An Analysis on the Predictability of CAPM Beta for Momentum Returns

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Abstract

This paper demonstrates that the forecasted CAPM beta of momentum portfolios explains a large portion of the return, ranging from 40% to 60% for stock level momentum, and 30% to 50% for industry level momentum. Beta forecasts are from a realized beta estimator using daily returns over the prior year. Periods such as 1969 to 1989 have been found in earlier studies to contain abnormal profits from momentum trading, however, we show that these were spuriously generated by measurement error in systematic risk. These results cast further doubt on the ability of standard momentum trading strategies to generate abnormal profits.

Key Words: Financial markets, Momentum trading strategies, Realized beta, Systematic risk, Time series.

JEL classification: G12, G17.

1 Introduction

Stock return persistence both at the individual stock level, as studied in Jegadeesh and Titman (1993), or the industry level, as studied in Moskowitz and Grinblatt (1999) is well documented and widely known as the momentum anomaly. It is perceived as an anomaly since prior studies have found momentum returns can not be explained by standard asset pricing models, such as the Capital Asset Pricing Model (CAPM) of Sharpe (1964) and Lintner (1965), or the three factor model of Fama and French (1993), where systematic risk from these models is typically computed from time series of monthly stock returns, see Fama and MacBeth (1973), Jegadeesh and Titman (1993), Fama and French (1993 and 1996), Grundy and Martin (2001) and Novy-Marx (2012).

Though monthly returns are widely used for measuring and forecasting systematic risk, higher frequency returns have been receiving greater attention in recent years, due to new developments in financial econometrics. In particular, the development of the realized volatility literature (initiated by Andersen and Bollerslev (1998) and Andersen et al. (2001a, 2001b and 2003)) and the realized beta literature (initiated by Barndorff-Nielsen and Shepherd (2004) and Andersen et al. (2005 and 2006)). In these literatures, consistent estimators have been developed for variance, covariance and beta over a fixed time period with sufficiently finely sampled returns. CAPM beta forecasting studies utilizing realized variance, covariance and beta include Ghysels and Jacquier (2006), Hooper et al. (2008), Chang et al. (2012), Reeves and Wu (2013), Papageorgiou et al. (2016) and Cenesizoglu et al. (2016), among others. An important finding in this literature is that generating beta forecasts from low frequency returns such as monthly returns, results in very poor one-month and one-quarter ahead forecasts. In addition, beta forecasts generated from higher frequency data, though with an insufficient number of observations, also leads to poor forecasts. In sum, an appropriately chosen prior estimation period and return sampling frequency are critical to CAPM beta forecast accuracy.

Beta forecasts play an important role in evaluating momentum returns. On the one hand, there is an extensive literature finding that CAPM beta forecasts have little predictability for momentum returns, starting from Jegadeesh and Titman (1993) and contining to present studies such as Daniel and Moskowitz (2016). The majority of studies have generated beta forecasts in a similiar fashion to Jegadeesh and Titman (1993) who based their forecasts on the Fama and MacBeth (1973) beta based on the prior five years of monthly returns, however, there have also been alternative beta forecasting procedures followed, for example, Daniel and Moskowitz (2016) generate CAPM beta forecasts utilizing the Dimson (1979) method computed from daily returns over the prior two months. On the other hand, Boguth et al. (2011) with an instrumental variables method incorporating a variety of instruments, including macroeconomic factors and realized betas computed from monthly and daily returns, reduces risk-adjusted momentum returns by 20% to 40%. Additionally, Barroso and Santa-Clara (2015) decompose risk-adjusted momentum returns finding that CAPM systematic risk accounts for about 23% of the total risk, utilizing a realized beta computed from daily returns over the prior 6 months.

This paper provides evidence that the CAPM beta explains a far greater portion of momentum returns (more than double) than previously documented in prior studies. This is achieved with a simple CAPM realized beta estimator computed from daily returns over the prior year, which explains in the range of 40% to 60% of stock level momentum returns, and 30% to 50% of industry level momentum returns. This beta estimator is favoured over other competing estimators such as the Fama and MacBeth (1973) beta based on five years of monthly returns, or a beta estimator based on daily returns over shorter periods, as these other estimators can have double the mean squared forecast error at the monthly and quarterly horizons, see Reeves and Wu (2013) and Cenesizoglu et al. (2016). This is mainly due to three sources of error in beta measurement and forecasting: (1) relying on monthly returns, when accurate daily returns are available; (2) relying on too small a sample of returns which provides insufficient observations to adequately reduce measurement error; and (3) relying on too long a sample of returns such as a five year period when beta is time-varying. For comparison with earlier studies, this paper also evaluates the Fama and MacBeth (1973) CAPM beta computed from monthly returns over the prior five years and confirms the findings in the previous literature that the Fama and MacBeth (1973) CAPM betas fail to explain returns on different momentum strategies.

Following a discussion of beta measurement and as part of the justification of the realized beta estimator from daily returns, we start with comparing the performance of the Fama-MacBeth beta and realized beta in accounting for the cross-sectional variation in returns of momentum portfolios provided by Kenneth French. We calculate average pricing errors as the average of the residuals from estimated cross-sectional regressions each month, as in Fama and MacBeth (1973) and find that our realized beta estimator from daily returns reduces the pricing error dramatically, relative to the beta estimator from monthly returns. Over the January 1969 to December 2010 period, the sum of squared pricing errors reduce by 45% for the equal-weighted stock momentum portfolio and by 44% for the value-weighted stock momentum portfolio.

Our main empirical analysis is on measuring the contribution of beta forecasts to momentum returns, where we measure the return performance of momentum portfolios for the 1, 3 and 6 month holding periods where market exposure (residual beta) is hedged using the S&P 500 index. For this analysis we need to estimate stock level betas and therefore we construct the dataset ourselves, which also allows us to examine different prior periods for the ranking on cumulative return, as in Novy-Marx (2012). Overall, our results on the Fama-MacBeth CAPM beta (computed from monthly returns over the prior 5 years) are consistent with prior literature in that this beta forecast can not explain momentum returns. However, our results with realized beta (computed from daily returns over the prior year) demonstrate the importance of forecasted CAPM beta to momentum returns. Where we find forecasted beta accounting for between 40% to 60% of stock level momentum returns and between 30% to 50% of industry level momentum returns. In addition, we assess whether abnormal momentum profits are achievable and conclude that they are not present when beta is appropriately measured. We also demonstrate that measuring beta with monthly returns over the prior 5 years can result in spurious abnormal momentum profits.

The empirical results of this paper are for both equal- and value-weighted portfolios which are constructed each month by buying stocks (industries) with recent strong performance and selling stocks (industries) with recent poor performance. These are defined by ranking on cumulative return over a prior period and assigning stocks (industries) into ten decile groups, with the upper decile being the "winners" and the lower decile group being the "losers," as in Jegadeesh and Titman (1993) and Novy-Marx (2012). The January 1969 to December 1989 period is analyzed for comparison with the period of study in Jegadeesh and Titman (1993), in addition to the recent period January 1990 to December 2010, along with full sample analysis from January 1969 to December 2010. Earlier sample periods are excluded from the analysis due to insufficient market liquidity which creates econometric problems for the realized beta estimator computed with daily stock returns.

