alue)
Big	BG	BN	BV
Small	SG	SN	SV

In Equation (3), β^i_{SMB} is the sensitivity of asset *i* to the return on a factor mimicking portfolio SMB (small-minus-big) measured as the equal-weight average of the returns on the three small stocks from the 2x3 size-BE/ME sorts minus the average of the returns on the three big stocks, i.e. SMB = 1/3*(SG+SN+SV) – 1/3*(BG+BN+BV). Analogously, β^i_{HML} is the sensitivity of asset *i* to the return on a factor mimicking portfolio HML (high-minus-low) measured as the equal-weight average of the returns for the two high BE/ME portfolios minus the average of the returns for the two low BE/ME portfolios, i.e. HML = ½*(BV+SV)- ½*(BG+SG). Fama and French (1995) show that book-to-market equity and slopes on HML proxy for relative distress. Firms with high β^i_{HML} are typically firms that have lost market value, e.g. because of poor performance. Such firms are likely to have high leverage ratios and are unlikely to survive adverse economic conditions. Based on its robust performance, the Fama-French (1993) model emerges as an important benchmark model in finance.

Yet, the three-factor model exhibits strong limitations related to the continuation of short-term returns (momentum). To address this shortcoming, Carhart (1997) makes an effort to explain profitable strategies that buy winners and sell losers based on the previous short-term returns by introducing a four-factor model which enhances the model in Equation (3) with an additional factor capturing Jegadeesh and Titman's (1993) one-year momentum anomaly:

$$E\left(R^{i,e}\right) = \lambda_M \beta^i_M + \lambda_{SMB}\beta^i_{SMB} + \lambda_{HML}\beta^i_{HML} + \lambda_{WML}\beta^i_{WML}. \qquad (4)$$

The momentum factor WML (winners-minus-losers) in Equation (4) is constructed from six size- and momentum sorted portfolios as the equal-weight average of the returns for the two winner portfolios minus the average of the returns for the two loser portfolios:

	Low past returns (**Loser**)	Middle past returns (**N**eutral)	High past returns (**W**inner)
Big	BL	BN	BW
Small	SL	SN	SW

The WML-factor is calculated as ½*(BW+SW) – ½*(BL+SL). This benchmark model is widely adopted by both researchers and practitioners as a tool to evaluate investment performance.

2.3 Our preferred alternatives

The basis of our preferred asset pricing models is the Fama and French (1993) three-factor model and the Carhart (1997) four-factor model. We argue that the suggestion of Fama and French (2012) to break down the HML and WML factors into one component mimicking the value, respectively, momentum effect in small stocks and another component mimicking the value, respectively, momentum effect in big stocks has important implications for the Fama and French (1993) and Carhart (1997) models' performance in explaining average stock returns.

The motivation for this decomposition is twofold. First, Reinganum (1981) documents that the value effect is strongly related to factors associated with size. Japan aside, value and momentum returns tend to decline consistently from small to big stocks in equity markets around the world (Fama and French (2012)). Two empirical strategies seem natural in this context. The first is to split the SMB factor in a component capturing the size premium across value stocks and one related to the size premium across growth stocks. Zhang (2008) studies this case for time variation in US stock returns and finds modest gains compared to the original three-factor model.[2] The second is to track the HML, respectively, WML factor for small and big stocks separately. This procedure is stimulated by Fama and French (1992) who show that the book-to-market ratio—in contrary to size—summarizes other stock characteristics such as leverage and dividend-to-price ratios. We pursue this second line of reasoning.

Second, a typical risk-based explanation of the stylized fact that value stocks offer higher returns than their growth counterparts is related to differences in the exposure to business cycle risk (Fama and French (1993), Lettau and Ludvigson (2001), and Yogo (2006)). Business cycle risk is also one potential explanation of a small stock premium: Small firms are more likely to suffer strongly from economic contractions than large stocks (Chan and Chen (1991)). This argument should hold particularly for small firms among value stocks with low price-to-fundamentals ratios and be less pronounced for small firms among stocks with high respective ratios. In this vein, Kapadia (2011) shows that the exposure to aggregate distress risk is the underlying source of the premiums for SMB and HML factors. This finding echoes Chan et al. (1985) who demonstrate that the small firms' premium can be explained by exposure to business cycle or default risk.

Against this background, we follow Fama and French (2012) and break the HML factor in Equation (3) into a low ME-based component—measured as a difference between returns on small value and small growth stocks (HMLS = SV-SG)—and a high

[2] In fact, a previous version of this manuscript shows that Fama-MacBeth (1973) regressions lead to generally better fit in this case than the standard three-factor model but the patterns in risk premia are not robust across different regions.

ME-based component—measured as a difference between big value and big growth stocks (HMLB = BV-BG):

$$E\left(R^{i,e}\right) = \lambda_M \beta_M^i + \lambda_{SMB} \beta_{SMB}^i + \lambda_{HMLS} \beta_{HMLS}^i + \lambda_{HMLB} \beta_{HMLB}^i . \tag{5}$$

The advantage of this model is that it allows for different sensitivities of assets to a risk factor mimicking the value premium in small stocks and one mimicking the value premium in big stocks. Both risk exposures can accordingly obtain different compensations, λ_{HMLS} and λ_{HMLB}.

Moreover, Hong et al. (2000) and Fama and French (2012) point out a higher momentum premium in small than in big stocks similar to the pattern observed in value and growth stocks along the size dimension. Cross-sectional implications of the size effect in common risk factors can be assessed via a decomposition of the momentum factor into a winner-minus-loser factor in small stocks variety (WMLS = SW-SL) and a winner-minus-loser factor in big stocks variety (WMLB = BW-BL), analogously to Equation (5):

$$E\left(R^{i,e}\right) = \lambda_M \beta_M^i + \lambda_{SMB} \beta_{SMB}^i + \lambda_{HML} \beta_{HML}^i + \lambda_{WMLS} \beta_{WMLS}^i + \lambda_{WMLB} \beta_{WMLB}^i . \tag{6}$$

This regression can be interpreted as a test of generality of the size effect in common risk factor portfolios.

3. Data

We first describe the explanatory returns used as factors in asset pricing tests of international stock markets. These returns are obtained by independent sorts on size and value or momentum, respectively, which results in six portfolios as illustrated in the previous section. These factors are meant to mimic the underlying risk factors in returns related to size, value, and momentum portfolios. We then describe the 5x5 stock portfolios formed on the basis of size and book-to-market equity and the 5x5 stock portfolios formed on the basis of momentum and book-to-market equity that we use as test assets in our empirical analysis.

3.1 Common risk factors in international equity markets

Size, value, and momentum are used widely in the finance literature as factors which proxy for common risks in returns.[3] Fama and French (2012) introduce a new dataset of global and regional varieties of size, value, and momentum factors to address the question on the relative importance of global versus regional risk forces behind the time variation in excess returns on (i) size and book-to-market and (ii) size and momentum sorted stock portfolio returns. The data are freely available on the website of Kenneth French.

We employ updated versions of risk factors used and extensively discussed in Fama and French (2012). The factors are constructed from sorts of stocks into (i) two size (ME) and three value (BE/ME) groups and (ii) two size and three momentum (past short-run returns) groups. The independent 2x3 sorts on size and BE/ME generate six portfolios: small growth (SG), small neutral (SN), small value (SV), big growth (BG), big neutral (BN), and big value (BV). Analogously, the second sort generates six portfolios on size and momentum: small losers (SL), small neutrals (SN), small winners (SW), big losers (BL), big neutrals (BN), and big winners (BW). The sorting is done for each region as well as globally, i.e. taking into account all stocks across all regions. Small stocks are in the bottom 10% of market capitalization of stocks whereas big stocks are in the top 90%

[3] For instance, Fama and French (1992) document that size and book-to-market equity are related to economic fundamentals. Liu and Zhang (2008) argue that momentum is driven by macroeconomic risks.

of the market capitalization. Growth stocks are in the bottom 30% of the book-to-market equity ratio sort. Neutral stocks are in the middle 40% and value stocks are in the top 30% of book-to-market equity ratios. The summary statistics are very similar to the ones presented in Fama and French (2012) and therefore not reported in detail but available upon request. We summarize the main features of the descriptive statistics of the factors as follows.

The factors are the standard market excess return (Mkt), size (SMB), value (HML), momentum (WML), small stocks' HML component (HMLS) and big stocks' HML component (HMLB), small stocks' WML component (WMLS) and big stocks' WML component (WMLB). Market excess returns vary from negative -0.10% per month in Japan to 0.81% per month in Asia Pacific. The monthly global equity premium is about 0.42%.

Echoing Horowitz et al. (2000) and Easterday et al. (2009), there is strong evidence against a reliable size effect in international returns as measured by the SMB factor, constructed as the equal weight average of the returns on the three small stock portfolios minus the average of the returns on the three big stock portfolios. SMB switches signs and is statistically insignificant in global as well as regional returns.

The value factor seems to hide more than it reveals: While HML is positive, statistically significant (except for North America), and economically closely related across all regions, there are strong differences in the value factor once it is split into its small stocks' and big stocks' components. The value premium becomes higher for small stocks, measured as the difference between the returns on SV and SG portfolios (HMLS). In contrary, it turns insignificant for big stocks measured as the difference between the returns on BV and BG portfolios (HMLB). We observe a similar pattern with respect to WML and its small stocks' and big stocks' components. Finally, momentum is negatively related to value in line with Asness (1997).

3.2 The 25 international size- and BE/ME- sorted portfolios

We use the factors presented in the previous subsection to study monthly value-weight dollar excess returns on 25 (5x5) international portfolios formed on (i) size (ME) and book-to-market equity (BE/ME) and (ii) size and momentum for global stock market as well as the four major regions around the world: North America, Europe, Japan, and Asia Pacific excluding Japan. The North American portfolios include Canada and the United States. The European portfolios include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom. The Japanese portfolios include only Japan. The Asia Pacific portfolios include Australia, Hong Kong, New Zealand, and Singapore. Finally, the global portfolios include all 23 countries in the four regions. We use the whole data set on developed market returns available in the online data library of Kenneth R. French. The sample period covers November 1990 to March 2012.

Table 1 gives the average monthly returns and standard deviations of international portfolios sorted on size and BE/ME in the four regions. The portfolios are organized in a squared matrix with growth stocks at the left, value stocks at the right, small stocks at the top, and large stocks at the bottom. Each panel supports a standard value premium in international stock returns: Value stocks promise higher returns than their growth counterparts. Moreover, Column V-G in Table 1 indicates that value premiums in average stock returns, except for Japan, decrease with size (Fama and French (2012)).

[Insert Table 1 here]

The size premium is economically less important, in general, and absent in Europe. In Japan and Asia Pacific it is very low and does not persist across all size categories. Apart from Japan, there is a reverse size effect in growth stocks: Small stock with low BE/ME ratios have lower average returns than their big counterparts. Finally, Column S-B demonstrates that the return differentials between small and big stocks are increasing from growth to value stocks in all regions around the world, except for Japan.

