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The 52-Week High and Momentum Investing: Implications for Asset Pricing Models

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We propose and test a new 4-factor asset pricing model, modifying the method of estimating the momentum risk factor, based on the conclusions of George and Hwang (2004). We proceed to compare the performance of our model with those of Fama and French (1993, 1996) and Carhart (1997)'s. We find that the authors' 52-week high strategy achieves a positive, though statistically insignificant return in 1980-2014, with severely divergent performances in subperiods 1980-2000 (significantly positive) and 2001-2014 (significantly negative). Overall, our model for portfolios built on momentum outperforms the 3-factor model but falls short from Carhart (1997)'s. Subperiod analysis shows results in line with the complete sample for 1980-2000, while both momentum models' performance in subperiod 2001-2014 seems influenced by the unanticipated momentum crash of 2009. We conclude that a momentum risk factor should be included in a given asset pricing model, but evidence suggests it should be based on Jegadeesh and Titman (1993).

Key Words: 52-week high; Momentum; Asset pricing models.
JEL Classification Numbers: G12, G14, G15.

1. INTRODUCTION

Several deviations to the Efficient Market Hypothesis (EMH) have been documented in the literature during the last decades. Among these anomalies, the momentum effect of Jegadeesh and Titman (1993) remains one of

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the most relevant, as the strategy provides significant abnormal returns, is computed using public information, and persists in subsequent studies. The implications are especially relevant for asset pricing models, since the effect is not captured by the CAPM or by Fama and French (1993, 1996)'s 3-factor model, paving the way for the development of Carhart (1997)'s 4-factor model.

However, George and Hwang (2004) provide an important extension to the momentum literature, by developing a strategy based on the nearness of a stock's price to its 52-week high which surpasses the performances of previous momentum strategies. Studies applying the methodology to different markets and geographies, such as Du (2008), Liu et al. (2011) and Li and Yu (2012), generally confirm the strategy's abnormal returns.

Based on these empirical findings, and as the 52-week high approach consistently surpasses the relative strength strategy, we conjecture that it must also be a superior basis on which to build a momentum risk factor. As such, we develop and test a new 4-factor model, by building the momentum risk factor according to George and Hwang (2004), instead of Jegadeesh and Titman (1993). As to provide a benchmark against which to compare the results, we also test the 3-factor and Carhart (1997) models for the same data. The tests follow the approach of Fama and French (2012), comprising of time-series regressions on the excess returns of portfolios sorted on size-BE/ME and size-momentum, from 1980 to 2014, in the US market.

To the best of our knowledge, there is no previous suggestion of such a model in the literature. Even though the model lacks a strong theoretical basis, if successful it would not only add to the on-going debate about market efficiency, but also increase the evidence of psychological factors' role in the formation of stock prices. The implications would also be significant for practical applications, potentially improving estimates of financial asset prices or the cost of capital.

Succinctly, we find that George and Hwang (2004) momentum is small and statistically insignificant for the US stock market, from 1980 to 2014, though subperiod analysis shows results in line with the literature from 1980 to 2000 and its apparent disappearance, with negative average returns, in the later period of 2001 to 2014. Results are qualitatively similar though, contrarily to George and Hwang (2004), much stronger for Jegadeesh and Titman (1993) momentum. We also find, in accordance with Daniel and Moskowitz (2016), that, due to their reliance on the continuation of returns, following persistently bear markets and contemporaneously with fast market reversals, momentum experiences crashes. We show that such a particular and especially strong crash occurred in 2009, which seems to drive the results for subperiod 2001-2014.

The tests on the asset pricing models show that, at worse, the inclusion of a momentum risk factor does not have an influence on their ability to capture the 25 size-BE/ME Fama-French portfolios' excess returns. However, for the 25 size-momentum portfolios, the inclusion of a momentum risk factor is generally crucial, with the performance of the Carhart (1997) 4-factor model consistently surpassing that of our proposed 52W 4-factor model. The only exception is for the subperiod 2001-2014, in which, as addressed, the momentum effect seems to disappear and the performance of both 4-factor models is very similar to that of the 3-factor model. Again that seems, at least in part, to rise from the influence of the momentum crash of 2009. If we exclude that year, momentum stages a reappearance, though somewhat more subdued, and the necessity of a momentum factor is, as for the complete sample, once again made clear.

Considering our results, and though as a whole they are not incompatible with the anchor-and-adjust bias, the performance of the George and Hwang (2004) momentum strategy on the subperiod 2001-2014 does not allow us to exclude the possibility that this effect has been absorbed by the market. However, Jegadeesh and Titman (1993) momentum seems to continue to show some resilience. It is possible, as such that the explanation for momentum may lie in the traditional underreaction-overreaction area.

This paper is structured as follows. We provide a review of the main literature concerning momentum and the 52-week high in section 2, address our view of the implications of George and Hwang (2004) for asset pricing models and the chosen methodology in section 3, present our findings in section 4, and conclude in section 5.

2. LITERATURE REVIEW

2.1. Common Momentum Strategies and Exegeses

There is substantial evidence that returns are predictable, by variables both at the aggregate and firm level (e.g., Bhandari 1988; Fama and French, 1989; Lee and Swaminathan 2000). Among the existing anomalies, the momentum effect identified by Jegadeesh and Titman (1993, 2001) represents one of the most serious challenges to the EMH. The authors document that a simple strategy that buys past winners and sells past losers generates relevant abnormal returns over different 3- to 12- months selecting and holding periods. The strategy maintains its profitability after its initial discovery, which is especially relevant since other anomalies have tended to disappear following the original studies (Schwert (2003)). The earliest theories of momentum proposed in the literature tend to focus either on the hypothesis of underreaction or overreaction by the traders, and the consequent effect on the movement of prices. De Bondt and Thaler (1985) had asserted that the observed mean reversion in longer horizons is consistent with the hypothesis of overreaction by traders to new information that, when corrected, generates reversion of stock prices in the long run. Jegadeesh and Titman

(1993) find this explanation simplistic, and hypothesize that transactions by investors who buy past winners and sell past losers move prices away from their long-run values temporarily.

Other relevant papers are Moskowitz and Grinblatt (1999), whose momentum strategy is based on the activity sector, consisting in buying stocks from winning industries and selling stocks from past losing industries; Rouwenhorst (1998) that applies Jegadeesh and Titman (1993)'s strategy to 12 European countries reaching similar conclusions; and Rouwenhorst (1999) which identifies the momentum effect in 20 emerging markets.

Daniel et al. (1998), Barberis et al. (1998) and Hong and Stein (1999), seek to reconcile momentum and mean-reversion within a behavioral finance framework. Succinctly, momentum would result from psychological biases affecting the behavior of investors, justifying the temporary divergence of stock prices from its fundamental value.

Lee and Swaminathan (2000), in their study of trading volume, find it is possible to create Jegadeesh and Titman (1993) style momentum portfolios that exhibit reversals of the type documented by De Bondt and Thaler (1985). The authors' Momentum Life Cycle hypothesis presents the market as in a constant state of convergence toward fundamental value, with stocks experiencing periods of favoritism and neglect.

Klein (2001) and Grinblatt and Han (2005), strive to explain momentum by expanding on Tversky and Kahneman (1974)'s adjustment and anchoring bias effect. In Klein (2001) the acquisition price acts as the anchor and the impact of taxes causes the divergence in prices. For Grinblatt and Han (2005) the anchor is also the acquisition price but momentum arises from some investors' aversion to losses. We should note that there are similarities between these approaches and that of George and Hwang (2004), which also relies on an anchor effect, as we detail in the next subsection.

Another approach are the rational momentum models, including Berk et al. (1999), Johnson (2002) and Shin (2006), that assume symmetric information, and Albuquerque and Miao (2014) and Cespa and Vives (2014), which assume asymmetric information.