Momentum profits have been extensively studied in the context of whether markets are efficient. Earlier studies provided mixed evidence, for example, Jegadeesh and Titman (1993) and Hong et al. (2000) suggest generous momentum abnormal returns are achievable after transaction costs, whereas, Grundy and Martin (2001) express doubt on whether momentum produces profits after transaction costs. Lesmond et al. (2004) with more realistic estimates of trading costs than earlier studies find that the magnitude of trading costs associated with momentum strategies to be larger than previously appreciated. They conclude that standard stock level momentum trading profits do not exist and that the momentum anomaly is not evidence against market efficiency. Korajczyk and Sadka (2004) provide evidence to suggest that even though equal-weighted momentum strategies may not be profitable after transaction costs, value-weighted momentum strategies may in some cases be profitable.

The results found in our study on CAPM beta accounting for a large portion of momentum returns, is further evidence to support a general conclusion that in most cases, standard momentum trading is not providing abnormal profits. We do not find that abnormal momentum profits exist after accounting for beta and transaction costs. In periods such as between 1969 and 1989 where abnormal momentum profits have been previously documented, see Jegadeesh and Titman (1993), we show that these were spuriously generated through measurement error in beta. It is important to note though, that there have been many variants to momentum investing developed and so our results do not rule out the possibility of these variants generating abnormal profits. For example, Frazzini et al. (2015) demonstrate with live trading data from a large institutional money manager that momentum style investing had been optimized in regard to a tracking error from a benchmark and trading costs, suggesting such an approach (which includes the application of propriety trading algorithms) may generate abnormal risk adjusted profits.

The rest of the paper is organized as follows. Section 2 provides an overview of momentum returns. Section 3 briefly reviews beta measurement and forecasting. Section 4 is on asset pricing performance and section 5 is on measuring the contribution of beta to momentum returns. Conclusions are presented in section 6.

2 Overview of Momentum Returns

In this section, we provide an overview of momentum returns. Typically, portfolios are constructed as either equal- or value-weighted, with asset selection based on prior return, excluding the most recent month. This one month gap avoids the short-term return reversals documented in Poterba and Summers (1988) and Jegadeesh (1990). Ranking on prior return is most commonly over the prior year, as in Jegadeesh and Titman (1993) and Fama and French (1996), though over the prior 6 month period is also common, as in Jegadeesh and Titman (1993) and Grundy and Martin (2001). These momentum strategies that rank on cumulative return from n to m months (inclusive) prior to portfolio formation can be denoted by n-m strategies. In addition to the 12-2 and 6-2 strategies, Novy-Marx (2012) advocates the 12-7 strategy which is shown to generate higher returns. This is found in both stock level and industry level momentum, and also in other assets such as commodities and currencies.

Following the ranking on prior return, assets are allocated to groups with the "winners" group typically being the assets ranked in the top ten percent and the "losers" group being the assets ranked in the bottom ten percent. Other variants on this strategy include increasing the number of assets in the "winners" and "losers" group, for example, taking the top thirty percent and bottom thirty percent. A zero net investment is constructed by taking a long position in the "winners" and an off-setting short position in the "losers". Holding periods often range from 1 to 12 months, with 3 and 6 months being common.

Table 1 and 2 present, respectively, the performance for the cross-sectional variation in monthly excess returns on ten equal- and value-weighted portfolios formed using return performance between 12 and 2 months prior to the current month. This data is from the website of Kenneth French at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/. The portfolios are constructed each month from NYSE, AMEX and NASDAQ stocks, using the NYSE prior (12-2) return decile breakpoints. The results clearly confirm the presence of a momentum premium in the data. There is a clear trend (although not always monotonous) across the 10 portfolios regardless of the sample period or weighting scheme. Let us first consider the results in table 2. We note that for the entire sample period, the monthly return obtained by buying the top performing portfolio in the formation period and selling the worst is a statistically significant 1.343%. This result is observed over the two sub-samples, with statistically significant returns of 1.632% and 1.054% for the 1969-1989 and 1990-2010 periods respectively. When we consider the equal-weighted portfolios in table 1, the results are similar although of a lesser magnitude. Over the entire sample, the return from buying past winners and selling past losers generated a statistically significant monthly return of 0.892%. This return was larger (1.296%) and significant over the 1969-1989 sample, however dropped to 0.488% and was not statistically significant over the second sub-sample.

These above results are for portfolios where transaction costs are excluded, thus in evaluating whether momentum generates abnormal profits, an adjustment for transaction costs is required. This adjustment can be relatively high, due to the winners and losers portfolios primarily being comprised of relatively illiquid stocks. Lesmond et al. (2004), using conservative assumptions, find little evidence that trading costs for standard momentum trading to be less than 6% over a holding period. This conservative estimate also accounts for a portion of the stocks remaining unchanged in the portfolio over consecutive holding periods. Later in the paper, in assessing abnormal profit performance of momentum, trading costs of 6% over a holding period will serve as a benchmark.

3 Beta Measurement and Forecasting

In this section, we briefly review beta measurement and forecasting. The Capital Asset Pricing Model (CAPM), defines β_i as

$$\frac{Cov(r_i, r_m)}{Var(r_m)}$$

where r_i is the security return and r_m the market return. Estimation of β_i is typically via the one factor model

$$r_i = \alpha_i + \beta_i r_m + e_i \tag{1}$$

through ordinary least squares, with standard estimation being with five years of monthly returns, following Fama and MacBeth (1973). There is currently two distinct econometric theories which guide empirical estimation of systematic risk. Firstly, the widely implemented systematic risk estimators of Fama and MacBeth (1973), Dimson (1979), and the three and four factor specifications of Fama and French (1993) and Cahart (1997) rely upon standard asympototic theory for the consistency of the ordinary least squares estimator. Secondly, the more recent realized beta estimators of CAPM systematic risk rely upon the econometric theory developed in Barndorff-Nielsen and Shephard (2004) where the consistency is based on high frequency return measurement over a fixed time period. This consistency, different from the well known "long span" asymptotics of the ordinary least squares estimator, is with the return sampling frequency tending to zero. It is motivated in the following environment, where the N^{th} element of $p(t)$ contains the log price of the market and the i^{th} element of $p(t)$ contains the log price of the i^{th} individual security, and where the logarithmic $N \times 1$ vector process $p(t)$ follows a multivariate continuous-time stochastic volatility diffusion,

$$dp(t) = \mu(t)dt + \theta_t dW(t) \tag{2}$$

where $W(t)$ is standard N-dimensional Brownian motion, $\Omega_t = \theta_t \theta_t'$ is the instantaneous covariance matrix and $\mu(t)$ is the N-dimensional instantaneous drift. Both $\Omega(t)$ and $\mu(t)$ are strictly stationary and jointly independent of $W(t)$. With the process sampled S times per period on an equally spaced grid. The $\delta = 1/S$ period return is defined as $r_{i,t,j} = p(t + j\delta) - p(t + (j-1)\delta)$, $j = 1, 2, \ldots, S$. And the realized beta is defined as

$$\beta_{i,t+1} = \frac{\sum_{j=1}^{S} r_{i,t,j} r_{N,t,j}}{\sum_{j=1}^{S} r_{N,t,j}^2} \tag{3}$$

which Barndorff-Nielsen and Shephard (2004) show is a consistent estimator of the true underlying integrated beta

$$\frac{\int_t^{t+1} \Omega_{iN}(\tau)d\tau}{\int_t^{t+1} \Omega_{NN}(\tau)d\tau} \tag{4}$$

for all t as $S \to \infty$. For additional details see Barndorff-Nielsen and Shephard (2004).