3.3 The 25 international size- and momentum- sorted portfolios

Table 2 displays the 5x5 matrices of average monthly returns and standard deviations of sorts of international stocks on size and momentum for global as well as regional markets in North America, Europe, Japan, and Asia Pacific. There exist momentum (apart from Japan) and size premia (apart from Europe) in double-sorted international portfolio returns. For every region excluding Japan, average momentum premia exceed average value premia presented in Table 2 for all size groups. Apart from Japan, the momentum premia decline from small to big stocks. Similar to the pattern in value portfolios, the return differentials between small and big stocks tend to increase from past losers to past winners stocks in all regions except for Japan. Around the world, the size premium is greater for momentum than for value stocks within each percentile of both sorting variables.

[Insert Table 2 here]

4. Empirical results

In what follows we evaluate the cross-sectional models in Equations (2)-(6) on international portfolio returns in four regions—North America, Europe, Japan, and Asia-Pacific—as well as the global equity markets. We show that the small stock components of HML and WML factors explain the cross section of portfolio returns. This result does not hold for the big stock counterparts. Our modified models outperform the original benchmark models in terms of general fit and total pricing errors. We begin by examining the 25 portfolios formed on size and BE/ME. We then turn to the 25 portfolios sorted on size and momentum. Finally, we address the issue of integration of international stock markets by evaluating the relative ability of global and regional factors to capture the cross-sectional dispersion in regional returns.

4.1 Asset pricing tests for size- and BE/ME- sorted portfolios

Table 3 shows the estimated betas for 25 size- and BE/ME- sorted global portfolios over the November 1990 to March 2012 period. We focus our attention on the cross section of HML betas as well as their small (HMLS) and big (HMLB) components. The structure of the betas matrix is similar to the presentation in Table 1. Column V-G at the right edge reports differences between extreme value and extreme growth in each size category; the bottom row S-B reports the differences between the smallest and the largest portfolios in each BE/ME-category. Bold faces highlight significant estimates. *T*-ratios associated with the V-G strategy are obtained from time-series regressions of excess returns on extreme value over extreme growth stocks in each size category on a constant and the respective risk factors. Analogously, *t*-ratios associated with the S-B strategy are obtained from time-series regressions of excess returns on the smallest over the biggest stocks in each BE/ME-category on a constant and the respective risk factors.

[Insert Table 3 here]

The HML betas range from -0.61 for the smallest BE/ME portfolio to 0.70 for the largest BE/ME portfolio. The HMLS and HMLB betas fluctuate from -0.58 to 0.59 and from -0.56 to 0.71, respectively. Value stocks have higher HML, HMLS, and HMLB betas than growth stocks but the spreads in extreme value and extreme growth portfolios are stronger pronounced for HML and HMLS factors.

Two other points are important. First, the spread in the HMLS betas increases from growth to value and from big to small stocks. In stark contrast, the HMLB betas show an opposite pattern with spreads increasing from small to big and from value to growth portfolios. We take this to be evidence that sensitivities to HMLS factor are the drivers behind the cross section of average returns of stock portfolios formed on size and BE/ME, while there is a zero or negative relation between expected excess stock returns and their HMLB betas. Second, growth stocks tend to offer insurance, while value stocks hide statistically grounded exposures to fluctuations in the HMLS factor. In general, Table 3 is indicative of a striking difference in the small and big HML beta components of size and BE/ME- portfolios. HMLS betas appear more informative about the pattern in average returns and should signal stronger implications for the risk-return trade-off than sensitivities to the HMLB factor.

To test this hypothesis, we examine the explanatory power of risk mimicking portfolios for the cross section of average returns. Table 4 presents the baseline asset pricing results for global value portfolios formed on size and BE/ME. It reports the second-stage Fama-MacBeth (1973) estimates of the risk prices. Standard Fama-MacBeth procedure is commonly employed as a tool to determine which explanatory variable has non-zero expected premiums for test asset returns. Shanken (1992) corrected *t*-statistics are given in parentheses below coefficient estimates. We discuss the results for global markets in detail since they are representative for regional equity markets and summarize the latter in Table 5.

[Insert Table 4 here]

Table 4 presents the asset pricing tests for (1) the CAPM, (2) the three-factor Fama-French (1993) model, (3) the four-factor Carhart (1997) model, and (4) the modified three-factor Fama-French (1993) model with decomposed HML factor. The models are provided in Equations (2)-(5) above. In addition, column (5) gives the results when we only employ the HMLS instead of the HML factor in the standard Fama-French model.

The anatomy of our findings is quite transparent. The standard CAPM in Column (1) of the table fails to explain the cross-sectional pattern in average returns on global portfolios sorted on size and book-to-market. Despite a significant relation between market betas and average stock returns, the pricing errors are too high to fit the data. The regression produces a negative $\overline{R^2}$ statistic of 37%. A similar picture emerges for regional portfolio returns as indicated in Table 5.

[Insert Table 5 here]

Column (2) of Table 4 reports the results for the original three-factor Fama-French (1993) model. The three common risk factors are the return on the market portfolio, the factor mimicking size, SMB, and the factor mimicking value, HML. Our estimates support De Moor and Sercu (2012) who show that the SMB factor lacks power in picking the return differentials across stocks of different size classes. Compared to the CAPM, the pricing errors are substantially lower while the cross-sectional fit is remarkably higher with an associated $\overline{R^2}$ statistic of 43%. The performance of the model is similar when faced with regional markets generating a variation in $\overline{R^2}$'s between 24% for Asia Pacific and 69% for Europe as is visual from Table 5.

The results of the four-factor Carhart (1997) model represented in Equation (4) are summarized in Column (3) of Table 4. The momentum factor generates a positive risk premium for covariance with WML of about 27% p.a. This estimate is, however, measured very imprecisely and appears economically too high to fit international data.

Finally, we break the HML factor into two components, one mimicking the value pattern in small stocks, and one mimicking the value pattern in big stocks. The corresponding regression is specified in Equation (5). This simple manipulation leads to substantial benefits in terms of general regression fit. Column (4) of Table 4 reveals that the adjusted $\overline{R^2}$ measure goes up from 43% for the standard Fama-French model to 65% for our preferred specification. In line with our intuition, strong sensitivities to the HMLS factor are reflected in high average returns with an economically reasonable risk premium of about 6% p.a. On contrary, we find no feedback of HMLB exposures on average stock returns. We obtain similar estimates for North America, Europe, Asia Pacific, and Japan.

Column (5) shows that the performance of the standard Fama-French model can be improved substantially by including the HMLS factor only and completely ignoring the value premium in big stocks. The general fit of this specification is, however, lower than in the case of our preferred alternative summarized in column (4). These findings underscore our main point that the information provided in tiny, small stocks is important to understand systematic risk on stock markets.

Figure 1 provides a visual summary of these estimates for global equity portfolios. It plots the predicted average excess return on the horizontal axis and the actual sample average excess return on the vertical axis. Under perfect fit, all points would fall on the 45° line displayed in each graph. The digits in the figures denote the 25 global size and BE/ME- portfolios with a first digit standing for size (1 for smallest and 5 for biggest stocks) and the second digit standing for BE/ME (1 for extreme growth and 5 for extreme value). The four diagrams correspond to the CAPM, the three-factor Fama-French, the four-factor Carhart (1997), and a four-factor model with market, SMB, HMLS and HMLB factors.

[Insert Figure 1 here]

These results relate to two strands in literature. The first is on a strong relation between the value effect and factors associated with size (Reinganum (1981) and Fama and French (2012)). The second highlights the typical risk-based explanation for small stock and value premium via differences in the exposure to business cycle risk. Echoing Chan et al. (1985), Fama and French (1995) find evidence that the book-to-market effect proxies for relative distress. Along this line of reasoning, Chan and Chen (1991) show that small firms are more likely to suffer strongly from economic contractions than large stocks. This argument is reinforced for small firms among stocks with low price-to-fundamentals ratios and less pronounced for small firms among stocks with high respective ratios. Our estimates confirm that value stocks have higher average returns compared to their growth counterparts on grounds of their stronger exposure to risks underlying the HMLS factor.

In general, the cross-sectional regressions in Table 4 indicate that decomposing the value factor into its small and big stocks' components leads to more accurate pricing, greater explanatory power, and generally lower pricing errors. These results are driven by a strong relation between average stock returns on international value portfolios and their sensitivities to the HMLS factor.

4.2 Asset pricing tests for size- and momentum- sorted portfolios

A study of international size- and momentum sorted portfolios is particularly interesting in view of the failure of the three-factor Fama-French (1993) model to explain momentum (Fama and French (1996)). We first present the generated WML betas of size and momentum sorted global portfolios and their small and big components, WMLS and WMLB, and turn then to cross-sectional asset pricing tests.

Table 6 reveals a great variation in sensitivities of size and momentum sorted portfolio returns to WML, WMLS and WMLB. Past winner stocks typically have higher WML and WMLS betas than past loser stocks independently of firm size, whereas stocks with poor past performance and small ME tend to have higher WMLB exposures than the respective stocks with strong past performance. Most interestingly, the spread in WMLS betas is generally declining from past winners to past losers and from small to big stocks. A similar pattern is prevalent in the cross section of average returns of size and momentum sorted portfolios of regional and global returns. In stark contrast, both the WML and WMLB betas tend to increase from past winners to past losers and from small to big stocks. Moreover, negative betas of stocks with poor past performance are indicative of their hedging value, while significantly positive betas of stocks with strong past performance are informative of their riskiness. In sum, Table 6 signals an economic relation between average momentum returns and WMLS betas as opposed to the total WML or WMLB betas, in line with our previous findings concerning the size and value sorted stocks and their HMLS betas.

[Insert Table 6 here]

We employ the estimated betas to study the cross section of average momentum portfolio returns. Table 7 gives the cross-sectional estimates for models presented in Equations (2)-(4) and (6). All estimates and pricing errors are given in % p.a. Again, we additionally provide results for a model when we only use WMLS instead of WML in the four-factor Carhart (1997) model to gauge the importance of the small stock component.

The main results are easily summarized. The CAPM does a poor job of explaining size- and momentum- sorted portfolios. This failure is captured in the negative $\overline{R^2}$ statistic. In contrary to value portfolios, the original Fama-French (1993) factors have low fitting power for momentum portfolios and explain less than 10% of cross-sectional return variation of size- and momentum- sorted stocks. Adding the WML factor helps in this respect. The $\overline{R^2}$ statistic increases to about 60% and the pricing errors become substantially lower. Most strikingly, the standard Carhart (1997) model is further outperformed by our proposed modification which leads to a $\overline{R^2}$ statistic of slightly beyond 80%. Decomposing the WML factor into its small and big stocks components reveals that the momentum premium in small stocks drives the explanatory power of the WML factor. This finding echoes the evidence on the decomposed HML factor. As in the case of the HMLS factor in otherwise standard three-factor model, using WMLS improves remarkably the performance of the standard four-factor model but cannot beat our preferred alternative. Column (5) in Table 7 gives the corresponding results. Figure 2 provides a graphical summary of these estimates.