Currently, momentum continues to be a puzzle and a much debated topic in the literature, as exemplified by Chui et al. (2010)'s study on individualism and momentum or the work of Israel and Moskowitz (2013). Even considering the inconsistent performance of momentum in more recent years, Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) show, through different techniques, that it is possible to improve the returns of the strategy by actively managing its risk.

2.2. The 52-Week High and Momentum Investing

George and Hwang (2004) propose that the nearness of a stock's price to its 52-week high is able to explain most of the profits from momentum investing, and that this effect stems from an anchor and adjust bias. In this view, investors would be reluctant to bid up stocks close to their 52-week high while simultaneously averse to selling those farther from said anchor, even when warranted by the available information. Comparing the strategy with those of Jegadeesh and Titman (1993) and Moskowitz and Grinblatt (1999), the authors find that the overall returns are all very close, but that they capture distinct effects as highlighted by pairwise comparisons. Combining all approaches on Fama and MacBeth (1973) cross-sectional regressions, this again indicates that, among the strategies, nearness to the 52-week high is the better predictor of future returns.

In the 10 years since the publication of George and Hwang (2004)'s paper, the studies applying the methodology to other markets generally confirm the abnormal returns of the 52-week high strategy. Marshall and Cahan (2005) and Du (2008) arrive at similar conclusions studying, respectively, Australian stocks and MSCI country indices for 18 developed markets. Gupta et al. (2010), Liu et al. (2011) and Bornholt and Malin (2011) attest the abnormal returns of George and Hwang (2004)'s strategy, but either the 52-week approach does not dominate the other strategies or they seem to be independent. Li and Yu (2012) find that nearness to the 52-week high predicts positive future returns while nearness to the historical high predicts negative future returns. Finally, Bhootra and Hur (2013) posit that stocks that have attained the 52-week price in the recent past significantly outperform those that have attained so in the distant past.

3. HYPOTHESIS AND METHODOLOGY

3.1. Implications for Asset Pricing Models

The results of George and Hwang (2004) motivate us to study the impact of the introduction of a new momentum risk factor, built according to the 52-week high strategy, on the overall performance of a given asset pricing model.

As such, we formulate and propose the 52W 4-factor model, which corresponds to a variation of the 4-factor model of Carhart (1997), specified as

$$E(R_i) = R_f + b_i[E(R_M) - R_f] + s_i E(SMB) + h_i E(HML) + m_i E(52W) \quad (1)$$

substituting the relative strength momentum factor E(WML) of Carhart (1997) for the new momentum factor E(52W) built according to the 52-week high strategy.

Succinctly, the 52W factor, similarly to the value-weighted SMB and HML, and also to WML, corresponds to the monthly equal-weight average returns of the 30 percent stocks with prices closest to their 52-week high minus the monthly equal-weight average returns of the 30 percent stocks with prices farthest from their 52-week high.

3.2. Data and Methodology

We follow the methodology of Fama and French (2012), comparing our own 4-factor model to Fama and French (1993, 1996) and Carhart (1997)'s models'.

Our data sample includes all US stocks, listed on NYSE, NYSE MKT and NASDAQ markets, from January 1980 to December 2014.

The tests comprise of time-series regressions of all models, seeking to capture the excess monthly return of a number of Fama-French benchmark portfolios, which we will next detail, following the ensuing formulations for

Fama-French 3-factor model:

$$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it} \quad (2)$$

Carhart 4-factor model:

$$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + w_i WML_t + \varepsilon_{it} \quad (3)$$

Proposed 52W 4-factor model:

$$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i 52W_t + \varepsilon_{it} \quad (4)$$

The monthly returns of the $R_M - R_f$, SMB, HML and WML risk factors, as well as data on the portfolios' returns, were all also collected from Kenneth R French's website[1].

In turn, 52W had to be built from raw daily data of the stocks listed on the NYSE, NYSE MKT and NASDAQ collected from DataStream. We used all stocks, including dead and delisted, for the given period and to insure results were not influenced by small and illiquid stocks, we excluded stocks that were not traded during the previous month as well as stocks under \$5 following Jegadeesh and Titman (2001). At the beginning of each month t stocks were ranked according to the nearness to the 52-week high at the end of month $t-2$, given by $\frac{Price_{i,t-2}}{High_{i,t-2}}$, where $Price_{i,t-2}$ is the price of stock i at the end of month $t-2$ and $High_{i,t-2}$ is the highest price of stock i during the 12-month period that ends on the last day of month $t-2$. 52W corresponds, for each month t, to the equal-weighted returns of the winner portfolio, comprised of the top 30% ranking stocks, minus the equal-weighted returns of the loser portfolio, constituted by the 30% worst ranking stocks. As in George and Hwang (2004) we use equal-weighted portfolios but, to increase comparison to WML, we skip the

[1] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

month between ranking and portfolio formation, and also do not consider overlapping holding periods.

The tests on the explanatory power of the models, following Fama and French (2012), evaluate the ability to capture the excess returns of a series of Fama-French portfolios, specifically the 25 size-BE/ME and the 25 size-momentum portfolios. We start by comparing the models' performance concerning the 25 size-BE/ME portfolios, given the well-known size and value effects. We follow by testing the models on 25 size-momentum portfolios, since it is expected that it is in these portfolios that the inclusion of a momentum factor provides a clearer boost to the 3-factor model, as the portfolios are built to expose the momentum effect. Finally, we also conduct robustness tests corresponding to subperiod analysis of the 25 size-momentum portfolios.

4. EMPIRICAL FINDINGS

4.1. Summary Statistics

The summary statistics from the risk factors are shown in Table 1. It is clear that the US market risk premium continues to be large in the US at 0.65% per month, and that the value premium is still a relevant 0.30% per month, but that the returns of the size premium are small and are not statistically significant. As regards the momentum effect, the competing factors WML and 52W show very different performances for the period. While WML has a high monthly return of 0.61% the 52W factor, problematically for our proposed model, achieves a modest and statistically insignificant 0.12% per month.

However, Table 1 shows three additional aspects we must also consider, namely (i) the relatively low to moderate correlations between the proposed risk factors for the entire period, suggesting they are able to capture time-series variation; (ii) that, when testing for robustness of the results, subperiod analysis shows that both WML and 52W have different performances for the subperiods 1980-2000 and 2001-2014; and (iii) that correlations for the momentum risk factors also change substantially for the subperiods.

Specifically, 52W achieves a statistically significant average return of 0.43% per month in the period from 1980 to 2000 (WML is an impressive 0.97%), very much in line with the results of George and Hwang (2004), but falls to a statistically insignificant average monthly return of −0.34% in the period from 2001 to 2014 (WML falls to an also statistically insignificant 0.07% per month). As already discussed, correlations between WML and 52W are significant for the entire sample, but increase impressively from 0.42 in 1980-2000 to 0.84 in 2001-2014. As such, our results are concordant with the finding of George and Hwang (2004) — whose sample period is from 1963 to 2001 — that these are different effects up to 2000, but put

TABLE 1.