An important difference of the Fama and MacBeth (1973) CAPM beta with the CAPM realized beta is that the Fama and MacBeth approach is based on relatively low frequency monthly returns over the estimation period. While the Dimson (1979) CAPM beta with leads and lags has a property of generally decreasing econometric efficiency as the number of leads and lags increases. Realized beta estimators are typically utilized in environments where relatively high frequency stock returns are accurately available over the estimation period. Empirical studies on realized beta include Andersen et al. (2005 and 2006), Ghysels and Jacquier (2006), Hooper et al. (2008), Todorov and Bollerslev (2010), Reeves and Wu (2013), Papageorgiou et al. (2016) and Cenesizoglu et al. (2016), with focus on the forecastability of beta and evaluation of competing models. Most commonly proposed models for forecasting beta have been autoregressive models of realized beta and simple realized beta estimates. Reeves and Wu (2013) find the realized beta computed from daily returns over the prior year to be the dominant forecasting approach for quarterly beta, which provides a balance of a sufficiently long sample to alleviate measurement error problems, without the sample being too long as to hinder the measurement of time-varying beta. Following these results, this study computes two types of beta forecasts. Firstly, for comparison with prior studies, the Fama-MacBeth beta from monthly returns over the prior five years, and secondly, the realized beta from daily returns over the prior year.

4 Asset Pricing Performance

In this section, we test the ability of our two beta estimators (Fama-MacBeth beta and realized beta) to explain the cross-sectional variation in monthly excess returns on the ten equal- and value-weighted portfolios discussed in section 2. We estimate the following Fama-MacBeth (1973) cross-sectional regression for each month t:

$$\mathbf{R}_t = \lambda_{0,t} + \lambda_{m,t}\hat{\boldsymbol{\beta}}_t + \boldsymbol{\alpha}_t \tag{5}$$

where $\mathbf{R}_t$ is the $N \times 1$ vector of excess returns on the test assets in month t (the Kenneth French momentum portfolios) and $\hat{\boldsymbol{\beta}}_t$ is the $N \times 1$ vector of conditional betas of the test assets in month t. In this framework, the average pricing errors can simply be obtained as the sample averages of pricing errors from the cross-sectional regressions estimated each month as:

$$\bar{\hat{\boldsymbol{\alpha}}} = \frac{1}{T}\sum_{t=1}^{T}\hat{\boldsymbol{\alpha}}_t \tag{6}$$

where $\hat{\boldsymbol{\alpha}}_t$ is the vector of pricing errors obtained from the estimation of cross-sectional regression in month t. The variance-covariance matrix of $\bar{\hat{\boldsymbol{\alpha}}}$ and its version corrected for autocorrelation are respectively:

$$cov(\bar{\hat{\boldsymbol{\alpha}}}) = \frac{1}{T^2}\sum_{t=1}^{T}(\hat{\boldsymbol{\alpha}}_t - \bar{\hat{\boldsymbol{\alpha}}})(\hat{\boldsymbol{\alpha}}_t - \bar{\hat{\boldsymbol{\alpha}}})' \tag{7}$$

$$\widetilde{cov}(\bar{\hat{\boldsymbol{\alpha}}}) = \frac{1}{T^2}\sum_{t=1}^{T}(\hat{\boldsymbol{\alpha}}_t - \bar{\hat{\boldsymbol{\alpha}}})(\hat{\boldsymbol{\alpha}}_t - \bar{\hat{\boldsymbol{\alpha}}})' + \frac{1}{T^2}\sum_{j=1}^{q}\sum_{t=j+1}^{T}(1 - \frac{j}{q+1})(\hat{\boldsymbol{\alpha}}_t - \bar{\hat{\boldsymbol{\alpha}}})(\hat{\boldsymbol{\alpha}}_{t-j} - \bar{\hat{\boldsymbol{\alpha}}})' \tag{8}$$

where we set $q = \lfloor(4(T/100)^{2/9})\rfloor$ and $\lfloor x \rfloor$ denotes largest integer not greater than x.

To compare the performance of different CAPM betas in accounting for the cross-sectional variation in returns, we consider two metrics. These are the sum of square pricing errors (SSPE) and root mean square pricing errors (RMSPE) (see Adrian and Rosenberg(2008)):

$$\text{SSPE} = \bar{\hat{\boldsymbol{\alpha}}}'\bar{\hat{\boldsymbol{\alpha}}} \tag{9}$$

$$\text{RMSPE} = (\text{SSPE}/N)^{1/2} \tag{10}$$

Tables 3 and 4 display the results from the cross-sectional regressions, both for equal and value-weighted portfolios, respectively, where CAPM betas are computed firstly with monthly returns over the prior 5 years (as in Fama and MacBeth (1973)), and secondly with daily returns over the prior year (realized beta). The average pricing errors for the winners minus losers are statistically significant for both the Fama-MacBeth beta and realized beta, though are lower for the realized beta. These results are consistent across both value-weighted and equal-weighted portfolios as well as for the two sub-periods. The differential in alphas is however much more pronounced over the second sub-sample.

More specifically, over the full sample (1969-2010), the alphas of the winners minus losers for the equal weighted portfolios in table 3 are 1.3739 based on the Fama-MacBeth beta compared to 0.9885 for the realized beta. This difference is mainly driven by results over the 1990-2010 sub-sample period, during which the alpha of the winners minus losers based on realized beta is in fact half that of the Fama-MacBeth beta. (i.e. 0.7046 compared to 1.4014). The SSPE and RMSPE are also lower for the realized beta, relative to the Fama-MacBeth beta. Over the full sample for the equal-weighted portfolios, the SSPE is 1.0734 for the Fama-MacBeth beta compared to 0.5926 for the realized beta. This again is largely driven by results in the second sub-sample, where the SSPE are 1.175 and 0.3917 respectively for Fama-MacBeth and realized beta.

The results in table 4 using value-weighted portfolios reinforce the results obtained in table 3. The alphas of the winners minus losers are 1.3724 for Fama-MacBeth beta compared to 0.9917 for the realized beta over the entire sample, and 1.4016 compared to 0.7095 over the second sub-sample. For the value-weighted portfolios, the full sample SSPE for Fama-MacBeth and realized beta are 1.0720 and 0.5966, respectively. For the most recent period, 1990-2010, the reduction in pricing error (SSPE) is even greater, specifically 1.1746 for Fama-MacBeth beta compared to 0.3981 for realized beta.

These asset pricing tests demonstrate how realized beta explains a substantial portion of the returns of the momentum portfolios, especially when compared to the explanatory power of the Fama-MacBeth beta, and provides further justification for realized beta as the appropriate beta measurement.

5 Measuring the Contribution of Beta

In this section, we measure the return performance of momentum portfolios where market exposure (residual beta) is hedged using the S&P 500 index. Momentum portfolios are constructed by ranking on cumulative return over a prior period and assigning stocks (industries) into ten decile groups, with the upper decile being the "winners" and the lower decile group being the "losers". The 12-2 and 6-2 strategies are analyzed due to their widespread use and the 12-7 strategy is also analyzed in light of the recent results in Novy-Marx (2012). Equal- and value-weighted portfolios are constructed each month, for the 1, 3 and 6 month holding periods, consisting of a $500,000 dollar long position in the "winners" and $500,000 dollar short position in the "losers", and residual market exposure is hedged with S&P 500 index. The number of contracts purchased for the hedge is calculated as $500,000(\beta_{s,t} - \beta_{l,t})/250P_t$, where $\beta_{s,t}$ is the beta forecast for the short portfolio at time t, $\beta_{l,t}$ is the beta forecast for the long portfolio at time t and P_t is the futures price at time t. (The S&P 500 index spot price is used as a proxy for the futures price.) Two hedged portfolios are constructed. Firstly, with the Fama-MacBeth stock beta forecasts from monthly returns over the prior five years, and secondly with the stock realized betas from daily returns over the prior year.