[Insert Table 7 here]

[Insert Figure 2 here]

The relative performance of the models remains unchanged for regional specifications summarized in Table 8. Decomposing the WML factor into a small stocks' component and a big stocks' component improves substantially the fit of the Carhart (1997) model. Japan is the only exception for which both the standard Carhart and the modified Carhart models do similarly well in terms of measures of fit and pricing errors.

[Insert Table 8 here]

To wrap up, our analysis points out that disentangling the risk sources associated with small and big stocks is important for cross-sectional asset pricing independent of the underlying characteristics the portfolio formation is based on. This result is valid for both global and domestic returns, value and momentum sorted portfolios. We find that small stocks are informative about common risks on international equity markets.

4.3 Asset pricing tests of international integration

Inspired by the international asset pricing theory and advancing financial market liberalization, a number of studies document the importance of global or "world" risk factors for the pricing of local stock returns (Harvey (1991), Campbell and Hamao (1992), and Hou et al. (2011)). Recently, however, the focus has shifted to firm-level characteristics related to size, book-to-market, and momentum, and several studies have found that local, region- or country-specific factors matter more for asset price determination than their global equivalents (Griffin (2002) and Fama and French (2012)). Griffin (2002) argues that country-specific versions of the three-factor Fama-French (1993) model provide a better description of international stock returns as compared to a global version of the model. His findings do not support the notion of globally integrated financial markets. By means of a GRS test, Fama and French (2012) similarly reject global versions of asset pricing models for region-specific returns. However, these studies highlight that asset pricing tests of international integration are also tests of the underlying asset pricing models. We show that extended versions of the Fama and French (1993) and Carhart (1997) models that take explicitly into account the factor risk premia in small stocks perform far better than the standard specifications. It is therefore natural to assess the degree of international integration by means of these modified models.

We first present results for the modified version of the three-factor Fama-French (1993) model which breaks the HML common risk factor into two components, one mimicking the value pattern in small stocks (HMLS), and one mimicking the value pattern in big stocks (HMLB). We ask whether global or regional factors are a better proxy of risk for regional size and book-to-market equity sorted stocks returns. Table 9 summarizes the findings. It reports estimates of regional and global versions of the model with markets excess returns, SMB, HMLS, and HMLB confronted with 25 size and BE/ME portfolios in four regions: North America, Europe, Japan, and Asia Pacific. Two observations are noteworthy. First, regional and global versions of HMLS are significantly priced in regional size and book-to-market equity sorted stock portfolio returns. HMLB is priced in Japanese stock returns along with HMLS but nowhere else. Second, the fit and the pricing errors are broadly similar between global and regional model versions. The only exception is Asia Pacific where the regional model clearly outperforms the global model. For all other regions a similar performance of the global and regional model versions signals an advanced degree of international equity markets integration.

[Insert Table 9 here]

Does this conclusion change once we regard other test assets? Table 10 provides estimates from global and regional versions of the modified Carhart (1997) model when confronted with regional size and momentum sorted stock portfolio returns. In this case regional models provide only a marginally better description of the data (except for North America) than the global model version.

[Insert Table 10 here]

Taken together, these tests suggest that global models are not necessarily a bad tool to explain regional markets. However, our results also highlight that the answer to the question on the market integration does not only dependent on the model specification but the choice of test assets is important. In our case, size and book-to-market ratio sorted stock portfolios signal a slightly higher degree of stock market integration compared to evidence based on size and momentum sorted stock portfolios.

5. Robustness

We conduct a number of robustness checks: We re-examine the time-series regressions performed in Fama and French (2012) and consider the proposed models with decomposed HML and WML factors. We estimate both in- and out-of-sample regressions, change the frequency of the data, and vary the number of test assets. We find that our conclusions remain qualitatively unaffected. All of these results are available upon request but not presented in detail to save space. The main results of these robustness checks can be summarized as follows.

5.1 Time series regressions

The decomposition of the HML and WML factors into small stock and big stock variants leaves the time-series tests discussed in Fama and French (2012) largely unaffected. The original Fama and French (1993) and Carhart (1997) models capture between 70% and 95% of the time series variation in size, value and momentum returns. Breaking the HML and WML factors along the size dimension cannot substantially improve the fit. Yet, a GRS test typically favours lower joint pricing errors for the modified models. The gains become stronger pronounced for a larger cross section of international portfolios comprised of both (i) size and value and (ii) size and momentum sorted portfolios.

5.2 In- and out-of-sample regressions

In a next exercise, we study the cross-sectional performance of models based on rolling window estimates of betas and average returns. We perform these regressions for 60-month rolling window estimates of betas and the average of the next 60-month rolling out-of-window returns on value and momentum stocks, individually and jointly. These results are representative for rolling windows of other lengths (we experimented with 36-, 48-, 72-, 90-, and 120-months) and in-sample returns estimated over the same rolling window. Our intuition is generally not affected by the way the betas are calculated and the average returns are measured. Out-of-sample regressions typically lead to a greater economic magnitude of risk premia but give further support for our main intuition.

5.3 Joint pricing of size-, value- and momentum-sorted stocks

So far, our findings suggest that value stocks are strongly related to HMLS factor, while momentum stocks reflect risks behind the WMLS factor. Relying on Fama and French (1995) and Chan and Chen (1991), we argue that small stocks are distress stocks which react strongly to adverse economic developments. This helps explain why small stocks contain important information about common risks on equity markets.

To examine the size effect in value and momentum factors jointly, we employ a large cross section of 50 portfolios containing both (i) size and value and (ii) size and momentum sorted stocks. We face these test assets with a six-factor model which emerges naturally[4] based on the decompositions in Equations (5) and (6):

$$E\left(R^{i,e}\right) = \lambda_M \beta_M^i + \lambda_{SMB}\beta_{SMB}^i + \lambda_{HMLS}\beta_{HMLS}^i + \lambda_{HMLB}\beta_{HMLB}^i + \lambda_{WMLS}\beta_{WMLS}^i + \lambda_{WMLB}\beta_{WMLB}^i. \quad (7)$$

Our results give strong support for the ability of small stocks to reflect common risks on equity markets. The model explains close to 80% of the cross-sectional variation in global size-, value- and momentum sorted stocks. The respective $\overline{R^2}$ measures vary between 50% for Asia Pacific and 87% for Europe for regional size-, value- and momentum sorted stocks.

[4] In an earlier draft of their manuscript, Fama and French (2012) show that this so-called „overkill“-model is strikingly successful in capturing the time-series patterns in the data but leave the cross-sectional properties of this representation unexplored.

5.4 Data frequency

Experiments with annual value and momentum portfolios do not alter our findings in any significant way. Our results prove robust to equal-weighted returns, pricing all international portfolios at a time in a pooled exercise, working with a lower number of assets and sample periods restricted to different time intervals.

6. Conclusions

This paper argues that recognizing the small stocks' and big stocks' components in the book-to-market (HML) risk factor of Fama and French (1993) and the momentum risk factor (WML) of Carhart (1997) has important cross-sectional asset pricing implications for sorts of stocks based on size, value, and momentum. Aggregate risk factors derived from small stock data reveal the sources of cross-sectional variation in stock returns and constitute a better measure of common risks than factors obtained from combinations of big and small stock data. This finding is consistent with the view that small stocks are particularly sensitive to business cycle fluctuations.

We find a robust pattern among value and momentum in global and regional stock returns: The value premium is positively related to the book-to-market factor in small stocks (HMLS). The momentum premium is positively related to the momentum factor in small stocks (WMLS). In contrast, the impact of the big stocks for risk-based explanations of cross-sectional dispersion in average stock returns is negligible. Modified models that explicitly account for risk factors derived from small stocks beat the standard Fama and French (1993) and Carhart (1997) models.

With respect to tests of stock market integration our tests provide no clear-cut picture. Regional and global factors generate roughly similar results but the conclusions depend on the underlying model specification and test assets.

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Table 1: Descriptive Statistics for International Value Portfolios

The table shows a summary of descriptive statistics of monthly excess returns (in %) on 25 portfolios formed on ME- and BE/ME. The sample period is November 1990 - March 2012.

	Mean						Std.				
	G	2	3	4	V	V-G	G	2	3	4	V
Global											
S	0.13	0.44	0.71	0.78	1.07	0.94	5.91	5.49	5.12	4.66	4.40
2	0.11	0.43	0.56	0.63	0.75	0.64	5.84	5.24	4.72	4.45	4.56
3	0.23	0.36	0.50	0.56	0.70	0.46	5.75	5.22	4.68	4.49	4.68
4	0.37	0.41	0.49	0.57	0.63	0.26	5.64	4.66	4.56	4.52	4.83
B	0.32	0.36	0.47	0.50	0.44	0.12	4.60	4.31	4.50	4.52	5.45
S-B	-0.19	0.09	0.24	0.27	0.63						
North America											
S	0.48	0.70	1.01	0.97	1.33	0.84	8.62	7.10	6.44	5.59	5.47
2	0.31	0.71	0.89	0.88	1.02	0.71	7.68	6.83	5.75	5.03	5.32
3	0.88	0.65	0.88	0.84	1.04	0.16	7.25	6.09	5.15	4.80	5.04
4	0.81	0.68	0.86	0.82	0.92	0.12	6.93	5.34	4.84	4.78	4.88
B	0.57	0.56	0.62	0.63	0.54	-0.03	4.85	4.30	4.42	4.38	5.51
S-B	-0.09	0.14	0.39	0.33	0.79						
Europe											
S	-0.13	0.24	0.40	0.57	0.76	0.89	5.86	5.51	5.24	5.02	4.97
2	0.14	0.35	0.46	0.67	0.78	0.64	5.89	5.52	5.19	5.25	5.43
3	0.23	0.46	0.55	0.56	0.73	0.50	6.03	5.41	5.26	5.40	5.66
4	0.40	0.52	0.58	0.56	0.73	0.33	5.61	5.08	5.14	5.48	5.93
B	0.36	0.49	0.58	0.71	0.59	0.23	4.97	4.89	5.31	5.70	6.50
S-B	-0.48	-0.25	-0.18	-0.13	0.17						
Japan											
S	-0.12	-0.07	0.07	0.12	0.27	0.39	9.15	7.64	7.44	7.17	7.13
2	-0.41	-0.35	-0.09	0.04	0.07	0.47	8.14	7.65	7.04	6.95	7.10
3	-0.36	-0.34	-0.23	-0.11	0.16	0.52	7.77	6.94	6.59	6.35	6.86
4	-0.47	-0.16	-0.18	0.00	0.08	0.55	7.32	6.32	5.95	5.94	6.73
B	-0.30	-0.08	-0.11	0.18	0.35	0.64	6.82	5.90	6.08	5.93	7.31
S-B	0.18	0.02	0.17	-0.06	-0.08						
Asia Pacific											
S	0.36	0.54	0.79	1.07	1.51	1.15	8.25	8.08	7.47	7.38	7.41
2	0.10	0.44	0.55	0.70	0.95	0.85	7.21	7.70	7.06	7.28	7.87
3	0.12	0.66	0.86	0.94	0.84	0.72	7.48	6.83	7.03	7.05	7.85
4	0.76	0.90	0.66	1.02	1.18	0.43	6.81	6.37	6.52	6.86	8.43
B	0.64	0.93	0.93	0.84	1.03	0.39	6.46	6.25	6.49	6.70	8.21
S-B	-0.29	-0.39	-0.14	0.23	0.48						

Table 2: Descriptive Statistics for International Momentum Portfolios

The table shows a summary of descriptive statistics of monthly excess returns (in %) on 25 portfolios formed on ME- and momentum. The sample period is November 1990 - March 2012.