Summary Statistics for the Risk Factors

Risk Factors	Average Monthly Return	Std. Dev.	t-stat	Median Monthly Return	Cross-Correlations $R_M - R_f$	SMB	HML	WML	52W
$R_M - R_f$	0.65	4.51	2.95	1.16	1.00	-	-	-	-
SMB	0.13	3.06	0.87	0.00	0.24	1.00	-	-	-
HML	0.30	3.03	2.04	0.27	-0.33	-0.31	1.00	-	-
WML	0.61	4.57	2.74	0.72	-0.12	0.06	-0.17	1.00	-
52W	0.12	3.86	0.65	0.50	-0.45	-0.34	0.26	0.68	1.00
WML (80-00)	0.97	3.82	4.03	1.05	0.21	0.26	-0.41	1.00	-
WML (01-14)	0.07	5.46	0.17	0.39	-0.48	-0.19	0.10	1.00	-
52W(80-00)	0.43	2.94	2.33	0.72	-0.28	-0.27	0.30	0.42	1.00
52W (01-14)	-0.34	4.90	-0.91	0.16	-0.64	-0.47	0.25	0.84	1.00

$R_M - R_f$ corresponds to the value-weighted return of all CRSP firms incorporated in the US and listed on the NYSE, NYSE MKT, and NASDAQ that have a CRSP share code of 10 or 11 minus the one-month Treasury bill rate from Ibbotson Associates. The factors SMB and HML are constructed using 6 value-weighted portfolios formed on the intersections of 2 portfolios formed on size and 3 portfolios formed on book-to-market, SMB being the average return on the three small portfolios (value / neutral / growth) minus the average return on the three big portfolios (value / neutral / growth) and HML the average return on the two value portfolios (small / big) minus the average return on the two growth portfolios (small / big). The risk factor WML is built from 6 value-weighted portfolios formed on the intersections of 2 portfolios formed on size and 3 portfolios formed on prior $t - 12$ to $t - 2$ month returns, and corresponds to the monthly average return of the two high prior return portfolios minus the average return of the two low prior return portfolios. Data for $R_M - R_f$, SMB, HML and WML risk factors were all collected from Kenneth R. French's website. 52W is a momentum factor built according to the 52-week high strategy, using all stocks listed on the NYSE, NYSE MKT and NASDAQ, collected from DataStream, excluding stocks under \$5 and stocks not traded during the previous month, corresponding to the equal-weighted returns of the 30% top ranked stocks minus the equal-weighted returns of the 30% worst ranked stocks. Returns are calculated in simple monthly percent. Sample period is January 1980 to December 2014.

them into question in the subsequent time-frame of 2001-2014 and for our whole period.

As more thoroughly addressed in subsection 4.3.3, it appears as though, in the more recent years, there seems to be no momentum effect in the US market but, when looking at monthly median returns, 52W achieves 0.50% for the whole period of 1980-2014 (WML 0.72%), 0.72% for the subperiod 1980-2000 (WML 1.05%), and 0.16% for the subperiod 2001-2014 (WML 0.39%). The underlying reason for the behavior of both 52W and WML seems to be related to more frequent periods of rapid inversion of market trends in the years of 2001-2014 appearing that, due to their reliance on the continuation of returns, it corresponds to periods in which momentum strategies appear to perform very negatively. In particular, both the returns for 52W and WML in the period are very affected by the impact of a single year, 2009, in which they respectively lose an astounding average of −4.18% and −5.43% per month. In subsection 4.3.3 we further discuss the nature of this apparent disappearance of momentum in 2001-2014.

Turning to the benchmark portfolios, the interpretation of the excess returns of the 25 size-BE/ME portfolios, shown below in Table 2, seems to be very much in line with the individual observations for the size (SMB) and value (HML) risk factors.

TABLE 2.

Summary Statistics for Monthly Percent Excess Returns on 25 Size-BE/ME Portfolios

	Average					Standard Deviation				
	Growth	2	3	4	Value	Growth	2	3	4	Value
Small	0.08	0.84	0.89	1.02	1.10	7.90	6.70	5.61	5.26	5.65
2	0.49	0.80	1.00	0.97	0.94	7.11	5.77	5.16	5.10	5.80
3	0.62	0.87	0.86	0.90	1.13	6.60	5.39	4.92	4.87	5.19
4	0.80	0.76	0.79	0.84	0.88	5.96	5.17	5.15	4.67	5.19
Big	0.66	0.73	0.63	0.63	0.77	4.71	4.58	4.56	4.37	5.08

The portfolios of NYSE, NYSE MKT and NASDAQ stocks, built each June, are the intersections of 5 portfolios formed on size (ME) and 5 portfolios formed on the ratio of book to market equity (BE/ME). The size breakpoints for year t are the NYSE market equity quintiles at the end of June of t. BE/ME for June of year t is the ratio of BE for the last fiscal year end in $t-1$ to ME for December of $t-1$. The BE/ME breakpoints are NYSE quintiles. R_f is the one-month Treasury bill rate at the beginning of the month t. All data from Kenneth R. French's website. Sample period is January 1980 to December 2014.

When analyzing the results, there seems to be no size effect for the lowest BE/ME quintile, with even an observed inverse size effect, though the size premium seems to apply in the remaining BE/ME quintiles, in line with the observed small average monthly return of SMB. On the other hand, the value effect seems very clear, independently of the size quintile, noting however that the effect seems especially large in small caps, with an excess return of 1.10% per month, in line with Siegel (2014).

As regards the excess returns of the 25 size-momentum portfolios, exhibited below in Panel A of Table 3, the interpretation concerning the size effect is somewhat similar to that of the 25 size-BE/ME portfolios.

There seems to be an inverse size effect in the extreme loser quintile, and an inexistent size effect in the second momentum quintile, but the size premium appears to hold in the remaining quintiles. Momentum seems to be clearly present in all size quintiles, with an increasing trend in excess returns from the left (extreme loser) to the right (extreme winner) quintiles, again especially large in small caps.

TABLE 3.
Summary Statistics for Monthly Percent Excess Returns on 25 Size-Momentum Portfolios

Panel A: 1980-2014										
	Average					Standard Deviation				
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
Small	−0.02	0.63	0.89	1.06	1.38	8.03	5.49	5.00	5.13	6.55
2	0.25	0.73	0.90	1.05	1.27	8.07	5.77	5.11	5.18	6.72
3	0.45	0.69	0.83	0.88	1.16	7.57	5.45	4.93	4.88	6.37
4	0.37	0.74	0.85	0.88	1.02	7.68	5.51	4.74	4.63	5.91
Big	0.42	0.67	0.52	0.73	0.85	7.05	4.89	4.35	4.34	5.34
Panel B: 1980-2000										
	Average					Standard Deviation				
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
Small	−0.70	0.42	0.75	0.94	1.45	6.51	4.82	4.65	5.02	6.82
2	−0.21	0.46	0.81	1.05	1.50	6.47	5.03	4.83	5.04	7.10
3	0.18	0.49	0.69	0.92	1.41	6.11	4.92	4.61	4.83	6.79
4	0.32	0.67	0.71	0.86	1.30	6.09	5.14	4.66	4.75	6.23
Big	0.57	0.79	0.53	0.83	1.04	5.87	4.48	4.44	4.60	5.79
Panel C: 2001-2014										
	Average					Standard Deviation				
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
Small	1.00	0.95	1.09	1.24	1.26	9.82	6.35	5.49	5.29	6.14
2	0.95	1.13	1.02	1.06	0.92	9.97	6.72	5.50	5.40	6.10
3	0.85	1.00	1.03	0.84	0.78	9.35	6.16	5.38	4.96	5.68
4	0.44	0.85	1.06	0.90	0.60	9.60	6.04	4.87	4.47	5.40
Big	0.19	0.50	0.50	0.57	0.58	8.54	5.46	4.21	3.91	4.59

The portfolios of NYSE, NYSE MKT and NASDAQ stocks, constructed monthly, are the intersections of 5 portfolios formed on size (ME) and 5 portfolios formed on prior $t-12$ to $t-2$ returns (the strategy skips the sort month). The size breakpoints are the NYSE market equity quintiles. The monthly prior $t-12$ to $t-2$ return breakpoints are NYSE quintiles. R_f is the one-month Treasury bill rate at the beginning of the month t. All data from Kenneth R. French's website. Sample period is January 1980 to December 2014.

Since we aim to address the robustness of the results, by analyzing subperiods 1980-2000 and 2001-2014, we also show the summary statistics of the 25 size-momentum portfolios for these subperiods. The results for subperiod 1980-2000, shown in Panel B of Table 3, are qualitatively similar to those of the entire period but with significantly higher momentum spreads between the winner and loser quintiles, in line with the higher average returns of both WML and 52W. For the subperiod 2001-2014 (Panel C), however, the size effect makes an impressive comeback, with clearly higher returns for small caps, but the momentum effect, again concurrently with the disappointing returns of WML and 52W, is, at best, tenuous.