In order to calculate the appropriate hedge ratio, we require individual beta forecasts for each stock (based on both 1 year of daily returns and 5 years of monthly returns) and therefore need to reconstruct the momentum portfolios using stocks on the NYSE, AMEX and NASDAQ exchanges, with data spanning from 1 January 1964 to 31 December 2010, sourced from the Center for Research in Security Prices (CRSP). In order to ensure that our results are comparable to previous findings in the literature, our first concern is to ensure that our stock universe is consistent with the one employed in previous empirical studies. In table 5, we provide the descriptive stats for our database and the descriptive statistics for the returns taken from Kenneth French's website. As expected, the two samples have similar (but not identical) statistical properties over the entire sample period and both sub-samples. Our data demonstrates lower average returns and lower volatility over both sub-samples and this is for both the equal- and value-weighted returns. Most importantly, the correlations are close to 95% for all periods and both weighting schemes, confirming that our sample is representative and well constructed. In addition, momentum portfolios are also constructed from industry portfolios, spanning from 1 January 1964 to 31 December 2010, sourced from Kenneth French's 48 Industry Portfolios dataset.

Tables 6, 7 and 8 present the results for the raw and hedged momentum returns for individual stocks for the full sample and two sub-sample periods respectively. All returns are gross of any market micro-structure issues, such as transaction prices and market impact. We calculate the performance for three different holding periods, namely 1 month, 3 months and 6 months based on three different formation periods (12-2, 12-7 and 6-2) and for both equal- and value-weighted. Results in the tables are not annualized (they are presented as holding period returns) in order to facilitate the discussion relating to transaction costs, as the latter are unrelated to the investment horizon (fixed percentage cost). The three panels in the table present the unhedged, the Fama-MacBeth hedged and realized beta hedged returns for the momentum portfolios. If we consider the entire sample period (table 6) we note that the unhedged momentum return is positive and statistically significant for all possible combinations of formation and holding periods. Combining a long formation period (12-2 or 12-7) with a short holding period (1 or 3 months) yields the highest returns, and that the value-weighted portfolios systematically outperform the equal-weighted portfolios. The middle panel presents the returns when the Fama-MacBeth beta is hedged using S&P 500 futures contracts. Not only does the Fama-MacBeth beta hedge not reduce the momentum return, in most cases it actually increases, albeit marginally, the magnitude of the returns. The results are dramatically altered when we hedge the residual realized beta of the momentum portfolio. We observe a dramatic and uniform decrease in the returns in the range of 40%-60%. For example, the returns for the 12-2 formation period with one month holding period decrease from 0.755% for the unhedged returns to 0.418% for the realized beta hedged returns, and furthermore the latter returns are no longer statistically significant at the 5% level. This pattern is consistent across all formation and holding periods, although the p-values for the hedged returns are not always above 5%.

Recent literature on momentum has focused on the trade-off between the returns generated by the strategy and the significant implementation (trading) costs. Using a conservative estimate of 6% as a round-trip trading cost per holding period as our benchmark (as per Lesmond et al. (2004)), we note that none of the holding period returns in table 6 exceed this threshold. In other words, no momentum strategy, regardless of formation and holding periods generates sufficient return over the entire sample period to compensate trading costs. The highest holding period returns are generated for value-weighted portfolios using a 12-2 formation period and 6 month holding for both the unhedged and Fama-MacBeth hedged returns, at 5.234% and 5.738% respectively.

Figures 1 to 4 display cumulative returns from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for the unhedged, Fama-MacBeth hedged and realized beta hedged momentum portfolios (12-2 and 12-7). When analyzing cumulative return, the realized beta hedged momentum return is dramatically less than the unhedged and Fama-MacBeth hedged momentum return. These results for the entire sample would lead us to conclude that a considerable portion of the momentum returns can be explained by market beta, as long as the beta is accurately measured.

Tables 7 and 8 present the results for the raw and hedged momentum returns for individual stocks for the two sub-sample periods, specifically 1969-1989 and 1990-2010. Even though the magnitude of the momentum returns are considerably greater over the earlier period, the pattern across the results for the different periods is consistent. The unhedged momentum returns in table 7 (1969-1989) are greater for all formation/holding period combinations than those observed over the second sub-sample period (table 8), indicating a decrease in the size of the momentum premium over time. In fact we can observe in table 8 that the returns in the latter subsample are not statistically significant. The impact of hedging the ex-ante beta component of the momentum returns using the Fama-MacBeth beta is ineffective for both subperiods, and generally leads to an increase in actual returns. This is again in stark contrast to the results obtained when we hedge the momentum portfolio using the realized beta. When the momentum portfolio's beta is hedged using the realized beta of the stocks, we observe a dramatic reduction in the returns for all formation and holding periods. This result, that we observed previously for the entire sample, is evident over both sub-samples. Even during the 1990-2010 period during which unhedged momentum returns are not statistically significant, we still observe a reduction of 30% to 50% for the realized beta hedged returns.

When we consider the two sub-sample periods, we identify only four holding/formation period combinations that generate returns greater than the 6% required to compensate trading costs. These four observations are in the 1969-1989 period (table 7). The 12-2 formation and 6 month holding period for the unhedged returns (for both equal and value-weighted), as well as the 12-2 formation/6 month holding (value weighted) and 6-2 formation/6 month holding (value weighted) for the Fama-MacBeth hedged returns which generate momentum returns that exceed the trading cost threshold. These results might erroneously lead us to conclude that there exists a profitable dynamic trading strategy associated to momentum over the 1969-1989 period. However, when we consider the realized beta hedged returns over the same period, the highest holding period return is only 3.717% (12-2 formation and 6 month holding period for value-weighted). These results indicate that if we hedge the residual realized beta of the portfolio, none of the momentum strategies implemented in the paper generate sufficient returns to compensate the trading costs over either sub-period.

The next step is to verify the robustness of these results by performing the same analysis using momentum portfolios constructed from Kenneth French's 48 Industry Portfolios. Tables 9, 10 and 11 present the results for the raw and hedged momentum returns for industry portfolios for the full sample and two sub-samples respectively. The results strongly support the empirical results that we observed at the stock level. Once again, we observe a significant return for the unhedged momentum strategy for the entire sample period for all formation and holding periods. As with the individual stock portfolios, the momentum premium decreases over time and is still positive but no longer significant for the second sub-sample (top panel table 11). Implementing a hedging strategy using the Fama-MacBeth betas reduces the return of the momentum strategy in most cases, however the impact is not dramatic. This slightly contrasts the results for the individual stock portfolios, for which the Fama-MacBeth hedge often had the opposite effect. When we calculate the hedge using the realized betas, the results are much more striking and corroborate our findings with the individual stocks. For all holding and formation periods, and regardless of the sample period, the industry momentum returns are greatly reduced when the realized beta is hedged. Returns decrease on average almost 40% when the realized beta hedge strategy is implemented indicating that a significant part of the industry momentum premium can be explained by market exposure. Figures 5 and 6 display cumulative returns from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for the unhedged, Fama-MacBeth hedged and realized beta hedged industry equal-weighted momentum portfolios (12-2 and 12-7). Similar to momentum at the stock level, the cumulative return of the realized beta hedged momentum portfolios are dramatically less than the unhedged and Fama-MacBeth hedged momentum portfolios.