	Mean						Std.				
	L	2	3	4	W	W-L	L	2	3	4	W
					Global						
S	0.14	0.64	0.75	1.08	1.48	1.35	6.46	4.41	3.99	4.10	5.46
2	0.13	0.47	0.53	0.74	1.04	0.91	6.72	4.67	4.21	4.24	5.56
3	0.24	0.45	0.52	0.55	0.80	0.56	6.68	4.92	4.30	4.22	5.56
4	0.25	0.44	0.50	0.53	0.82	0.57	6.62	4.80	4.23	4.26	5.38
B	0.12	0.33	0.37	0.51	0.57	0.45	6.30	4.61	4.12	4.22	5.37
S-B	0.01	0.31	0.38	0.57	0.91						
					North America						
S	0.49	0.92	1.12	1.45	1.86	1.37	7.71	5.12	4.80	5.35	7.11
2	0.49	0.92	0.90	0.96	1.43	0.94	7.92	5.22	4.89	4.98	7.47
3	0.56	0.72	0.90	1.01	1.22	0.66	7.45	5.17	4.61	4.80	6.94
4	0.55	0.78	0.83	0.77	1.23	0.68	7.34	4.82	4.34	4.46	6.53
B	0.39	0.53	0.46	0.70	0.94	0.55	6.56	4.57	3.96	4.25	6.16
S-B	0.10	0.39	0.66	0.75	0.92						
					Europe						
S	-0.36	0.34	0.53	0.95	1.65	2.01	6.62	4.92	4.62	4.50	5.55
2	-0.24	0.33	0.61	0.80	1.38	1.62	6.98	5.42	4.98	4.86	5.71
3	0.12	0.38	0.57	0.70	1.04	0.92	7.12	5.52	5.03	4.91	5.73
4	0.18	0.47	0.59	0.74	1.05	0.87	7.26	5.56	5.04	5.08	5.50
B	0.19	0.45	0.63	0.61	0.68	0.49	7.60	5.69	4.86	4.88	5.64
S-B	-0.55	-0.12	-0.11	-0.34	0.97						
					Japan						
S	0.24	0.31	0.20	0.26	-0.02	-0.26	8.71	7.08	6.53	6.37	7.74
2	-0.03	-0.01	-0.01	0.05	-0.05	-0.02	8.56	6.97	6.48	6.51	7.24
3	-0.05	-0.18	-0.08	-0.02	-0.03	0.02	7.95	6.75	6.04	6.11	6.80
4	-0.07	-0.07	-0.15	-0.14	-0.05	0.03	7.84	6.46	5.98	5.82	6.56
B	-0.10	-0.23	-0.30	-0.13	-0.07	0.02	8.17	6.43	6.06	5.79	6.76
S-B	0.34	0.54	0.49	0.39	0.05						
					Asia Pacific						
S	0.49	0.96	1.25	1.83	1.61	1.11	8.59	6.91	6.46	6.92	8.13
2	-0.23	0.76	0.77	1.03	1.07	1.30	9.02	7.21	6.41	6.55	7.72
3	0.05	0.52	0.74	1.20	1.18	1.13	8.87	6.82	6.23	6.60	7.93
4	0.39	0.89	0.78	0.94	1.19	0.80	8.73	7.32	6.04	6.05	7.79
B	1.09	0.81	1.02	0.98	1.06	-0.03	8.83	7.28	6.61	6.37	7.09
S-B	-0.60	0.25	0.23	0.85	0.55						

Table 3: HML, HMLS and HMLB Betas of Global Value Portfolios

The table shows the estimated HML (β_{HML}), HMLS (β_{HMLS}) and HMLB (β_{HMLB}) betas 25 global portfolios formed on size and BE/ME. Significant estimates at the 5% level are highlighted in bold face. The sample period is November 1990 - March 2012.

	G	2	3	4	V	V-G
			HML Beta			
S	**-0.45**	**-0.21**	0.01	**0.25**	**0.46**	**0.92**
2	**-0.47**	**-0.13**	**0.11**	**0.44**	**0.63**	**1.10**
3	**-0.56**	**-0.14**	**0.28**	**0.50**	**0.68**	**1.23**
4	**-0.56**	**0.08**	**0.31**	**0.49**	**0.70**	**1.26**
B	**-0.61**	**-0.06**	**0.21**	**0.41**	**0.58**	**1.19**
S-B	**0.16**	**-0.15**	**-0.20**	**-0.16**	**-0.11**	
			HMLS Beta			
S	**-0.58**	**-0.37**	**-0.14**	**0.14**	**0.49**	**1.07**
2	**-0.55**	**-0.33**	0.02	**0.32**	**0.59**	**1.14**
3	**-0.49**	**-0.19**	**0.16**	**0.32**	**0.51**	**0.99**
4	**-0.44**	**0.10**	**0.25**	**0.30**	**0.30**	**0.74**
B	-0.02	0.06	-0.01	-0.02	**-0.19**	**-0.17**
S-B	**-0.56**	**-0.43**	**-0.13**	**0.16**	**0.67**	
			HMLB Betas			
S	0.08	**0.13**	**0.13**	**0.11**	0.01	-0.08
2	0.04	**0.17**	**0.08**	**0.13**	**0.08**	0.04
3	**-0.10**	0.04	**0.12**	**0.19**	**0.19**	**0.28**
4	**-0.14**	-0.01	**0.07**	**0.20**	**0.39**	**0.53**
B	**-0.56**	**-0.11**	**0.21**	**0.40**	**0.71**	**1.27**
S-B	**0.65**	**0.23**	-0.07	**-0.29**	**-0.70**	

Table 4: Baseline Asset Pricing Tests for Global Value Portfolios

The table reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using 25 global portfolios formed on size and BE/ME; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are (1) the CAPM; (2) three-factor Fama-French (1993); (3) four-factor Carhart (1997); and (4) the modified Fama-French model with HMLS and HMLB. Column (5) presents results when we use only the HMLS factor to replace HML. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

	(1)	(2)	(3)	(4)	(5)
λ_M	5.77	4.26	5.26	4.70	4.31
	(6.96)	(4.95)	(5.47)	(6.72)	(5.63)
λ_{SMB}		1.79	1.22	1.87	1.88
		(1.53)	(1.11)	(2.03)	(1.79)
λ_{HML}		5.03	5.30		
		(3.79)	(4.40)		
λ_{WML}			26.97		
			(1.59)		
λ_{HMLS}				5.99	4.59
				(4.59)	(3.68)
λ_{HMLB}				1.97	
				(1.00)	
$\overline{R^2}$	-0.37	0.43	0.54	0.65	0.54
MSPE	0.70	0.27	0.21	0.16	0.22
MAPE	2.24	1.26	1.08	1.16	1.20

Table 5: Summary of Baseline Asset Pricing Tests for Regional Value Portfolios

The table reports a summary of the second-stage Fama-MacBeth (1973) regressions in % p.a. using 25 regional portfolios formed on size and BE/ME. For further details see notes to Table 4.

	$\overline{R^2}$	*MSPE*	*MAPE*	$\overline{R^2}$	*MSPE*	*MAPE*
	North America			Europe		
CAPM	-0.64	0.89	2.62	0.00	0.52	1.87
3F-FF	0.26	0.37	1.54	0.69	0.15	0.99
4F-Carhart	0.60	0.19	1.11	0.76	0.11	0.82
Modified FF	0.61	0.19	1.12	0.84	0.08	0.72
	Japan			Asia Pacific		
CAPM	0.02	0.53	2.06	-0.04	1.19	2.84
3F-FF	0.65	0.17	1.26	0.24	0.80	2.57
4F-Carhart	0.70	0.14	1.16	0.43	0.57	2.22
Modified FF	0.64	0.17	1.26	0.50	0.51	1.95

Table 6: WML, WMLS, and WMLB Betas of Global Size and Momentum Portfolios

The table shows the estimated WML (β_{WML}), WMLS (β_{WMLS}) and WMLB (β_{WMLB}) betas for 25 global portfolios formed on size and momentum. Significant estimates at the 5% level are highlighted in bold face. The sample period is November 1990 - March 2012.