4.2. Asset Pricing Tests for the 25 size-BE/ME Portfolios

The summary results for the tests on the 25 size-BE/ME portfolios are presented in Table 4. Analyzing the regressions α it seems that the Fama and French (1993, 1996) 3-factor model is able to capture most of the excess returns, with an average absolute α of 0.12%. However, concurrently with the existing literature, it leaves significant unexplained returns in the lowest BE/ME quintile, especially a large negative return for low BE/ME microcaps stocks of around −0.69% per month. Additionally, the 3-factor model leaves a hint of the value effect on the smallest size quintile and creates a reverse value effect in the biggest size quintile. The explanation follows from the fact that value-growth spreads are larger for smaller stocks and the spreads in the HML loadings are not wider for these same smaller stocks. As a result, the model underestimates the value-growth spreads in microcaps while overestimating the spread for large caps (in the particular case of low BE/ME microcaps there seems to be an additional overestimation of the spread for the size effect).

TABLE 4.

Regressions for Monthly Percent Excess Returns on 25 Size-BE/ME Portfolios (Jan. 1980 - Dec. 2014)

Fama-French 3-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it}$									
	Growth	2	3	4	Value	Growth	2	3	4	Value
	α					$t(\alpha)$				
Small	−0.69	0.05	0.10	0.19	0.13	−5.41	0.59	1.46	2.49	1.61
2	−0.24	−0.01	0.15	0.08	−0.13	−3.27	−0.07	2.11	1.04	−1.74
3	−0.03	0.05	0.01	0.01	0.16	−0.42	0.69	0.13	0.10	1.47
4	0.19	−0.04	−0.10	−0.01	−0.10	2.28	−0.39	−1.01	−0.08	−1.21
Big	0.18	0.09	−0.08	−0.16	−0.13	3.30	1.04	−0.93	−2.06	−1.09
Average $\lvert\alpha\rvert$	0.12					-				
	R^2					$s(e)$				
Small	0.90	0.93	0.94	0.93	0.93	2.45	1.77	1.33	1.40	1.47
2	0.95	0.94	0.93	0.93	0.94	1.52	1.46	1.34	1.39	1.40
3	0.95	0.90	0.88	0.88	0.88	1.50	1.71	1.68	1.69	1.86
4	0.94	0.88	0.87	0.87	0.87	1.50	1.76	1.86	1.69	1.87
Big	0.95	0.89	0.87	0.89	0.80	1.10	1.49	1.67	1.45	2.27
Average R^2	0.91					-				

Adding a momentum factor, be it either WML or 52W, seems to have virtually no effect in the power of the regressions on the excess returns on

TABLE 4—*Continued*

Carhart 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + w_i WML_t + \varepsilon_{it}$									
	Growth	2	3	4	Value	Growth	2	3	4	Value
	α					$t(\alpha)$				
Small	−0.62	0.05	0.09	0.17	0.17	−4.77	0.65	1.35	2.23	1.96
2	−0.18	0.02	0.15	0.08	−0.11	−2.77	0.26	2.38	1.08	−1.50
3	0.01	0.09	0.02	0.02	0.20	0.18	1.02	0.27	0.24	1.77
4	0.19	−0.02	−0.04	0.01	−0.05	2.42	−0.19	−0.44	0.16	−0.62
Big	0.20	0.06	−0.09	−0.13	−0.08	3.64	0.72	−1.00	−1.69	−0.70
Average $\|\alpha\|$	0.11					-				
	R^2					$s(e)$				
Small	0.91	0.93	0.94	0.93	0.93	2.43	1.77	1.33	1.40	1.46
2	0.96	0.94	0.93	0.93	0.94	1.49	1.46	1.35	1.40	1.40
3	0.95	0.90	0.88	0.88	0.87	1.48	1.71	1.68	1.69	1.85
4	0.94	0.88	0.87	0.87	0.87	1.50	1.76	1.84	1.69	1.85
Big	0.95	0.90	0.87	0.89	0.80	1.10	1.48	1.67	1.45	2.25
Average R^2	0.91					-				
52W 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i 52W_t + \varepsilon_{it}$									
	Growth	2	3	4	Value	Growth	2	3	4	Value
	α					$t(\alpha)$				
Small	−0.62	0.06	0.08	0.20	0.16	−4.88	0.71	1.28	2.37	1.79
2	−0.21	−0.01	0.13	0.06	−0.13	−3.13	−0.12	1.99	0.90	−1.70
3	−0.02	0.05	0.00	0.00	0.18	−0.21	0.64	0.00	0.03	1.64
4	0.19	−0.04	−0.10	−0.01	−0.08	2.36	−0.44	−1.01	−0.13	−0.99
Big	0.18	0.06	−0.09	−0.15	−0.09	3.32	0.70	−1.04	−2.07	−0.78
Average $\|\alpha\|$	0.12					-				
	R^2					$s(e)$				
Small	0.91	0.93	0.94	0.93	0.93	2.36	1.77	1.32	1.40	1.45
2	0.96	0.94	0.93	0.93	0.94	1.49	1.46	1.34	1.39	1.40
3	0.95	0.90	0.88	0.88	0.87	1.49	1.72	1.68	1.69	1.85
4	0.94	0.88	0.87	0.87	0.87	1.50	1.77	1.87	1.69	1.86
Big	0.95	0.90	0.87	0.89	0.81	1.11	1.47	1.67	1.46	2.23
Average R^2	0.91					-				

The table shows the results from time-series regressions of the Fama and French (1993, 1996) 3-factor model, Carhart (1997) 4-factor model and 52W 4-factor model on the monthly percent excess returns of the 25 portfolios created from 5×5 sorts on size and BE/ME. Reported only the α, respective HAC Newey-West t-statistics, adjusted R^2 and the regressions' standard errors (for complete Tables contact the authors). Sample period is January 1980 to December 2014.

the 25 size-BE/ME portfolios. The inclusion of WML reduces the average absolute α from 0.12% to 0.11%, while the inclusion of 52W has no impact on the average absolute α. Unsurprisingly, the loadings for the WML or the 52W factors (not shown) are very small and mostly statistically insignificant, while the impact on the adjusted R^2 is irrelevant.

A more relevant test of the momentum factors is presented in the next subsection when we address their power on the excess returns of the 25 size-momentum portfolios.

4.3. Asset Pricing Tests for the 25 Size-Momentum Portfolios

The results of the regressions of all 3 models on the excess returns of the 25 size-momentum portfolios are shown below in Table 5.

The Fama and French (1993, 1996) model fares much worse on these portfolios, with a high average absolute α of 0.31%, while estimating strongly negative intercepts for short-term losers and high positive intercepts for short-term winners, with an average adjusted R^2 of 0.82. The problem is past losers load more on $R_M - R_f$ and HML than past winners (not shown), and as such the model predicts the reversal of future returns for both losers and winners, missing the short-term continuation of the returns.

In this case, introducing a momentum factor (either WML or 52W) significantly reduces the average absolute α and provides a boost to the average adjusted R^2.

The results for the Carhart (1997) 4-factor model show a decrease of the average absolute α to 0.14% and an improvement of the average adjusted R^2 to 0.90. However there are still clearly traces of the momentum effect on the two lowest size quintiles, the greatest problem being the high negative intercept of the microcaps' losers (-0.45%), while the model also creates a mild reverse momentum effect for large caps.

The question is that, as previously shown in Table 3, and addressed in subsection 4.1, the momentum returns are greater for small caps than for large caps, while the spreads in the WML factor loadings (not shown) from losers to winners are at least as large for the biggest size quintiles as for the smallest size quintiles.

Our own 52W 4-factor model also corresponds to an improvement relative to the 3-factor model, but less so than the Carhart (1997) 4-factor model, reducing the average α to a still economically relevant 0.20% and improving the average adjusted R^2 to 0.88. The intercepts for the short-term losers remain strongly negative, once again the microcap losers being the greatest problem with -0.75%, and the intercepts for short-term winners, especially in the three smaller size quintiles, remain strongly positive. The issue is that besides having similar but less severe difficulties as the Carhart (1997) model in capturing the different momentum spreads for the distinct size quintiles, the loadings on the HML factor (not shown) continue to predict

TABLE 5.