6 Conclusion

Recent advances in the financial econometrics of variance, covariance and beta has led to further improvements in the predictability of CAPM beta. Realized beta estimators have proved particularly useful both in generating forecasts and in evaluating forecasts. Inferior beta forecasting approaches that have existed for many years in the empirical asset pricing literature can now be more critically reviewed, leading to a higher standard of econometric analysis in asset pricing.

In this paper we have extended results from the recent literature on the forecasting of CAPM beta. The realized beta estimator computed from daily returns over the prior year has been shown to be a strong predictor of CAPM beta, see Reeves and Wu (2013) and we find this result extending to the predictability of momentum returns. We show that forecasted CAPM systematic risk explains a large portion of momentum returns, up to 60% for stock level momentum and up to 50% for industry level momentum. This result is in contrast to most of the extensive literature on momentum returns from initial papers such as Jegadeesh and Titman (1993) to more recent studies such as Daniel and Moskowitz (2016). Our results are related to findings in Boguth et al. (2011) and Barroso and Santa-Clara (2015), though we show more than double the level of predictability of CAPM beta for momentum returns than these papers. These results, coupled with relatively high trading costs, support a general conclusion that in most cases, standard momentum trading is not providing abnormal profits. Nevertheless, analyzing whether variants to standard momentum trading generate abnormal profits, is still an important topic for future research.

This paper also has implications to the wider asset pricing literature. Just as the voluminous literature on the momentum anomaly developed on the basis of systematic risk estimators computed from monthly returns, it has also been the case that many other asset pricing anomalies have been identified with these inaccurate estimators. Re-examination of this broader asset pricing literature with the more accurate realized beta estimators is also left for future research.

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Table 1: Momentum returns for individual equities, using 10 equal-weighted portfolios

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
					1969:1-2010:12						
Average	0.796	0.953	1.010	1.058	1.134	1.180	1.257	1.370	1.507	1.688	0.892
Std. Error	0.421	0.302	0.265	0.239	0.229	0.222	0.221	0.227	0.244	0.305	0.297
T-stat	1.889	3.155	3.814	4.420	4.947	5.311	5.679	6.032	6.169	5.528	3.007
					1969:1-1989:12						
Average	0.366	0.834	0.982	1.014	1.124	1.158	1.261	1.325	1.509	1.662	1.296
Std. Error	0.514	0.422	0.393	0.363	0.359	0.351	0.350	0.356	0.376	0.425	0.313
T-stat	0.712	1.977	2.498	2.792	3.136	3.297	3.607	3.725	4.017	3.910	4.143
					1990:1-2010:12						
Average	1.226	1.071	1.037	1.103	1.143	1.201	1.253	1.414	1.505	1.714	0.488
Std. Error	0.668	0.433	0.356	0.313	0.286	0.273	0.272	0.283	0.313	0.439	0.504
T-stat	1.835	2.476	2.918	3.525	3.992	4.405	4.602	4.998	4.805	3.901	0.970

Note: This table displays average monthly returns in percent for the 10 equal-weighted momentum portfolios from the Kenneth French Data Library.

Table 2: Momentum returns for individual equities, using 10 value-weighted portfolios

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P10-P1
						1969:1-2010:12					
Average	0.069	0.663	0.835	0.886	0.761	0.863	0.925	1.073	1.084	1.412	1.343
Std. Error	0.379	0.293	0.251	0.224	0.207	0.212	0.203	0.206	0.224	0.284	0.329
T-stat	0.182	2.260	3.326	3.946	3.670	4.072	4.564	5.198	4.839	4.980	4.078
						1969:1-1989:12					
Average	-0.156	0.616	0.927	0.919	0.772	0.959	0.978	1.063	1.305	1.477	1.632
Std. Error	0.450	0.386	0.340	0.322	0.305	0.325	0.311	0.319	0.344	0.398	0.356
T-stat	-0.345	1.597	2.724	2.849	2.534	2.950	3.148	3.330	3.791	3.712	4.581
						1990:1-2010:12					
Average	0.293	0.710	0.743	0.853	0.750	0.768	0.873	1.083	0.863	1.348	1.054
Std. Error	0.610	0.443	0.370	0.313	0.282	0.273	0.261	0.263	0.287	0.405	0.554
T-stat	0.481	1.603	2.009	2.726	2.660	2.814	3.342	4.125	3.009	3.328	1.902

Note: This table displays average monthly returns in percent for the 10 value-weighted momentum portfolios from the Kenneth French Data Library.

Table 3: Asset pricing test results for equal-weighted portfolios

	Fama-MacBeth beta					
	1969:1-1989:12		1990:1-2010:12		1969:1-2010:12	
	Alpha	T-stat	Alpha	T-stat	Alpha	T-stat
Portfolio 1	-0.7450	-4.0338	-0.7059	-3.2020	-0.7239	-5.0205
Portfolio 2	-0.1066	-0.9184	-0.2294	-1.3879	-0.1676	-1.6485
Portfolio 3	0.0200	0.1838	-0.0928	-0.6330	-0.0368	-0.4092
Portfolio 4	0.0259	0.2648	-0.0212	-0.1915	0.0020	0.0271
Portfolio 5	-0.1919	-1.8259	-0.1044	-0.9429	-0.1481	-1.9177
Portfolio 6	0.0683	0.7437	-0.0784	-0.7509	-0.0048	-0.0691
Portfolio 7	-0.0244	-0.2681	0.1239	1.1470	0.0497	0.7023
Portfolio 8	0.0468	0.4550	0.2896	2.7252	0.1676	2.2476
Portfolio 9	0.3016	2.5548	0.1230	0.8442	0.2119	2.2621
Portfolio 10	0.6054	4.0388	0.6955	2.6993	0.6500	4.4194
Winners-Losers	1.3504	5.2226	1.4014	3.3336	1.3739	5.6268
Constant	1.1088	2.3469	0.4289	0.7415	0.7753	2.0878
Risk Premium	-0.7555	-1.5460	0.0750	0.1150	-0.3465	-0.8530
RMSPE	0.3270		0.3428		0.3276	
SSPE	1.0693		1.1751		1.0734	

	Realized beta					
	1969:01-1989:12		1990:1-2010:12		1969:1-2010:12	
	Alpha	T-stat	Alpha	T-stat	Alpha	T-stat
Portfolio 1	-0.8212	-5.0132	-0.4672	-2.0375	-0.6439	-4.5588
Portfolio 2	-0.0973	-0.8365	-0.1410	-0.9475	-0.1187	-1.2527
Portfolio 3	0.1417	1.5141	-0.0145	-0.1172	0.0638	0.8232
Portfolio 4	0.1016	1.1213	0.1225	1.0838	0.1124	1.5453
Portfolio 5	-0.0780	-0.7303	0.0114	0.1263	-0.0329	-0.4667
Portfolio 6	0.0648	0.6630	-0.0007	-0.0064	0.0323	0.4467
Portfolio 7	0.0061	0.0732	0.0701	0.6440	0.0379	0.5584
Portfolio 8	0.0295	0.2913	0.2649	2.8328	0.1468	2.1306
Portfolio 9	0.1991	1.8494	-0.0828	-0.7364	0.0576	0.7331
Portfolio 10	0.4538	3.2810	0.2373	1.6391	0.3447	3.5011
Winners-Losers	1.2749	5.3548	0.7046	2.4652	0.9885	5.3011
Constant	0.7392	1.1082	-1.0934	-1.9008	-0.1804	-0.3982
Risk Premium	-0.4366	-0.6561	1.6057	2.4216	0.5879	1.2202
RMSPE	0.3116		0.1979		0.2434	
SSPE	0.9709		0.3918		0.5926	

Note: This table displays results from the cross-sectional regressions for the 10 equal-weighted momentum portfolios from the Kenneth French Data Library. T-statistics are based on Newey-West standard errors.