	L	2	3	4	W	W-L
			WML Beta			
S	**-0.59**	**-0.17**	-0.01	**0.13**	**0.34**	**0.93**
2	**-0.68**	**-0.22**	-0.02	**0.15**	**0.42**	**1.10**
3	**-0.66**	**-0.27**	**-0.04**	**0.15**	**0.49**	**1.15**
4	**-0.71**	**-0.27**	**-0.04**	**0.20**	**0.54**	**1.25**
B	**-0.70**	**-0.27**	0.02	**0.29**	**0.64**	**1.34**
S-B	**0.11**	**0.10**	-0.03	**-0.16**	**-0.30**	
			WMLS Beta			
S	**-0.64**	**-0.19**	0.03	**0.20**	**0.49**	**1.13**
2	**-0.70**	**-0.24**	-0.04	**0.19**	**0.51**	**1.21**
3	**-0.57**	**-0.24**	**-0.09**	**0.09**	**0.44**	**1.01**
4	**-0.39**	**-0.18**	**-0.06**	**0.06**	**0.32**	**0.71**
B	0.02	**0.10**	**0.08**	0.02	**-0.07**	**-0.09**
S-B	**-0.66**	**-0.29**	-0.05	**0.18**	**0.56**	
			WMLB Beta			
S	-0.00	0.01	-0.03	-0.05	**-0.10**	**-0.10**
2	-0.04	0.00	0.01	-0.02	**-0.04**	0.01
3	**-0.13**	-0.04	0.04	**0.07**	**0.08**	**0.21**
4	**-0.32**	**-0.10**	0.01	**0.13**	**0.22**	**0.55**
B	**-0.66**	**-0.33**	-0.05	**0.25**	**0.65**	**1.31**
S-B	**0.66**	**0.34**	0.02	**-0.30**	**-0.75**	

Table 7: Baseline Asset Pricing Tests for Global Momentum Portfolios

The table reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using 25 global portfolios formed on size and momentum; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are (1) the CAPM; (2) three-factor Fama-French (1993); (3) four-factor Carhart (1997); and (4) the modified Carhart model. Column (5) presents results when we use only the WMLS factor to replace WML. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

	(1)	(2)	(3)	(4)	(5)
λ_M	6.28	4.18	4.61	4.40	4.58
	(5.00)	(2.38)	(4.06)	(5.43)	(4.56)
λ_{SMB}		5.74	3.42	3.73	3.36
		(2.39)	(2.07)	(3.17)	(2.31)
λ_{HML}		-4.51	3.67	4.19	4.26
		(-1.13)	(1.12)	(1.79)	(1.47)
λ_{WML}			7.38		
			(4.37)		
λ_{WMLS}				9.64	7.28
				(6.31)	(4.86)
λ_{WMLB}				3.14	
				(1.48)	
$\overline{R^2}$	-0.37	0.09	0.62	0.81	0.70
MSPE	1.61	0.98	0.39	0.19	0.30
MAPE	3.30	2.57	1.58	1.12	1.39

Table 8: Summary of Baseline Asset Pricing Tests for Regional Momentum Portfolios

The table reports a summary of the second-stage Fama-MacBeth (1973) regressions in % p.a. using 25 regional portfolios formed on size and momentum. For further details see notes to Table 7.

	$\overline{R^2}$	*MSPE*	*MAPE*	$\overline{R^2}$	*MSPE*	*MAPE*
	North America			Europe		
CAPM	-0.32	1.94	3.81	-0.27	2.86	4.50
3F-FF	0.11	1.19	2.84	0.09	1.89	3.60
4F-Carhart	0.76	0.31	1.44	0.64	0.71	2.15
Modified Carhart	0.83	0.20	1.21	0.89	0.20	1.19
	Japan			Asia Pacific		
CAPM	-0.00	0.25	1.22	-0.33	2.91	4.32
3F-FF	0.48	0.12	0.97	0.16	1.68	3.27
4F-Carhart	0.46	0.12	0.96	0.21	1.51	3.22
Modified Carhart	0.46	0.11	0.93	0.40	1.10	2.81

Table 9: Global versus Regional Pricing Factors and Regional Value Portfolios

The table reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using 25 regional portfolios formed on size and BE/ME; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are the regional and global versions of the modified Fama-French model. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

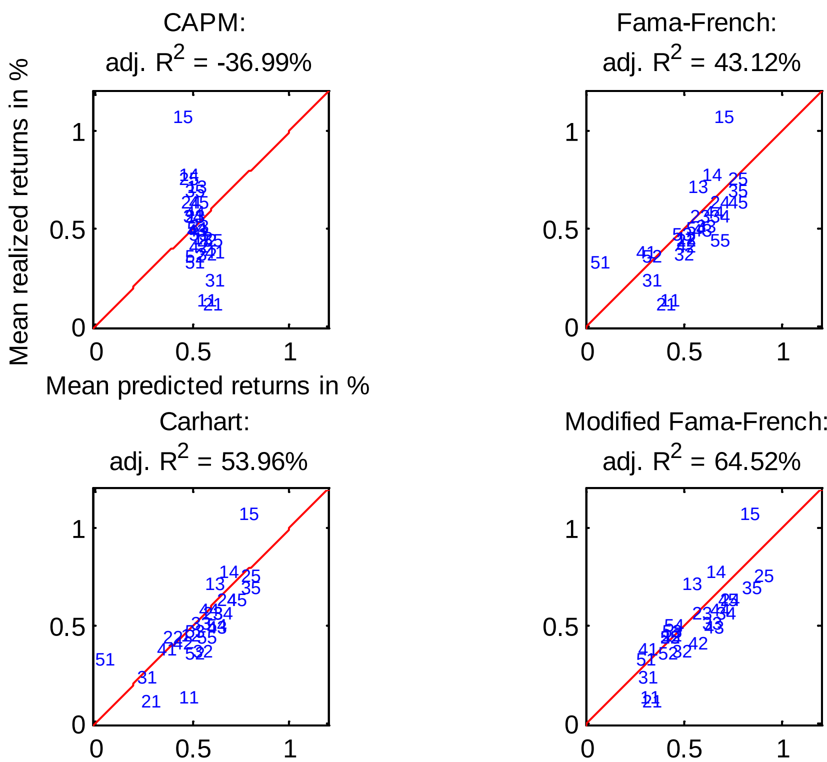
Factors	North America		Europe		Japan		Asia Pacific	
Returns	local	global	local	global	local	global	local	global
λ_M	8.12	10.71	6.18	6.81	-1.79	-4.54	9.89	5.76
	(10.49)	(13.33)	(13.18)	(6.85)	(-2.31)	(-1.61)	(8.17)	(2.43)
λ_{SMB}	2.56	3.36	-0.90	-0.47	-0.35	-3.82	-1.40	-2.11
	(2.64)	(3.10)	(-1.37)	(-0.51)	(-0.37)	(-1.94)	(-0.85)	(-0.68)
λ_{HMLS}	6.10	6.73	6.23	5.13	5.00	9.20	9.45	11.59
	(4.13)	(4.16)	(7.12)	(5.88)	(3.40)	(4.37)	(3.48)	(2.50)
λ_{HMLB}	-0.34	0.99	2.28	1.59	6.83	2.85	1.69	1.83
	(-0.16)	(0.58)	(1.68)	(0.79)	(3.55)	(0.70)	(0.48)	(0.21)
$\overline{R^2}$	0.61	0.64	0.84	0.81	0.64	0.64	0.50	0.30
MSPE	0.19	0.17	0.08	0.09	0.17	0.17	0.51	0.70
MAPE	1.12	1.04	0.72	0.77	1.26	1.22	1.95	2.11

Table 10: Global versus Regional Pricing Factors and Regional Momentum Portfolios

The table reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using 25 regional portfolios formed on size and BE/ME; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are the regional and global versions of the modified Carhart model. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

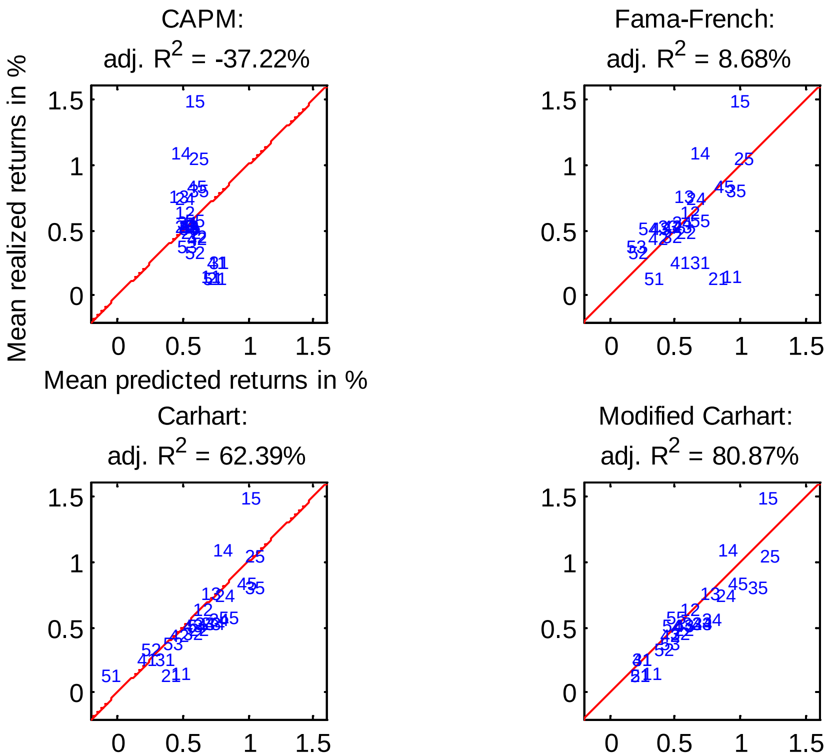
Factors	North America		Europe		Japan		Asia Pacific	
Returns	local	global	local	global	local	global	local	global
λ_M	7.16	9.45	6.17	4.08	-1.97	-3.77	10.57	7.00
	(8.44)	(12.71)	(7.25)	(3.41)	(-2.65)	(-3.10)	(5.26)	(1.86)
λ_{SMB}	4.42	2.79	0.98	3.81	3.19	2.90	1.53	-2.12
	(3.38)	(2.49)	(0.79)	(2.26)	(2.52)	(2.46)	(0.40)	(-0.50)
λ_{HML}	7.85	5.82	5.34	3.71	-0.53	0.05	-6.36	6.75
	(2.96)	(3.12)	(1.52)	(1.13)	(-0.14)	(0.02)	(-0.32)	(0.78)
λ_{WMLS}	9.57	8.18	15.47	23.11	-0.78	0.23	12.94	21.77
	(6.12)	(4.24)	(9.76)	(9.09)	(-0.65)	(0.16)	(3.28)	(2.62)
λ_{WMLB}	4.59	3.27	4.23	4.13	0.72	2.50	1.85	14.46
	(2.03)	(1.56)	(1.96)	(1.52)	(0.43)	(0.64)	(0.33)	(1.84)
$\overline{R^2}$	0.83	0.84	0.89	0.89	0.46	0.43	0.40	0.36
MSPE	0.20	0.19	0.20	0.22	0.11	0.12	1.10	1.17
MAPE	1.21	1.19	1.19	1.25	0.93	0.97	2.81	3.07

Figure 1: The cross section of global value portfolios



The four diagrams correspond to (clockwise from top left) the CAPM, the three-factor Fama-French (1993) model, the four-factor Carhart (1997) model, and the modified Fama-French (1993) model with HML split into HMLS and HMLB. The horizontal axes correspond to the predicted average excess returns and the vertical axes to the sample average realized excess returns. The predicted values are from regressions presented in Table 4 of the manuscript. The test assets are 25 global portfolios formed on size and BE/ME.

Figure 2: The cross section of global momentum portfolios



The four diagrams correspond to (clockwise from top left) the CAPM, the three-factor Fama-French (1993) model, the four-factor Carhart (1997) model, and the modified Carhart (1997) model with WML split into WMLS and WMLB. The horizontal axes correspond to the predicted average excess returns and the vertical axes to the sample average realized excess returns. The predicted values are from regressions presented in Table 7 of the manuscript. The test assets are 25 global portfolios formed on size and momentum.