Regressions for Monthly Percent Excess Returns on 25 Size-Momentum Portfolios (Jan. 1980 - Dec. 2014)

Fama-French 3-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_iSMB_t + h_iHML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−1.08	−0.24	0.08	0.29	0.57	−5.74	−2.36	0.94	3.19	4.01
2	−0.86	−0.19	0.07	0.25	0.45	−4.70	−1.72	0.86	3.46	4.42
3	−0.57	−0.18	0.00	0.09	0.39	−2.85	−1.56	−0.02	0.93	3.70
4	−0.66	−0.14	0.07	0.15	0.34	−2.94	−1.23	0.63	1.72	2.71
Big	−0.48	−0.04	−0.13	0.12	0.28	−2.10	−0.30	−1.63	1.42	2.50
Average $\lvert\alpha\rvert$	0.31					-				
	R^2					$s(e)$				
Small	0.73	0.87	0.89	0.89	0.87	4.20	1.98	1.63	1.69	2.36
2	0.77	0.86	0.90	0.92	0.90	3.90	2.15	1.63	1.45	2.08
3	0.70	0.84	0.88	0.87	0.87	4.15	2.17	1.72	1.75	2.28
4	0.64	0.81	0.86	0.87	0.80	4.58	2.41	1.75	1.70	2.61
Big	0.62	0.75	0.88	0.86	0.77	4.36	2.47	1.49	1.61	2.57
Average R^2	0.82					-				
Carhart 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_iSMB_t + h_iHML_t + w_iWML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.45	−0.03	0.13	0.24	0.36	−2.96	−0.42	1.71	2.47	2.78
2	−0.20	0.08	0.12	0.21	0.19	−1.72	0.91	1.42	2.64	2.24
3	0.10	0.08	0.11	0.01	0.08	0.82	0.86	1.24	0.12	1.00
4	0.07	0.18	0.18	0.07	−0.03	0.55	1.97	1.85	0.81	−0.24
Big	0.18	0.32	−0.05	−0.03	−0.10	1.03	3.79	−0.63	−0.32	−1.26
Average $\lvert\alpha\rvert$	0.14					-				
	R^2					$s(e)$				
Small	0.89	0.91	0.90	0.89	0.90	2.65	1.66	1.61	1.68	2.06
2	0.95	0.92	0.90	0.92	0.95	1.80	1.61	1.61	1.43	1.50
3	0.91	0.91	0.89	0.88	0.94	2.21	1.66	1.61	1.71	1.58
4	0.89	0.90	0.88	0.87	0.91	2.51	1.75	1.65	1.65	1.79
Big	0.86	0.89	0.89	0.89	0.91	2.63	1.61	1.45	1.42	1.58
Average R^2	0.90					-				

a reversal of the future returns. The results indicate that the 52W factor is unable to capture the momentum effect as well as the WML factor, leaving the overall performance of the 52W model somewhere between the 3-factor model and Carhart (1997)'s model.

TABLE 5—*Continued*

52W 4-Factor Model

$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i 52W_t + \varepsilon_{it}$

	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.75	−0.14	0.10	0.26	0.50	−4.38	−1.47	1.22	2.84	3.59
2	−0.55	−0.07	0.08	0.22	0.35	−4.29	−0.80	0.92	3.04	3.44
3	−0.24	−0.08	0.03	0.04	0.25	−1.90	−0.74	0.33	0.40	2.56
4	−0.32	−0.02	0.11	0.10	0.17	−1.91	−0.21	1.02	1.16	1.44
Big	−0.20	0.10	−0.10	0.05	0.14	−0.93	0.99	−1.23	0.66	1.41
Average $\lvert\alpha\rvert$			0.20					-		
	R^2					$s(e)$				
Small	0.88	0.90	0.89	0.89	0.88	2.82	1.76	1.62	1.68	2.25
2	0.91	0.90	0.90	0.93	0.93	2.46	1.84	1.63	1.42	1.84
3	0.87	0.88	0.88	0.88	0.92	2.74	1.92	1.69	1.68	1.84
4	0.82	0.85	0.87	0.88	0.88	3.26	2.13	1.72	1.64	2.08
Big	0.76	0.82	0.89	0.88	0.84	3.46	2.09	1.47	1.49	2.15
Average R^2			0.88					-		

The table shows the results from time-series regressions of the Fama and French (1993, 1996) 3-factor model, Carhart (1997) 4-factor model and 52W 4-factor model on the monthly percent excess returns of the 25 portfolios created from 5 × 5 sorts on size and momentum. Reported only the α, respective HAC Newey-West t-statistics, adjusted R^2 and the regressions' standard errors (for complete Tables contact the authors). Sample period is January 1980 to December 2014.

On one hand, the results are not surprising, considering the summary statistics shown in Table 1 for WML and 52W, with WML exhibiting far larger average returns and variance, indicating a greater capacity to explain the portfolios' excess returns. However, on the other hand, we must also take into account that, since the portfolios are built on Jegadeesh and Titman (1993) momentum, there is a tilt towards the excess returns being better captured by the model with the WML factor.

Since the robustness test of the risk factors shows very different average premiums for both WML and 52W, in the subperiods 1980-2000 and 2001-2014, we repeat the regressions on the 25 size-momentum portfolios for these subsamples.

4.3.1. Asset Pricing Tests for the 25 Size-Momentum Portfolios (1980-2000)

The results for the subperiod 1980-2000, presented in Table 6, show that the issues for all the 3 models are qualitatively similar to those of the entire period 1980-2014, although they appear to be greatly magnified. We suggest this is a consequence from the combined effect that momentum returns are much larger during this subperiod and, concurrently, the sample period is much smaller.

TABLE 6.

Regressions for Monthly Percent Excess Returns on 25 Size-Momentum Portfolios (Jan. 1980 - Dec. 2000)

Fama-French 3-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−1.59	−0.39	−0.05	0.12	0.70	−8.58	−3.12	−0.44	1.13	3.95
2	−1.17	−0.43	−0.07	0.19	0.71	−5.53	−3.10	−0.64	1.80	5.73
3	−0.80	−0.47	−0.25	−0.02	0.59	−3.29	−3.31	−2.00	−0.21	5.26
4	−0.70	−0.37	−0.26	−0.08	0.57	−2.34	−2.42	−2.25	−0.79	4.41
Big	−0.35	−0.02	−0.30	0.02	0.31	−1.30	−0.13	−3.03	0.18	2.27
Average $\|\alpha\|$	0.42					-				
	R^2					$s(e)$				
Small	0.77	0.85	0.86	0.90	0.89	3.17	1.90	1.75	1.62	2.24
2	0.80	0.84	0.88	0.91	0.93	2.89	2.00	1.68	1.48	1.90
3	0.70	0.81	0.85	0.86	0.91	3.36	2.17	1.78	1.82	1.98
4	0.61	0.77	0.84	0.87	0.88	3.81	2.49	1.86	1.68	2.20
Big	0.56	0.69	0.88	0.89	0.84	3.92	2.50	1.54	1.50	2.29
Average R^2	0.82					-				
Carhart 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + w_i WML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.97	−0.09	0.09	0.10	0.43	−6.18	−0.76	0.77	0.76	2.78
2	−0.43	−0.04	0.10	0.18	0.37	−3.62	−0.41	0.86	1.48	3.29
3	0.02	−0.05	−0.04	−0.04	0.24	0.15	−0.41	−0.29	−0.26	2.26
4	0.24	0.19	0.01	−0.09	0.14	1.35	1.50	0.08	−0.79	1.14
Big	0.62	0.57	−0.12	−0.13	−0.24	3.45	4.43	−1.25	−1.45	−2.66
Average $\|\alpha\|$	0.22					-				
	R^2					$s(e)$				
Small	0.85	0.89	0.87	0.90	0.91	2.50	1.63	1.69	1.62	2.08
2	0.93	0.90	0.89	0.91	0.95	1.69	1.57	1.59	1.48	1.57
3	0.88	0.88	0.87	0.86	0.94	2.15	1.70	1.65	1.82	1.64
4	0.85	0.88	0.87	0.87	0.92	2.38	1.76	1.65	1.69	1.74
Big	0.83	0.86	0.90	0.90	0.94	2.45	1.67	1.43	1.43	1.48
Average R^2	0.89					-				