Table 4: Asset pricing results for value-weighted portfolios

	Fama-MacBeth Beta					
	1969:1-1989:12		1990:1-2010:12		1969:1-2010:12	
	Alpha	T-stat	Alpha	T-stat	Alpha	T-stat
Portfolio 1	-0.7438	-4.0311	-0.7092	-3.2179	-0.7249	-5.0340
Portfolio 2	-0.1100	-0.9455	-0.2184	-1.3154	-0.1638	-1.6051
Portfolio 3	0.0228	0.2083	-0.0959	-0.6561	-0.0370	-0.4112
Portfolio 4	0.0291	0.2968	-0.0255	-0.2289	0.0014	0.0188
Portfolio 5	-0.1968	-1.8778	-0.1053	-0.9520	-0.1510	-1.9604
Portfolio 6	0.0725	0.7909	-0.0753	-0.7245	-0.0012	-0.0177
Portfolio 7	-0.0310	-0.3389	0.1216	1.1238	0.0453	0.6368
Portfolio 8	0.0517	0.5001	0.2993	2.8245	0.1748	2.3433
Portfolio 9	0.3021	2.5589	0.1163	0.8007	0.2088	2.2334
Portfolio 10	0.6035	4.0338	0.6924	2.6854	0.6475	4.4032
Winners-Losers	1.3473	5.2067	1.4016	3.3313	1.3724	5.6180
Constant	1.1016	2.3220	0.4334	0.7469	0.7739	2.0780
Risk Premium	-0.7486	-1.5253	0.0709	0.1085	-0.3451	-0.8478
RMSPE	0.3271		0.3427		0.3274	
SSPE	1.0698		1.1746		1.0720	

	Realized beta					
	1969:1-1989:12		1990:1-2010:12		1969:1-2010:12	
	Alpha	T-stat	Alpha	T-stat	Alpha	T-stat
Portfolio 1	-0.8211	-5.0053	-0.4727	-2.0675	-0.6466	-4.5874
Portfolio 2	-0.0985	-0.8508	-0.1311	-0.8736	-0.1144	-1.2020
Portfolio 3	0.1429	1.5257	-0.0206	-0.1669	0.0614	0.7914
Portfolio 4	0.1028	1.1370	0.1180	1.0373	0.1108	1.5179
Portfolio 5	-0.0839	-0.7900	0.0102	0.1121	-0.0364	-0.5165
Portfolio 6	0.0697	0.7140	0.0050	0.0471	0.0376	0.5200
Portfolio 7	-0.0017	-0.0202	0.0699	0.6363	0.0339	0.4946
Portfolio 8	0.0338	0.3292	0.2725	2.9449	0.1528	2.2132
Portfolio 9	0.2010	1.8621	-0.0880	-0.7860	0.0559	0.7125
Portfolio 10	0.4550	3.2943	0.2368	1.6320	0.3450	3.5023
Winners-Losers	1.2761	5.3509	0.7095	2.4853	0.9917	5.3196
Constant	0.7456	1.1187	-1.0921	-1.8969	-0.1764	-0.3896
Risk Premium	-0.4428	-0.6665	1.6046	2.4192	0.5842	1.2132
RMSPE	0.3123		0.1995		0.2442	
SSPE	0.9754		0.3981		0.5966	

Note: This table displays results from the cross-sectional regressions for the 10 value-weighted momentum portfolios from the Kenneth French Data Library. T-statistics are based on Newey-West standard errors.

Table 5: Descriptive (and comparative) statistics

	Equal-weighted		Value-weighted	
	Our sample	French sample	Our sample	French sample
	Annualized average return			
1969:01-1989:12	14.492%	15.551%	17.716%	19.588%
1990:01-2010:12	3.631%	5.862%	10.059%	12.652%
1969:01-2010:12	9.062%	10.707%	13.888%	16.120%
	Annualized standard deviation			
1969:01-1989:12	16.888%	17.201%	19.236%	19.595%
1990:01-2010:12	22.093%	27.695%	28.183%	30.483%
1969:01-2010:12	19.706%	23.072%	24.129%	25.618%
	Correlations between our sample and French sample			
1969:01-1989:12	95.925%		98.609%	
1990:01-2010:12	94.244%		97.913%	
1969:01-2010:12	94.351%		98.089%	

Note: This table displays statistics on the returns from the 12-2 stock momentum portfolio constructed in section 5 and the 12-2 stock momentum portfolio from the Kenneth French Data Library.

Table 6: Raw and hedged momentum returns for individual stocks (1969:1-2010:12)

	Unhedged returns for different formation periods					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.755%	0.782%	0.321%	1.157%	1.347%	0.557%
	(0.0029)	(0.0000)	(0.1899)	(0.0002)	(0.0000)	(0.0482)
	[0.0036]	[0.0004]	[0.1813]	[0.0003]	[0.0000]	[0.0591]
3 months	2.292%	1.924%	1.579%	3.157%	3.316%	1.759%
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0002)
	[0.0004]	[0.0015]	[0.0087]	[0.0002]	[0.0000]	[0.0176]
6 months	3.276%	1.934%	3.449%	5.235%	4.027%	4.336%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0037]	[0.0407]	[0.0023]	[0.0002]	[0.0002]	[0.0010]
	Hedged returns using Fama-MacBeth beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.785%	0.853%	0.294%	1.181%	1.433%	0.603%
	(0.0049)	(0.0000)	(0.2894)	(0.0004)	(0.0000)	(0.0870)
	[0.0014]	[0.0000]	[0.2445]	[0.0001]	[0.0000]	[0.0849]
3 months	2.442%	2.143%	1.553%	3.281%	3.539%	1.738%
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0017)
	[0.0000]	[0.0000]	[0.0076]	[0.0000]	[0.0000]	[0.0391]
6 months	3.759%	2.425%	3.637%	5.738%	4.180%	4.708%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0001]	[0.0041]	[0.0002]	[0.0000]	[0.0000]	[0.0001]
	Hedged returns using realized beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.418%	0.358%	0.193%	0.614%	0.628%	0.284%
	(0.0652)	(0.0336)	(0.2640)	(0.0307)	(0.0008)	(0.1840)
	[0.0566]	[0.0408]	[0.2751]	[0.0158]	[0.0004]	[0.2284]
3 months	1.439%	1.070%	0.952%	2.044%	1.850%	1.041%
	(0.0000)	(0.0001)	(0.0015)	(0.0000)	(0.0000)	(0.0017)
	[0.0044]	[0.0171]	[0.0210]	[0.0007]	[0.0000]	[0.0316]
6 months	1.804%	0.813%	1.847%	2.868%	2.145%	2.298%
	(0.0000)	(0.0118)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0248]	[0.1653]	[0.0184]	[0.0024]	[0.0011]	[0.0093]

Note: This table displays holding period returns for momentum portfolios constructed from individual stocks. P-values are presented in parentheses immediately below returns. The second set of p-values in parentheses are Newey-West corrected.