Appendix to "The size effect in value and momentum factors: Implications for the cross-section of international stock returns"

Table 1A: Size, value, and momentum risk factors

The table shows monthly average returns, standard deviations, *t*-statistics and correlation coefficients of common risk factors. Mkt, SMB, and HML are the standard market, size, and value factors of Fama and French (1993); WML is the momentum factor of Carhart (1997); HMLS, HMLB, WMLS and WMLB are constructed following Fama and French (2012) as SV-SG, BV-BG, SW-SL, and BW-BL, respectively. Correlation coefficients significant at the 5% level are highlighted in bold face. The sample period is November 1990 - March 2012.

	Mean	Correlation							
		Mkt	SMB	HML	WML	HMLS	HMLB	WMLS	WMLB
					Global				
Mkt	0.42	1.00							
SMB	0.10	-0.01	1.00						
HML	**0.38**	**-0.15**	**-0.18**	1.00					
WML	**0.59**	**-0.22**	**0.18**	**-0.24**	1.00				
HMLS	**0.61**	**-0.38**	**-0.28**	**0.90**	-0.11	1.00			
HMLB	0.16	0.12	-0.05	**0.90**	**-0.33**	**0.61**	1.00		
WMLS	**0.80**	**-0.26**	**0.12**	**-0.23**	**0.95**	-0.08	**-0.33**	1.00	
WMLB	0.38	**-0.18**	**0.21**	**-0.24**	**0.96**	**-0.13**	**-0.30**	**0.83**	1.00
					North America				
Mkt	**0.65**	1.00							
SMB	0.21	**0.23**	1.00						
HML	0.28	**-0.25**	**-0.36**	1.00					
WML	0.61	**-0.13**	**0.23**	**-0.23**	1.00				
HMLS	**0.53**	**-0.38**	**-0.51**	**0.94**	**-0.16**	1.00			
HMLB	0.04	-0.03	-0.09	**0.89**	**-0.27**	**0.68**	1.00		
WMLS	**0.81**	**-0.16**	**0.21**	**-0.22**	**0.96**	**-0.15**	**-0.26**	1.00	
WMLB	0.40	-0.10	**0.23**	**-0.22**	**0.96**	**-0.16**	**-0.26**	**0.85**	1.00
					Europe				
Mkt	0.51	1.00							
SMB	-0.06	**-0.15**	1.00						
HML	0.42	**0.15**	-0.07	1.00					
WML	**0.90**	**-0.30**	0.08	**-0.35**	1.00				
HMLS	**0.56**	**-0.13**	-0.10	**0.84**	-0.04	1.00			
HMLB	0.28	**0.37**	-0.01	**0.86**	**-0.38**	**0.44**	1.00		
WMLS	**1.34**	**-0.28**	0.08	**-0.22**	**0.94**	-0.01	**-0.36**	1.00	
WMLB	0.46	**-0.29**	0.07	**-0.25**	**0.96**	-0.06	**-0.37**	**0.80**	1.00
					Japan				
Mkt	-0.10	1.00							
SMB	-0.06	**0.13**	1.00						
HML	**0.47**	**-0.19**	0.08	1.00					
WML	0.03	**-0.21**	**-0.16**	**-0.20**	1.00				
HMLS	**0.47**	**-0.27**	**-0.21**	**0.80**	-0.11	1.00			
HMLB	**0.48**	-0.07	**0.29**	**0.88**	**-0.21**	**0.42**	1.00		
WMLS	-0.04	**-0.20**	**-0.17**	**-0.17**	**0.90**	-0.10	**-0.18**	1.00	
WMLB	0.10	**-0.19**	**-0.13**	**-0.19**	**0.95**	-0.10	**-0.21**	**0.72**	1.00

Asia Pacific									
Mkt	**0.81**	1.00							
SMB	-0.22	0.03	1.00						
HML	**0.58**	**0.13**	-0.06	1.00					
WML	**0.69**	**-0.25**	0.05	**-0.34**	1.00				
HMLS	**0.88**	-0.06	0.06	**0.80**	**-0.13**	1.00			
HMLB	0.29	**0.24**	**-0.13**	**0.89**	**-0.41**	**0.44**	1.00		
WMLS	**1.03**	**-0.22**	0.04	**-0.29**	**0.90**	-0.11	**-0.35**	1.00	
WMLB	0.35	**-0.23**	0.05	**-0.33**	**0.94**	**-0.13**	**-0.40**	**0.70**	1.00

Table 2A: Time series regressions with value stocks

The table reports a summary of the first-stage Fama-MacBeth (1973) regressions using the 25 portfolios formed on size and BE/ME. The tested models are the CAPM, three-factor Fama-French (1993) model, four-factor Carhart (1997) model, and the modified Fama-French model. The GRS statistic tests whether all intercepts in a set of 25 regressions are zero; a is the average intercept; |a| is the average absolute intercept; s(a) is the average standard error of the intercepts; and $\overline{R^2}$ is the average adjusted $\overline{R^2}$. With 25 portfolios and 257 monthly returns, critical values of the GRS statistic for all models are: 90%: 1.41; 95%: 1.55; 99%: 1.86. The sample period is November 1990 - March 2012.

	GRS	a	|a|	s(a)	$\overline{R^2}$	GRS	a	|a|	s(a)	$\overline{R^2}$
	North America					Europe				
CAPM	2.97	0.07	0.22	0.18	0.74	1.47	-0.00	0.16	0.14	0.82
3F-FF	2.82	-0.03	0.13	0.09	0.93	1.19	-0.01	0.08	0.08	0.94
4F-Carhart	2.51	-0.01	0.12	0.10	0.93	1.10	0.01	0.07	0.09	0.94
Modified FF	1.83	0.02	0.09	0.10	0.93	0.96	-0.00	0.07	0.08	0.95
	Japan					Asia Pacific				
CAPM	1.21	0.02	0.17	0.21	0.77	2.82	-0.07	0.24	0.21	0.79
3F-FF	0.97	-0.02	0.11	0.12	0.93	2.56	0.00	0.21	0.15	0.89
4F-Carhart	0.96	-0.02	0.10	0.12	0.93	2.28	0.03	0.19	0.15	0.89
Modified FF	0.97	-0.02	0.11	0.11	0.94	1.87	0.06	0.19	0.15	0.90

Table 3A: Time series regressions with momentum stocks

The table reports a summary of the first-stage Fama-MacBeth (1973) regressions using the 25 portfolios formed on size and momentum. The tested models are the CAPM, three-factor Fama-French (1993) model, four-factor Carhart (1997) model, and the modified Carhart model. The GRS statistic tests whether all intercepts in a set of 25 regressions are zero; a is the average intercept; |a| is the average absolute intercept; s(a) is the average standard error of the intercepts; and $\overline{R^2}$ is the average adjusted $\overline{R^2}$. With 25 portfolios and 257 monthly returns, critical values of the GRS statistic for all models are: 90%: 1.41; 95%: 1.55; 99%: 1.86. The sample period is November 1990 - March 2012.

	GRS	a	|a|	s(a)	$\overline{R^2}$	GRS	a	|a|	s(a)	$\overline{R^2}$
	North America					Europe				
CAPM	3.36	0.19	0.36	0.20	0.70	4.39	0.08	0.38	0.16	0.78
3F-FF	3.32	0.06	0.31	0.15	0.83	4.58	0.04	0.41	0.13	0.87
Carhart	3.00	0.09	0.14	0.10	0.92	3.48	0.09	0.18	0.10	0.93
4F-FF	2.73	0.10	0.14	0.10	0.93	1.94	0.09	0.13	0.10	0.94
	Japan					Asia Pacific				
CAPM	0.77	0.07	0.12	0.22	0.75	4.43	0.06	0.37	0.22	0.77
3F-FF	0.90	-0.01	0.13	0.15	0.87	4.63	0.10	0.46	0.18	0.85
Carhart	0.93	-0.01	0.10	0.12	0.92	3.83	0.14	0.28	0.15	0.89
4F-FF	0.93	-0.00	0.11	0.11	0.93	3.24	0.13	0.26	0.15	0.90

Table 4A: Time series regressions with value and momentum stocks

The table reports a summary of the first-stage Fama-MacBeth (1973) regressions using (i) the 25 portfolios formed on size and BE/ME and (ii) 25 portfolios formed on size and momentum. The tested models are the CAPM, three-factor Fama-French (1993) model, four-factor Carhart (1997) model, and a six-factor model with Mkt, SMB, HMLS, HMLB, WMLS, and WMLB factors. The GRS statistic tests whether all intercepts in a set of 25 regressions are zero; a is the average intercept; |a| is the average absolute intercept; s(a) is the average standard error of the intercepts; and $\overline{R^2}$ is the average adjusted $\overline{R^2}$. With 25 portfolios and 257 monthly returns, critical values of the GRS statistic for all models are: 90%: 1.41; 95%: 1.55; 99%: 1.86. The sample period is November 1990 - March 2012.

	GRS	a	|a|	s(a)	$\overline{R^2}$	GRS	a	|a|	s(a)	$\overline{R^2}$
	North America					Europe				
CAPM	2.61	0.13	0.29	0.19	0.72	2.95	0.04	0.27	0.15	0.80
3F-FF	2.47	0.01	0.22	0.12	0.88	2.75	0.02	0.25	0.11	0.90
4F-Carhart	2.30	0.04	0.13	0.10	0.92	2.20	0.05	0.12	0.09	0.94
6F-FF+Carhart	1.70	0.07	0.11	0.10	0.93	1.43	0.06	0.10	0.09	0.95
	Japan					Asia Pacific				
CAPM	1.00	0.05	0.14	0.21	0.76	3.26	-0.00	0.30	0.22	0.78
3F-FF	0.90	-0.02	0.12	0.14	0.90	3.09	0.05	0.34	0.17	0.87
4F-Carhart	0.92	-0.01	0.10	0.12	0.93	2.67	0.08	0.24	0.15	0.89
6F-FF+Carhart	0.93	-0.01	0.11	0.11	0.93	2.11	0.11	0.22	0.16	0.90