The regressions on the 3-factor model show overall large α, corresponding to an average absolute of 0.42%, with especially large negative intercepts

TABLE 6—*Continued*

52W 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i 52W_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
			α					$t(\alpha)$		
Small	−1.25	−0.24	0.02	0.11	0.65	−5.64	−1.73	0.16	0.89	3.47
2	−0.85	−0.28	−0.04	0.16	0.63	−4.99	−2.21	−0.41	1.46	4.24
3	−0.46	−0.34	−0.20	-0.07	0.45	−2.38	−2.56	−1.65	−0.50	3.89
4	−0.35	−0.21	−0.19	−0.11	0.38	-1.36	−1.38	−1.58	−1.11	2.84
Big	−0.01	0.17	−0.23	−0.04	0.15	−0.05	1.04	−2.21	−0.50	1.25
Average $\|\alpha\|$			0.30					-		
			R^2					$s(e)$		
Small	0.85	0.88	0.87	0.90	0.89	2.50	1.68	1.71	1.62	2.23
2	0.88	0.87	0.88	0.92	0.93	2.20	1.78	1.67	1.47	1.84
3	0.79	0.83	0.85	0.86	0.93	2.78	2.04	1.76	1.81	1.82
4	0.71	0.80	0.85	0.88	0.90	3.26	2.32	1.82	1.68	1.94
Big	0.67	0.75	0.89	0.90	0.87	3.41	0.75	1.48	1.47	2.11
Average R^2			0.85					-		

The table shows the results from time-series regressions of the Fama and French (1993, 1996) 3-factor model, Carhart (1997) 4-factor model and 52W 4-factor model on the monthly percent excess returns of the 25 portfolios created from 5 × 5 sorts on size and momentum. Reported only the α, respective HAC Newey-West t-statistics, adjusted R^2 and the regressions' standard errors (for complete Tables contact the authors). Sample period is January 1980 to December 2000.

in short-term losers and large positive intercepts in past winners. Again the factor loadings in HML and also very slightly on $R_M - R_f$ (not shown) continue to be larger for past losers than for past winners, erroneously predicting the future reversal of returns.

The Carhart (1997) model once again corresponds to a vast improvement relative to the 3-factor model, reducing the overall average absolute α to 0.22% while increasing the average adjusted R^2 to 0.89. However, not only does the model not capture the momentum effect on small caps, with large negative intercepts for small cap losers and large positive intercepts for small cap winners, it also creates a very significant reverse momentum effect for large caps. Succinctly, the problems already observed for the entire period, shown in Table 5, also apply in the subperiod 1980-2000. However, the spreads in the WML factor loadings (not shown) are now even larger, especially for the biggest size than smallest size quintiles, exacerbating the issue.

The performance of the 52W 4-factor model lies somewhere between the Fama and French (1993, 1996) and Carhart (1997) models, as occurs for the entire period. The average absolute α is 0.30%, still very high despite a clear advance relative to the 3-factor model, and clearly worse than the 0.22% of the Carhart (1997) 4-factor model. The average adjusted R^2 improves slightly to 0.85. The problems with the intercepts correspond mostly, but not exclusively, to large negative intercepts in almost all short-term losers size quintiles and generally large positive intercepts for short-term winners. Once again the spreads in the 52W factor (not shown) fail to account for the different momentum returns for each size quintile. Additionally, the loadings on the HML factor (not shown) continue to predict a future, though unobserved, reversion of the returns.

In summary, notwithstanding the fact that the performance of all models is worse for the subperiod of 1980-2000, the conclusions are similar to those of the entire period.

4.3.2. Asset Pricing Tests for the 25 Size-Momentum Portfolios (2001-2014)

The results for the subperiod 2001-2014 are presented in Table 7 and, as the momentum effect is much more diffuse in the subsample, Fama and French (1993, 1996) model's performance improves and is again much closer to that of the other models.

The 3-factor model's average absolute α is 0.22%, and the average adjusted R^2 is 0.85, but problems persist in the individual intercepts. Though the trend is not as clear, the model continues to show large negative intercepts for extreme losers and generally relevant positive intercepts in all other quintiles. In this case, it is the loadings of $R_M - R_f$ and SMB (not shown) that lead to the prediction of the future reversal of returns.

The introduction of WML does not lead, in this case, to quite as impressive results, with the Carhart (1997) 4-factor model exhibiting an average absolute α on these portfolios of 0.19%, a very slight decrease relative to the 3-factor model. This is somewhat expected as the average WML for this subperiod is a mere 0.07%. The issues remain with the individual intercepts but now without leaving a clear pattern. However, it is relevant to note that the loadings for WML (not shown) are mostly statistically significant and that the average adjusted R^2 improves to 0.92.

As regards the 52W 4-factor model, as would be expected considering that the 52W factor achieves an insignificant negative average return of -0.34%, the performance of the model is virtually identical to the Fama and French (1993, 1996) model. The average absolute α is 0.21% and the patterns in the individual intercepts do not significantly vary from those of the 3-factor model. Again, as in the Carhart (1997) model, the

TABLE 7.

Regressions for Monthly Percent Excess Returns on 25 Size-Momentum Portfolios (Jan. 2001 - Dec. 2014)

Fama-French 3-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.19	−0.01	0.24	0.45	0.38	−0.51	−0.03	1.84	3.18	1.77
2	−0.25	0.18	0.19	0.25	0.07	−0.76	1.09	1.55	2.53	0.47
3	−0.13	0.22	0.29	0.15	0.06	−0.39	1.40	2.60	1.27	0.33
4	−0.47	0.14	0.45	0.35	0.01	−1.62	1.02	3.91	3.28	0.03
Big	−0.44	0.01	0.09	0.18	0.18	−1.43	0.10	0.84	1.51	0.98
Average $\|\alpha\|$	0.22					-				
	R^2					$s(e)$				
Small	0.76	0.90	0.93	0.89	0.85	4.88	1.97	1.40	1.76	2.40
2	0.80	0.90	0.94	0.94	0.88	4.51	2.11	1.39	1.30	2.07
3	0.77	0.91	0.93	0.90	0.82	4.51	1.88	1.47	1.56	2.41
4	0.75	0.89	0.93	0.88	0.71	4.76	2.00	1.26	1.54	2.90
Big	0.74	0.83	0.90	0.84	0.65	4.37	2.23	1.37	1.57	2.70
Average R^2	0.85					-				
Carhart 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + w_i WML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	0.07	0.06	0.24	0.42	0.30	0.33	0.42	1.90	2.85	1.43
2	0.01	0.26	0.19	0.22	−0.03	0.05	2.04	1.52	2.31	−0.24
3	0.11	0.29	0.31	0.10	−0.06	0.63	2.19	2.81	0.91	−0.51
4	−0.22	0.22	0.46	0.30	−0.13	−1.42	1.96	4.00	2.88	−0.76
Big	−0.23	0.12	0.11	0.12	0.05	−0.96	1.34	0.96	1.01	0.38
Average $\|\alpha\|$	0.19					-				
	R^2					$s(e)$				
Small	0.93	0.93	0.93	0.89	0.89	2.59	1.63	1.40	1.71	2.04
2	0.97	0.95	0.94	0.95	0.95	1.70	1.56	1.39	1.21	1.38
3	0.94	0.94	0.93	0.92	0.93	2.26	1.47	1.41	1.36	1.47
4	0.92	0.94	0.93	0.91	0.89	2.63	1.48	1.25	1.33	1.82
Big	0.89	0.93	0.90	0.90	0.87	2.75	1.40	1.34	1.25	1.65
Average R^2	0.92					-				

loadings for 52W (not shown) are mostly statistically significant but do not meaningfully improve the overall performance.