Table 7: Raw and hedged momentum returns for individual stocks (1969:1-1989:12)

	Unhedged returns for different formation periods					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.208%	1.237%	0.549%	1.476%	1.421%	0.889%
	(0.0001)	(0.0000)	(0.0633)	(0.0000)	(0.0000)	(0.0059)
	[0.0000]	[0.0000]	[0.0311]	[0.0000]	[0.0000]	[0.0043]
3 months	3.669%	3.211%	2.254%	4.097%	3.964%	2.302%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)
	[0.0000]	[0.0000]	[0.0004]	[0.0000]	[0.0000]	[0.0074]
6 months	5.762%	4.388%	4.989%	6.977%	5.118%	5.050%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0002]
	Hedged returns using Fama-MacBeth beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.265%	1.349%	0.523%	1.636%	1.607%	0.933%
	(0.0002)	(0.0000)	(0.1019)	(0.0000)	(0.0000)	(0.0084)
	[0.0000]	[0.0000]	[0.0454]	[0.0000]	[0.0000]	[0.0034]
3 months	4.011%	3.526%	2.404%	4.676%	4.329%	2.767%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0000]	[0.0000]	[0.0002]	[0.0000]	[0.0000]	[0.0016]
6 months	6.569%	4.971%	5.579%	8.190%	5.791%	6.276%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
	Hedged returns using realized beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.664%	0.553%	0.304%	0.869%	0.688%	0.414%
	(0.0156)	(0.0072)	(0.1991)	(0.0059)	(0.0049)	(0.0838)
	[0.0030]	[0.0003]	[0.1649]	[0.0017]	[0.0006]	[0.0719]
3 months	2.463%	1.679%	1.272%	2.529%	2.072%	1.279%
	(0.0000)	(0.0000)	(0.0003)	(0.0000)	(0.0000)	(0.0022)
	[0.0000]	[0.0001]	[0.0030]	[0.0001]	[0.0001]	[0.0232]
6 months	3.055%	2.688%	2.902%	3.717%	3.008%	2.769%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	[0.0000]	[0.0000]	[0.0000]	[0.0001]	[0.0001]	[0.0016]

Note: This table displays holding period returns for momentum portfolios constructed from individual stocks. P-values are presented in parentheses immediately below returns. The second set of p-values in parentheses are Newey-West corrected.

Table 8: Raw and hedged momentum returns for individual stocks (1990:1-2010:12)

	Unhedged returns for different formation periods					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.303%	0.327%	0.094%	0.838%	1.274%	0.225%
	(0.4513)	(0.2722)	(0.8108)	(0.1019)	(0.0007)	(0.6261)
	[0.4931]	[0.3754]	[0.8202]	[0.1215]	[0.0012]	[0.6506]
3 months	0.904%	0.627%	0.899%	2.210%	2.662%	1.211%
	(0.1560)	(0.2646)	(0.1711)	(0.0097)	(0.0001)	(0.0992)
	[0.3920]	[0.5242]	[0.3657]	[0.1082]	[0.0149]	[0.2970]
6 months	0.740%	-0.569%	1.878%	3.458%	2.913%	3.608%
	(0.3929)	(0.4584)	(0.0622)	(0.0034)	(0.0011)	(0.0029)
	[0.6612]	[0.7035]	[0.3068]	[0.1186]	[0.0759]	[0.0932]
	Hedged returns using Fama-MacBeth beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.172%	0.162%	0.082%	0.725%	1.260%	0.273%
	(0.6335)	(0.5423)	(0.7458)	(0.1897)	(0.0026)	(0.6538)
	[0.6513]	[0.6020]	[0.7687]	[0.1279]	[0.0008]	[0.6554]
3 months	0.407%	0.455%	0.628%	1.875%	2.743%	0.699%
	(0.4325)	(0.3112)	(0.1921)	(0.0183)	(0.0000)	(0.4508)
	[0.6188]	[0.5459]	[0.3641]	[0.1024]	[0.0046]	[0.6099]
6 months	0.529%	-1.101%	0.771%	3.237%	2.537%	3.108%
	(0.4601)	(0.0330)	(0.2993)	(0.0007)	(0.0010)	(0.0038)
	[0.6927]	[0.2347]	[0.5576]	[0.0539]	[0.0460]	[0.0815]
	Hedged returns using realized beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.819%	0.704%	0.652%	0.359%	0.568%	0.154%
	(0.0046)	(0.0153)	(0.0129)	(0.4474)	(0.0455)	(0.6639)
	[0.0031]	[0.0214]	[0.0282]	[0.4059]	[0.0548]	[0.7056]
3 months	0.718%	0.539%	0.527%	1.555%	1.627%	0.802%
	(0.0001)	(0.0041)	(0.0037)	(0.0232)	(0.0007)	(0.1214)
	[0.0080]	[0.0709]	[0.0679]	[0.1230]	[0.0173]	[0.2961]
6 months	0.524%	0.416%	0.268%	2.001%	1.264%	1.817%
	(0.0001)	(0.0060)	(0.0638)	(0.0235)	(0.0326)	(0.0365)
	[0.0256]	[0.1502]	[0.3222]	[0.2024]	[0.2081]	[0.2143]

Note: This table displays holding period returns for momentum portfolios constructed from individual stocks. P-values are presented in parentheses immediately below returns. The second set of p-values in parentheses are Newey-West corrected.

Table 9: Raw and hedged momentum returns for industry portfolios (1969:1-2010:12)

	Unhedged returns for different formation periods					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.272%	1.055%	0.928%	0.585%	0.899%	0.403%
	(0.0000)	(0.0003)	(0.0004)	(0.0681)	(0.0024)	(0.1602)
	[0.0000]	[0.0001]	[0.0018]	[0.0587]	[0.0123]	[0.1396]
3 months	3.135%	2.735%	2.345%	1.924%	2.782%	0.686%
	(0.0000)	(0.0000)	(0.0000)	(0.0008)	(0.0000)	(0.1845)
	[0.0005]	[0.0008]	[0.0068]	[0.0198]	[0.0019]	[0.3436]
6 months	4.366%	5.291%	2.496%	3.239%	3.379%	2.738%
	(0.0000)	(0.0000)	(0.0041)	(0.0001)	(0.0000)	(0.0001)
	[0.0118]	[0.0002]	[0.1248]	[0.0342]	[0.0271]	[0.0183]
	Hedged returns using Fama-MacBeth beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.027%	1.200%	0.973%	0.542%	0.811%	0.414%
	(0.0004)	(0.0000)	(0.0002)	(0.0909)	(0.0062)	(0.1491)
	[0.0002]	[0.0001]	[0.0011]	[0.0798]	[0.0239]	[0.1276]
3 months	2.742%	3.182%	2.304%	1.810%	2.888%	0.730%
	(0.0000)	(0.0000)	(0.0000)	(0.0016)	(0.0000)	(0.1581)
	[0.0007]	[0.0004]	[0.0078]	[0.0284]	[0.0013]	[0.3136]
6 months	4.355%	4.746%	2.780%	3.338%	3.225%	2.652%
	(0.0000)	(0.0000)	(0.0014)	(0.0000)	(0.0001)	(0.0002)
	[0.0020]	[0.0062]	[0.0874]	[0.0289]	[0.0350]	[0.0223]
	Hedged returns using realized beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.819%	0.704%	0.652%	0.384%	0.638%	0.266%
	(0.0046)	(0.0153)	(0.0129)	(0.2305)	(0.0313)	(0.3530)
	[0.0031]	[0.0214]	[0.0282]	[0.2145]	[0.0756]	[0.3288]
3 months	2.154%	1.617%	1.582%	1.245%	1.949%	0.380%
	(0.0001)	(0.0041)	(0.0037)	(0.0296)	(0.0006)	(0.4618)
	[0.0080]	[0.0709]	[0.0679]	[0.1314]	[0.0297]	[0.5996]
6 months	3.141%	2.494%	1.609%	2.034%	2.244%	1.733%
	(0.0001)	(0.0060)	(0.0638)	(0.0130)	(0.0066)	(0.0158)
	[0.0256]	[0.1502]	[0.3222]	[0.1835]	[0.1422]	[0.1353]

Note: This table displays holding period returns for momentum portfolios constructed from industry portfolios. P-values are presented in parentheses immediately below returns. The second set of p-values in parentheses are Newey-West corrected.