Table 5A: Asset pricing tests with value portfolios

The tables reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using 25 portfolios formed on size and BE/ME over 1990:11-2012:03; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are (1) the CAPM; (2) three-factor Fama-French (1993); (3) four-factor Carhart (1997); and (4) the modified Fama-French model. Column (5) presents results when we use only the HMLS factor to replace HML. Significant estimates at the 5% level are highlighted in bold face. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**8.33**	**7.21**	**8.54**	**8.12**	**7.28**	**6.04**	**5.94**	**6.46**	**6.18**	**6.02**
λ_{SMB}		2.56	**2.02**	**2.56**	**2.66**		-0.92	-1.10	-0.90	-0.88
λ_{HML}		**4.52**	**4.99**				**5.29**	**4.99**		
λ_{WML}			**35.79**					15.47		
λ_{HMLS}				**6.10**	**3.98**				**6.23**	**5.61**
λ_{HMLB}				-0.34					2.28	
$\overline{R^2}$	-0.64	0.26	0.60	0.61	0.37	0.00	0.69	0.76	0.84	0.80
MSPE	0.89	0.37	0.19	0.19	0.31	0.52	0.15	0.11	0.08	0.09
MAPE	2.62	1.54	1.11	1.12	1.42	1.87	0.99	0.82	0.72	0.81
	Japan					Asia Pacific				
λ_M	-1.01	**-1.77**	-1.42	-1.79	-1.45	**8.93**	**8.78**	**10.12**	**9.89**	**9.10**
λ_{SMB}		-0.34	-0.33	-0.35	-0.21		-0.70	-2.17	-1.40	-0.90
λ_{HML}		**5.90**	**5.99**				**6.23**	**6.79**		
λ_{WML}			11.04					25.31		
λ_{HMLS}				**5.00**	**5.98**				**9.45**	**7.25**
λ_{HMLB}				**6.83**					1.69	
$\overline{R^2}$	0.02	0.65	0.70	0.64	0.54	-0.04	0.24	0.43	0.50	0.41
MSPE	0.53	0.17	0.14	0.17	0.23	1.19	0.80	0.57	0.51	0.62
MAPE	2.06	1.26	1.16	1.26	1.32	2.84	2.57	2.22	1.95	2.26

Table 6A: Asset pricing tests with momentum portfolios

The tables reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using 25 portfolios formed on size and momentum over 1990:11-2012:03; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are (1) the CAPM; (2) three-factor Fama-French (1993); (3) Carhart (1997); and (4) the modified Carhart model. Column (5) presents results when we use only the WMLS factor to replace WML. Significant estimates at the 5% level are highlighted in bold face. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**9.53**	**6.23**	**7.35**	**7.16**	**7.32**	**6.45**	**6.62**	**6.35**	**6.17**	**6.27**
λ_{SMB}		**8.40**	**4.18**	**4.42**	**4.15**		3.58	1.06	0.98	0.82
λ_{HML}		-2.52	**7.09**	**7.85**	**7.57**		**-14.96**	3.75	5.34	5.83
λ_{WML}			**8.03**					**11.04**		
λ_{WMLS}				**9.57**	**8.16**				**15.47**	**12.00**
λ_{WMLB}				**4.59**					**4.23**	
$\overline{R^2}$	-0.32	0.11	0.76	0.83	0.80	-0.27	0.09	0.64	0.89	0.77
MSPE	1.94	1.19	0.31	0.20	0.25	2.86	1.89	0.71	0.20	0.46
MAPE	3.81	2.84	1.44	1.21	1.34	4.50	3.60	2.15	1.19	1.84
	Japan					Asia Pacific				
λ_M	-0.35	**-2.05**	**-2.02**	**-1.97**	**-1.97**	**9.97**	**11.41**	**10.48**	**10.57**	**10.12**
λ_{SMB}		**3.13**	**3.23**	**3.19**	**3.34**		2.88	-0.46	1.53	-0.93
λ_{HML}		-0.09	-0.50	-0.53	-0.98		**-18.05**	4.05	-6.36	8.57
λ_{WML}			-0.15					**8.83**		
λ_{WMLS}				-0.78	-0.38				**12.94**	**11.23**
λ_{WMLB}				0.72					1.85	
$\overline{R^2}$	-0.00	0.48	0.46	0.46	0.46	-0.33	0.16	0.21	0.40	0.36
MSPE	0.25	0.12	0.12	0.11	0.12	2.91	1.68	1.51	1.10	1.23
MAPE	1.22	0.97	0.96	0.93	0.96	4.32	3.27	3.22	2.81	2.95

Table 7A: Asset pricing tests with value and momentum portfolios

The tables reports the second-stage Fama-MacBeth (1973) estimates in % p.a. using (i) 25 portfolios formed on size and BE/ME and (ii) 25 portfolios formed on size and momentum over 1990:11-2012:03; Shanken (1992) corrected *t*-statistics are in parentheses. The tested models are (1) the CAPM; (2) three-factor Fama-French (1993); (3) Carhart (1997); and (4) a six-factor model with Mkt, SMB, HMLS, HMLB, WMLS, and WMLB factors. Column (5) presents results when we use only the HMLS factor to replace HML, and WMLS factor to replace WML. Significant estimates at the 5% level are highlighted in bold face. Mean squared pricing errors *(MSPE)* and mean absolute pricing errors *(MAPE)* are in % p.a.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**8.92**	**6.35**	**7.60**	**8.21**	**7.71**	**6.25**	**5.42**	**6.33**	**6.37**	**6.49**
λ_{SMB}		**5.00**	**3.18**	**3.26**	**3.21**		0.85	-0.17	-0.02	-0.19
λ_{HML}		3.52	**5.57**				1.95	**5.20**		
λ_{WML}			**8.19**					**11.01**		
λ_{HMLS}				**7.06**	**5.44**				**6.26**	**6.33**
λ_{HMLB}				0.39					3.40	
λ_{WMLS}				**9.43**	**8.23**				**15.45**	**11.66**
λ_{WMLB}				**5.44**					**3.96**	
$\overline{R^2}$	-0.40	-0.04	0.65	0.78	0.71	-0.20	-0.22	0.66	0.87	0.76
MSPE	1.45	1.04	0.34	0.21	0.28	1.69	1.65	0.45	0.16	0.31
MAPE	3.33	2.58	1.47	1.15	1.36	3.18	3.07	1.48	1.04	1.26

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	Japan					Asia Pacific				
λ_M	-0.69	**-2.15**	**-2.14**	**-2.10**	**-1.85**	**9.45**	**9.12**	**9.88**	**10.49**	**10.21**
λ_{SMB}		0.57	0.51	0.49	0.57		0.65	-1.16	-1.31	-1.37
λ_{HML}		**5.43**	**5.96**				1.27	**6.83**		
λ_{WML}			0.03					**9.29**		
λ_{HMLS}				**5.20**	**5.80**				**10.30**	**9.21**
λ_{HMLB}				**6.64**					0.14	
λ_{WMLS}				-0.26	0.12				**12.56**	**10.87**
λ_{WMLB}				0.45					3.57	
$\overline{R^2}$	0.01	0.49	0.54	0.52	0.48	-0.21	-0.26	0.31	0.50	0.47
MSPE	0.40	0.20	0.18	0.17	0.20	2.08	2.07	1.11	0.77	0.85
MAPE	1.66	1.28	1.20	1.20	1.21	3.65	3.66	2.82	2.35	2.49

Table 8A: In-sample asset pricing tests with value portfolios and time-varying betas

The monthly recursive cross-sectional regressions are based on 60-month rolling window estimates of betas and average returns over the same rolling window. Significant estimates at the 5% level are highlighted in bold face. For further details please consult notes to Table 5A.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**6.40**	**6.14**	**12.64**	**14.92**	**8.53**	**7.21**	**2.69**	**5.06**	**8.62**	**7.48**
λ_{SMB}		3.14	-1.35	**10.71**	**5.27**		-0.14	-0.16	1.22	1.00
λ_{HML}		**7.92**	**16.20**				**7.56**	**10.63**		
λ_{WML}			**51.97**					24.17		
λ_{HMLS}				**30.59**	**12.30**				**10.84**	**9.71**
λ_{HMLB}				**-12.93**					-1.67	
$\overline{R^2}$	-0.65	0.30	0.59	0.56	0.42	-0.13	0.72	0.75	0.85	0.85
MSPE	1.11	0.43	0.24	0.26	0.36	1.01	0.23	0.19	0.12	0.12
MAPE	2.89	1.66	1.37	1.37	1.51	2.72	1.19	1.11	0.91	0.88
	Japan					Asia Pacific				
λ_M	-1.34	0.34	5.17	0.08	0.86	**7.89**	**6.54**	**9.80**	**13.13**	**9.04**
λ_{SMB}		-0.69	-0.47	-1.69	1.38		-0.16	-2.71	-2.65	-1.14
λ_{HML}		**6.55**	**8.42**				**6.43**	**11.68**		
λ_{WML}			18.09					27.12		
λ_{HMLS}				2.67	**7.32**				**13.87**	**8.55**
λ_{HMLB}				**7.24**					-9.52	
$\overline{R^2}$	0.03	0.66	0.72	0.71	0.56	-0.01	0.27	0.35	0.52	0.45
MSPE	0.64	0.20	0.16	0.17	0.26	1.49	0.99	0.84	0.63	0.75
MAPE	2.21	1.32	1.18	1.23	1.31	3.21	2.85	2.57	2.33	2.52

Table 9A: In-sample asset pricing tests with momentum portfolios and time-varying betas

The monthly recursive cross-sectional regressions are based on 60-month rolling window estimates of betas and average returns over the same rolling window. Significant estimates at the 5% level are highlighted in bold face. For further details please consult notes to Table 6A.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**7.85**	0.70	**7.25**	**7.73**	**7.80**	**8.01**	**20.11**	5.52	2.19	3.42
λ_{SMB}		7.03	**4.93**	**4.87**	**4.76**		**7.85**	1.73	0.08	0.55
λ_{HML}		-4.64	**13.64**	**15.25**	**15.01**		-20.81	8.60	10.60	11.75
λ_{WML}			**14.12**					**15.53**		
λ_{WMLS}				**22.21**	**15.19**				**32.56**	**16.92**
λ_{WMLB}				-8.28					**-21.43**	
$\overline{R^2}$	-0.25	0.09	0.76	0.82	0.82	-0.23	0.12	0.66	0.88	0.79
MSPE	2.35	1.56	0.40	0.28	0.30	3.33	2.20	0.81	0.28	0.49
MAPE	4.22	3.45	1.60	1.40	1.43	4.86	3.81	2.18	1.38	1.80
	Japan					Asia Pacific				
λ_M	-0.76	**-3.39**	-1.36	-1.52	-1.66	**9.15**	**13.80**	**10.29**	**11.94**	**9.29**
λ_{SMB}		**3.28**	2.07	2.05	2.29		2.33	-0.75	-0.32	-2.42
λ_{HML}		-3.29	1.76	1.06	1.16		**-22.63**	3.66	-6.77	14.47
λ_{WML}			2.16					12.37		
λ_{WMLS}				-1.42	1.85				**26.58**	**18.73**
λ_{WMLB}				4.50					-23.08	
$\overline{R^2}$	0.02	0.33	0.41	0.40	0.38	-0.21	0.19	0.23	0.53	0.45
MSPE	0.25	0.15	0.13	0.13	0.14	3.00	1.83	1.66	0.96	1.19
MAPE	1.40	1.17	1.11	1.10	1.12	4.40	3.39	3.28	2.67	2.82

Table 10A: Out-of-sample asset pricing tests with value portfolios and time-varying betas