In summary, for the subperiod 2001-2014, the apparent disappearance of momentum (at least partly connected with the very negative performance

TABLE 7—*Continued*

52W 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_iSMB_t + h_iHML_t + m_i52W_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.18	−0.01	0.24	0.45	0.38	−0.72	−0.03	1.83	3.07	1.75
2	−0.25	0.17	0.19	0.24	0.07	−1.29	1.21	1.53	2.68	0.57
3	−0.13	0.22	0.29	0.15	0.06	−0.82	1.53	2.57	1.34	0.42
4	−0.46	0.14	0.44	0.35	0.00	−2.08	1.16	3.95	3.22	0.02
Big	−0.44	0.02	0.09	0.18	0.18	−1.42	0.13	0.85	1.40	1.29
Average $\|\alpha\|$	0.21					-				
	R^2					$s(e)$				
Small	0.91	0.92	0.93	0.89	0.87	3.02	1.84	1.40	1.73	2.24
2	0.93	0.92	0.94	0.95	0.92	2.61	1.86	1.39	1.19	1.73
3	0.93	0.93	0.93	0.93	0.90	2.45	1.66	1.46	1.34	1.79
4	0.90	0.92	0.93	0.91	0.84	3.03	1.72	1.27	1.35	2.19
Big	0.84	0.89	0.89	0.89	0.80	3.40	1.81	1.37	1.33	2.07
Average R^2	0.90					-				

The table shows the results from time-series regressions of the Fama and French (1993, 1996) 3-factor model, Carhart (1997) 4-factor model and 52W 4-factor model on the monthly percent excess returns of the 25 portfolios created from 5 × 5 sorts on size and momentum. Reported only the α, respective HAC Newey-West t-statistics, adjusted R^2 and the regressions' standard errors (for complete Tables contact the authors). Sample period is January 2001 to December 2014.

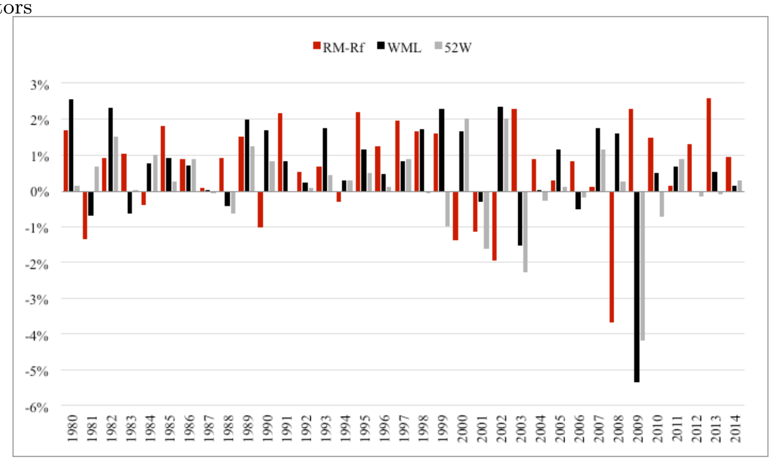
of the strategy in 2009), already addressed in subsection 4.1, leads to both the Carhart (1997) and 52W 4-factor models representing irrelevant improvements relative to the 3-factor model. However, both improve the adjusted R^2. The relevance of the WML and 52W factors depends, then, on whether this corresponds to an effective absorption of the anomaly by the market or if, contrarily, it is at least partly the result of the outlier year of 2009. Concurrently, we discuss this issue in greater detail over the next subsection.

4.3.3. Momentum Returns: The Specific Case of the Year 2009

In order to address the eventual distinct nature of the year 2009, we start by inspecting the average monthly returns of the momentum risk factors from 1980 to 2014. As shown in Figure 1, we plot the mentioned average monthly returns, per year, for WML and 52W, while also showing the results for our proxy for excess market return.

From Figure 1, three results seem to present themselves fairly clearly: (i) up from 2001, negative average returns in momentum risk factors seem

FIG. 1. Average Monthly Returns (per Year) of $R_M - R_f$, WML and 52W Risk Factors



The figure shows average monthly returns, per year, for the excess market return RM-Rf and the momentum risk factors WML and 52W. RM-Rf corresponds to the value-weighted return of all CRSP firms incorporated in the US and listed on the NYSE, NYSE MKT, and NASDAQ that have a CRSP share code of 10 or 11 minus the one-month Treasury bill rate from Ibbotson Associates. WML is built from 6 value-weighted portfolios formed on the intersections of 2 portfolios formed on size and 3 portfolios formed on prior $t-12$ to $t-2$ month returns, and corresponds to the monthly average return of the two high prior return portfolios minus the average return of the two low prior return portfolios. Data for $R_M - R_f$ and WML was collected from Kenneth R. French's website. 52W is a momentum factor built according to the 52-week high strategy, using all stocks listed on the NYSE, NYSE MKT and NASDAQ, collected from DataStream, excluding stocks under \$5 and stocks not traded during the previous month, corresponding to the equal-weighted returns of the 30% top ranked stocks minus the equal-weighted returns of the 30% worst ranked stocks. Sample period is January 1980 to December 2014.

somewhat more frequent and more pronounced; (ii) $R_M - R_f$ achieves, unsurprisingly, an extreme negative return in 2008, losing an average -3.68% per month, related to that year's profound financial crisis; (iii) WML and 52W show very negative average returns in 2009, respectively -5.43% and -4.18% per month, which are contemporaneous with the strong rebound of $R_M - R_f$ up from the crash of 2008. In fact, as previously noted, strong negative momentum performance seems to generally occur in tandem with rapid and strong inversions in the overall market trend.

Our results are in line with Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) which find that, despite high positive average returns, momentum strategies can experience infrequent, but persistent and relatively long periods of strong negative returns. Also coherently with our results, Daniel and Moskowitz (2016) show that these extreme momentum crashes occur following market declines, when volatility is high, and are contemporaneous with market rebounds. The explanation is that, when there has been a significant market decline over the formation period, the resulting portfolio will be long on low beta and short on high beta stocks. When the market reversal occurs, the portfolio obtains extremely negative returns. The feature does not equally apply for winners during bull markets, justifying the asymmetry of the momentum crashes. The authors also note that three of the worst fifteen months for momentum strategies in the US stock market, between January 1927 and March 2013, occurred during 2009.

We suggest that momentum crashes during market reversals are also compatible with the anchor-and-adjust bias implied by the 52-week high strategy. Similarly, during downturns investors would be long on defensive low beta stocks, which would remain closer to their 52-week high, and short on the high beta stocks. Concurrently, the strategy would perform negatively simultaneously with the market upturn. Given that 2009 seems to have been a momentum crash year, and it appears that the extreme negative returns influence our results for the subperiod 2001-2014, we follow by analyzing the subperiods' data while excluding that year. It would be expected that, if 2009 represents in fact an outlier, or at least a particularly strong momentum crash, the effect would reappear for the remaining years of the subsample. In Table 8, shown below, we present the regressions for the subperiod 2001-2014 while excluding 2009.

Succinctly, the average absolute α and adjusted R^2 are, respectively, 0.24% and 0.86 for the 3-factor model, 0.15% and 0.92 for the Carhart (1997) 4-factor model, and 0.21% and 0.91 for our own 4-factor model. Again, we find the already familiar pattern of a reduction in the average absolute α and increase in the adjusted R^2 with the inclusion of a momentum factor, with the performance of WML far surpassing that of the 52W.

We conclude then that the exclusion of 2009 leads to results for the subperiod 2001-2014 that are qualitatively similar to those of the whole period and of the subperiod 1980-2000, even though the impact of the momentum factors is not quite as dramatic as for the remaining sample periods. In particular, and concerning 52W, the improvement in the regressions' inter-

TABLE 8.

Regressions for Monthly Percent Excess Returns on 25 Size-Momentum Portfolios (Jan. 2001 - Dec. 2014 excluding 2009)

Fama-French 3-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_iSMB_t + h_iHML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.49	−0.10	0.23	0.41	0.44	−1.66	−0.61	1.69	3.01	2.08
2	−0.49	0.07	0.12	0.26	0.17	−2.13	0.48	1.00	2.51	1.31
3	−0.34	0.09	0.23	0.16	0.16	−1.17	0.70	2.04	1.24	0.89
4	−0.57	0.04	0.36	0.36	0.01	−1.96	0.34	3.95	3.36	0.02
Big	−0.47	−0.06	0.02	0.15	0.20	−1.45	−0.41	0.17	1.18	1.05
Average $\vert\alpha\vert$	0.24					-				
	R^2					$s(e)$				
Small	0.79	0.91	0.93	0.90	0.86	4.05	1.74	1.39	1.59	2.23
2	0.87	0.92	0.93	0.94	0.89	3.14	1.68	1.32	1.21	1.95
3	0.80	0.93	0.93	0.89	0.83	3.73	1.53	1.28	1.52	2.33
4	0.79	0.92	0.94	0.88	0.74	3.98	1.58	1.14	1.52	2.75
Big	0.75	0.85	0.90	0.83	0.66	3.85	1.88	1.16	1.57	2.68
Average R^2	0.86					-				
Carhart 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_iSMB_t + h_iHML_t + w_iWML_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.10	0.00	0.24	0.37	0.31	−0.42	0.03	1.79	2.53	1.34
2	−0.15	0.18	0.10	0.20	0.00	−1.19	1.47	0.89	2.06	0.03
3	0.03	0.18	0.24	0.04	−0.06	0.17	1.50	2.22	0.37	−0.54
4	−0.19	0.14	0.36	0.26	−0.25	−1.09	1.28	3.98	2.72	−1.43
Big	−0.12	0.11	0.01	0.03	−0.06	−0.48	1.11	0.06	0.27	−0.51
Average $\vert\alpha\vert$	0.15					-				
	R^2					$s(e)$				
Small	0.92	0.93	0.93	0.91	0.89	2.43	1.52	1.39	1.56	1.96
2	0.97	0.95	0.94	0.95	0.95	1.36	1.39	1.32	1.11	1.37
3	0.93	0.94	0.93	0.94	0.93	2.18	1.33	1.28	1.17	1.44
4	0.92	0.94	0.94	0.91	0.90	2.51	1.37	1.15	1.29	1.73
Big	0.89	0.92	0.90	0.90	0.88	2.57	1.34	1.16	1.19	1.56
Average R^2	0.92					-				

cepts is marginal. As such, though 2009 seems to have a clear effect on the overall conclusions one may reach regarding momentum, even with its exclusion the results may point to a weakening of the effect in the subperiod 2001-2014.

TABLE 8—*Continued*

52W 4-Factor Model										
	$R_{it} - R_{ft} = \alpha_i + b_i(R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i 52W_t + \varepsilon_{it}$									
	Loser	2	3	4	Winner	Loser	2	3	4	Winner
	α					$t(\alpha)$				
Small	−0.37	−0.08	0.23	0.40	0.41	−1.39	−0.48	1.66	2.85	1.86
2	−0.39	0.09	0.10	0.24	0.14	−2.59	0.66	0.95	2.47	1.09
3	−0.22	0.11	0.22	0.12	0.10	−1.39	0.84	2.04	1.07	0.65
4	−0.45	0.06	0.36	0.33	−0.07	−1.98	0.55	3.89	3.12	−0.36
Big	−0.38	−0.02	0.01	0.12	0.14	−1.14	−0.15	0.11	0.94	0.93
Average $\|\alpha\|$	0.21					-				
	R^2					$s(e)$				
Small	0.90	0.92	0.93	0.91	0.87	2.76	1.68	1.39	1.58	2.14
2	0.95	0.93	0.94	0.95	0.92	1.93	1.57	1.29	1.11	1.72
3	0.93	0.93	0.93	0.93	0.90	2.26	1.45	1.28	1.22	1.81
4	0.90	0.92	0.94	0.91	0.85	2.79	1.49	1.14	1.33	2.13
Big	0.83	0.88	0.90	0.88	0.79	3.15	1.65	1.16	1.33	2.12
Average R^2	0.91					-				

The table shows the results from time-series regressions of the Fama and French (1993, 1996) 3-factor model, Carhart (1997) 4-factor model and 52W 4-factor model on the monthly percent excess returns of the 25 portfolios created from 5 × 5 sorts on size and momentum. Reported only the α, respective HAC Newey-West t-statistics, adjusted R^2 and the regressions' standard errors (for complete Tables contact the authors). Sample period is January 2001 to December 2014 excluding 2009.

In our view, any definitive answers regarding how we consider 2009 and the resilience of momentum will depend on the evolution to be observed in the US stock market in the next future years. However, the findings of Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) as well as our regressions' results seem to point that at least WML momentum, though not so clearly in the case of 52W momentum, is still a relevant risk factor. We must also stress that seems to be plainly the case when considering the longer and therefore more robust full sample period.

5. CONCLUSION

We propose and test a new 52W 4-factor asset pricing model with the momentum factor built according to the 52-week high strategy of George and Hwang (2004).

Problematically for our model, results show that a 52W momentum risk factor for the US market, from January 1980 to December 2014, achieves a statistically insignificant return of only 0.12% per month (the relative-strength WML is 0.61% per month). Even so, robustness tests show that the performance of both momentum risk factors is very strong during 1980-2001, especially WML, while in the period 2001-2014 the returns are negative for 52W and irrelevant for WML. We find that the results for 2001-2014 are influenced by the momentum crash of 2009. We show, in line with Daniel and Moskowitz (2016), that the issue is that due to the dependence on the continuation of returns, momentum strategies tend to perform very negatively following persistently bear markets, and contemporaneously with a quick inversion in the market trend.

The performance of all models on the 25 size-BE/ME portfolios is fairly similar, with no clear improvement inherent to the inclusion of WML or 52W.

The need for a momentum factor becomes apparent when analyzing the portfolios built on momentum. The 3-factor model clearly fails to capture the anomaly and introducing a momentum risk factor greatly reduces the average absolute α and increases the average adjusted R2. Nevertheless, although the performance of our model does surpass the 3-factor model, it still falls short from that of the Carhart (1997) model.

Robustness tests for the 25 size-momentum portfolios find that, for 1980-2000, conclusions are qualitatively similar to those of the whole period. For the subperiod 2001-2014, as the momentum effect is much more diffuse, the performance of the models is again extremely close. However, if we exclude the momentum crash year of 2009, the pattern somewhat reemerges, though much weaker than for the other periods.

In conclusion, we find that the inclusion of a momentum factor at worse does not have any effect and at best clearly improves the overall performance of asset pricing models, with Carhart (1997)'s model fitting the data better than the proposed 52W model.

The inclusion of a momentum risk factor on future applications of asset pricing models depends on how one looks at the results from 2001-2014. At least as regards WML, though less so for 52W, reports about its death seem greatly exaggerated. We must also point out that the debate concerning the nature of momentum continues very much alive, as exemplified by Novy-Marx (2012)'s paper concerning the superior predictive power of intermediate horizon past performance over recent past performance, and the subsequent dispute of these conclusions in Goyal and Wahal (2015). Additionally, Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) show that it is possible to improve the returns of the momentum strategy by actively managing its risk. Consequently, we believe that much remains to be done regarding the construction of a momentum risk factor that is able to capture the many different aspects of the anomaly.

Further avenues for research may also include repeating the tests for a larger sample or after allowing for more years of data, given the influence of 2009; conducting out-of-sample tests in other markets or geographies; augmenting the tests with Fama and French (2015)'s 5-factor model; and considering alternative estimating techniques.

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