The monthly recursive cross-sectional regressions are based on 60-month rolling window estimates of betas and the average of the next 60-month rolling out-of-window returns. Significant estimates at the 5% level are highlighted in bold face. For further details please consult notes to Table 5A.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**4.31**	**6.95**	**10.14**	**17.06**	**10.43**	**6.52**	**5.79**	**5.81**	**11.33**	**9.44**
λ_{SMB}		**7.43**	2.78	**17.66**	**11.19**		2.33	2.34	**4.45**	**3.84**
λ_{HML}		**12.55**	**19.40**				**10.07**	**10.18**		
λ_{WML}			**47.09**					0.88		
λ_{HMLS}				**41.95**	**21.36**				**15.93**	**13.30**
λ_{HMLB}				-10.84					-3.23	
$\overline{R}^2$	-0.42	0.41	0.61	0.54	0.49	-0.21	0.77	0.76	0.88	0.88
MSPE	1.64	0.63	0.39	0.47	0.54	1.89	0.32	0.32	0.16	0.18
MAPE	3.71	2.10	1.74	1.76	1.89	3.88	1.42	1.42	1.09	1.06
	Japan					Asia Pacific				
λ_M	0.91	1.11	**6.36**	1.15	1.80	**9.58**	4.99	**11.00**	**13.79**	**7.53**
λ_{SMB}		-1.14	0.36	-0.53	**2.60**		0.49	-3.14	-2.63	-0.63
λ_{HML}		**9.65**	**12.89**				**7.33**	**17.30**		
λ_{WML}			**18.13**					**49.73**		
λ_{HMLS}				**5.92**	**10.06**				**16.75**	**9.49**
λ_{HMLB}				**7.37**					-13.84	
$\overline{R}^2$	-0.01	0.82	0.86	0.83	0.77	0.06	0.25	0.43	0.52	0.43
MSPE	1.07	0.18	0.13	0.16	0.22	1.96	1.44	1.04	0.87	1.10
MAPE	2.96	1.24	1.04	1.19	1.34	3.71	3.43	2.76	2.69	2.98

Table 11A: Out-of-sample asset pricing tests with momentum portfolios and time-varying betas

The monthly recursive cross-sectional regressions are based on 60-month rolling window estimates of betas and the average of the next 60-month rolling out-of-window returns. Significant estimates at the 5% level are highlighted in bold face. For further details please consult notes to Table 6A.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**6.29**	3.16	**7.96**	**8.29**	**8.31**	**7.71**	**8.19**	**7.45**	**3.94**	**6.44**
λ_{SMB}		**12.05**	**10.01**	**9.56**	**9.63**		7.57	4.41	1.53	3.13
λ_{HML}		8.84	**16.02**	**16.89**	**16.71**		-1.65	9.26	**14.79**	11.90
λ_{WML}			**8.49**					**12.27**		
λ_{WMLS}				12.07	**9.20**				**28.66**	**13.72**
λ_{WMLB}				-3.41					**-19.81**	
$\overline{R^2}$	-0.19	0.41	0.79	0.81	0.82	-0.24	-0.03	0.60	0.84	0.74
MSPE	2.14	0.98	0.32	0.28	0.28	3.30	2.52	0.93	0.36	0.61
MAPE	4.21	2.72	1.45	1.38	1.37	4.90	4.17	2.40	1.70	2.05
	Japan					Asia Pacific				
λ_M	**2.03**	**-3.44**	0.44	0.34	0.07	**10.73**	**28.18**	18.52	13.95	10.42
λ_{SMB}		**7.98**	**4.09**	**4.06**	**4.26**		3.70	1.18	0.34	-0.95
λ_{HML}		**-7.28**	5.12	5.63	5.26		**-28.72**	-9.03	-2.63	6.87
λ_{WML}			**6.13**					8.51		
λ_{WMLS}				4.88	**6.04**				**24.20**	**15.60**
λ_{WMLB}				1.85					-18.11	
$\overline{R^2}$	-0.03	0.62	0.78	0.78	0.79	-0.40	0.05	0.09	0.39	0.31
MSPE	0.59	0.20	0.11	0.10	0.11	3.43	2.13	1.96	1.25	1.48
MAPE	2.23	1.13	1.00	0.98	0.99	4.79	3.88	3.73	3.05	3.14

Table 12A: Asset pricing tests with annual value portfolios over 1991-2011

For details please consult notes to Table 5A.

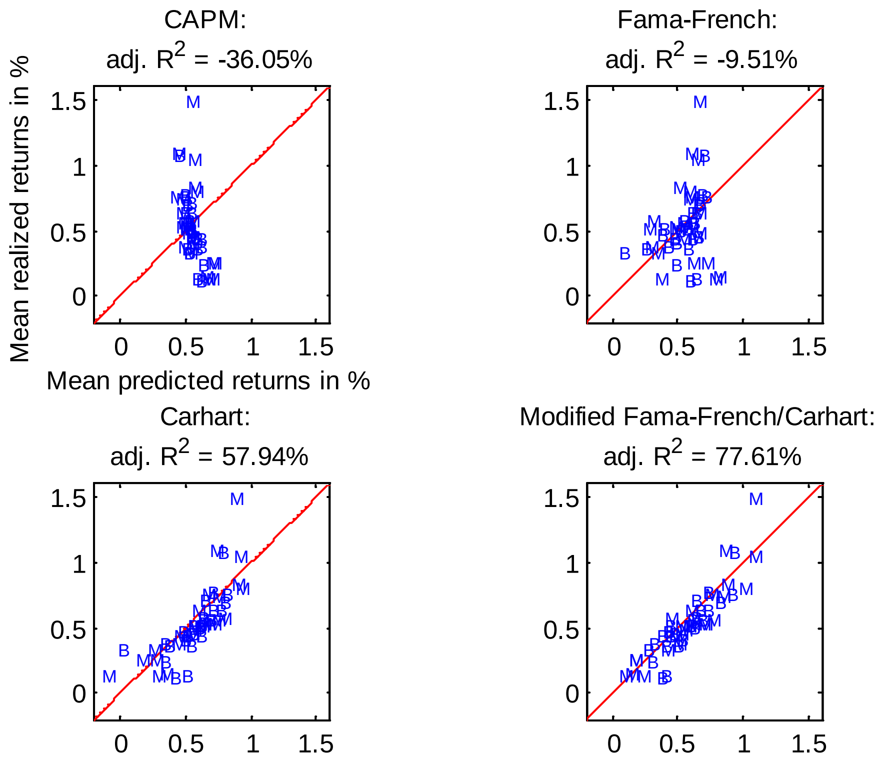
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**8.78**	**7.36**	**7.30**	**7.53**	**7.39**	**6.41**	**6.51**	**6.65**	**6.62**	**6.55**
λ_{SMB}		2.68	**2.74**	**2.92**	**2.69**		0.28	0.23	0.37	0.31
λ_{HML}		**4.62**	**4.22**				**5.44**	**5.45**		
λ_{WML}			-11.59					0.06		
λ_{HMLS}				**4.08**	**3.70**				**6.14**	**5.74**
λ_{HMLB}				2.24					**4.03**	
$\overline{R^2}$	-0.98	0.30	0.30	0.44	0.34	-0.20	0.75	0.75	0.79	0.78
MSPE	15.90	5.12	4.92	3.90	4.84	7.38	1.40	1.34	1.12	1.23
MAPE	3.26	1.70	1.74	1.54	1.64	2.16	0.96	0.93	0.92	0.94
	Japan					Asia Pacific				
λ_M	0.68	0.30	0.32	-0.27	-0.10	**11.41**	**11.38**	**11.37**	**11.88**	**11.98**
λ_{SMB}		0.46	0.58	0.55	1.15		1.99	1.99	1.33	1.22
λ_{HML}		1.98	**3.39**				**6.64**	**6.64**		
λ_{WML}			**8.11**					7.82		
λ_{HMLS}				0.22	1.34				**9.33**	**9.40**
λ_{HMLB}				**5.26**					2.24	
$\overline{R^2}$	-0.01	0.14	0.54	0.41	0.08	-0.07	0.43	0.40	0.53	0.55
MSPE	5.57	4.32	2.23	2.83	4.62	16.09	7.87	7.87	6.17	6.20
MAPE	2.06	1.72	1.32	1.39	1.77	3.08	2.23	2.24	2.02	2.00

Table 13A: Asset pricing tests with annual momentum portfolios over 1991-2011

For details please consult notes to Table 6A.

	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
	North America					Europe				
λ_M	**10.35**	**8.71**	**7.75**	**7.70**	**7.79**	**7.25**	**6.75**	**6.79**	**6.76**	**6.79**
λ_{SMB}		3.62	**4.43**	**4.27**	**4.52**		3.50	**3.22**	1.45	**2.91**
λ_{HML}		-4.50	**5.95**	**6.54**	**5.50**		-8.94	0.68	**8.05**	2.11
λ_{WML}			**7.66**					**12.25**		
λ_{WMLS}				**10.50**	**11.28**				**14.69**	**14.24**
λ_{WMLB}				**5.95**					**6.69**	
$\overline{R^2}$	-0.32	-0.36	0.89	0.90	0.87	-0.19	0.15	0.84	0.91	0.86
MSPE	31.81	29.92	2.30	1.98	2.77	42.45	27.94	4.90	2.80	4.22
MAPE	4.57	4.44	1.19	1.10	1.26	4.92	4.33	1.67	1.24	1.54
	Japan					Asia Pacific				
λ_M	**1.53**	-0.36	-0.35	-0.60	-0.34	**12.87**	**12.10**	**12.20**	**12.27**	**12.14**
λ_{SMB}		**3.27**	**3.35**	**2.84**	**3.41**		2.57	3.06	2.97	3.08
λ_{HML}		-1.84	-2.23	0.38	-2.48		**7.47**	5.61	5.61	5.77
λ_{WML}			1.93					**8.89**		
λ_{WMLS}				0.38	1.40				**9.19**	**9.67**
λ_{WMLB}				**5.09**					8.71	
$\overline{R^2}$	0.12	0.48	0.46	0.66	0.46	-0.10	0.44	0.43	0.40	0.42
MSPE	5.28	2.86	2.85	1.69	2.80	36.70	16.96	16.68	16.66	16.72
MAPE	1.82	1.37	1.36	0.99	1.35	4.48	3.23	3.19	3.20	3.19

Figure 1A: The cross section of global value and momentum portfolios



The four diagrams correspond to (clockwise from top left) the CAPM, the three-factor Fama-French (1993) model, the four-factor Carhart (1997) model, and the modified Fama-French (1993)/Carhart (1997) model with HML split into HMLS and HMLB and WML split into WMLS and WMLB. The horizontal axes correspond to the predicted average excess returns and the vertical axes to the sample average realized excess returns. The test assets are 25 global value portfolios formed on size and BE/ME and denoted by B and 25 global momentum portfolios formed on size and momentum and denoted by M.