Table 10: Raw and hedged momentum returns for industry portfolios (1969:1-1989:12)

	Unhedged returns for different formation periods					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.469%	1.238%	1.279%	0.376%	0.820%	0.059%
	(0.0001)	(0.0002)	(0.0002)	(0.2734)	(0.0160)	(0.8564)
	[0.0002]	[0.0003]	[0.0009]	[0.2978]	[0.0221]	[0.8481]
3 months	3.685%	3.209%	3.261%	2.041%	2.870%	0.223%
	(0.0000)	(0.0000)	(0.0000)	(0.0032)	(0.0000)	(0.7323)
	[0.0006]	[0.0007]	[0.0018]	[0.0327]	[0.0006]	[0.8125]
6 months	5.452%	6.068%	4.326%	3.590%	3.114%	1.314%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0004)	(0.1414)
	[0.0021]	[0.0002]	[0.0085]	[0.0120]	[0.0243]	[0.3310]
	Hedged returns using Fama-MacBeth beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.209%	1.397%	1.325%	0.332%	0.731%	0.068%
	(0.0003)	(0.0002)	(0.0001)	(0.3330)	(0.0316)	(0.8353)
	[0.0005]	[0.0004]	[0.0006]	[0.3578]	[0.0412]	[0.8249]
3 months	3.215%	3.732%	3.220%	1.927%	2.980%	0.270%
	(0.0000)	(0.0000)	(0.0000)	(0.0054)	(0.0000)	(0.6789)
	[0.0006]	[0.0005]	[0.0020]	[0.0438]	[0.0003]	[0.7741]
6 months	5.129%	5.830%	4.608%	3.690%	2.962%	1.228%
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0008)	(0.1694)
	[0.0019]	[0.0010]	[0.0050]	[0.0098]	[0.0322]	[0.3637]
	Hedged returns using realized beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.000%	0.903%	1.004%	0.173%	0.561%	-0.077%
	(0.0028)	(0.0155)	(0.0039)	(0.6137)	(0.1003)	(0.8152)
	[0.0037]	[0.0212]	[0.0093]	[0.6315]	[0.1180]	[0.8047]
3 months	2.629%	2.165%	2.500%	1.369%	2.034%	-0.084%
	(0.0001)	(0.0028)	(0.0003)	(0.0481)	(0.0015)	(0.8976)
	[0.0053]	[0.0429]	[0.0167]	[0.1519]	[0.0143]	[0.9289]
6 months	3.916%	3.584%	3.439%	2.381%	1.971%	0.310%
	(0.0000)	(0.0004)	(0.0003)	(0.0070)	(0.0250)	(0.7287)
	[0.0177]	[0.0434]	[0.0363]	[0.0958]	[0.1535]	[0.8186]

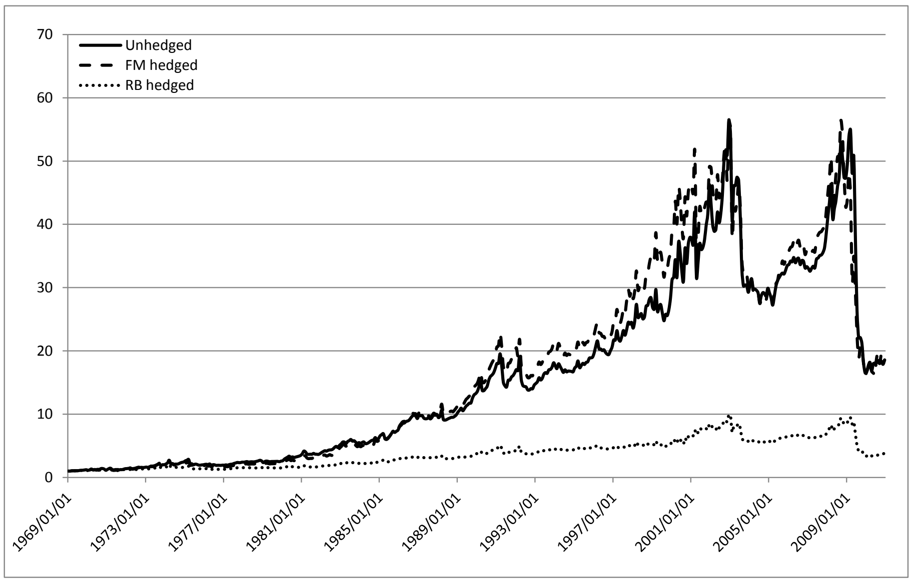
Note: This table displays holding period returns for momentum portfolios constructed from industry portfolios. P-values are presented in parentheses immediately below returns. The second set of p-values in parentheses are Newey-West corrected.

Table 11: Raw and hedged momentum returns for industry portfolios (1990:1-2010:12)

	Unhedged returns for different formation periods					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	1.074%	0.873%	0.576%	0.794%	0.977%	0.747%
	(0.0159)	(0.0645)	(0.1421)	(0.1430)	(0.0440)	(0.1128)
	[0.0226]	[0.0452]	[0.1955]	[0.1134]	[0.1084]	[0.0975]
3 months	2.585%	2.262%	1.429%	1.807%	2.694%	1.149%
	(0.0028)	(0.0067)	(0.0881)	(0.0479)	(0.0045)	(0.1522)
	[0.0612]	[0.0755]	[0.2791]	[0.1740]	[0.0785]	[0.2777]
6 months	3.280%	4.515%	0.666%	2.887%	3.644%	4.163%
	(0.0297)	(0.0003)	(0.6449)	(0.0366)	(0.0093)	(0.0002)
	[0.2405]	[0.0351]	[0.8005]	[0.2574]	[0.1571]	[0.0187]
	Hedged returns using Fama-MacBeth beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.845%	1.002%	0.621%	0.752%	0.890%	0.759%
	(0.0734)	(0.0244)	(0.1134)	(0.1653)	(0.0667)	(0.1067)
	[0.0525]	[0.0335]	[0.1627]	[0.1337]	[0.1439]	[0.0909]
3 months	2.268%	2.633%	1.387%	1.693%	2.796%	1.190%
	(0.0066)	(0.0023)	(0.0977)	(0.0637)	(0.0032)	(0.1382)
	[0.0747]	[0.0566]	[0.2934]	[0.2027]	[0.0679]	[0.2609]
6 months	3.580%	3.662%	0.951%	2.986%	3.489%	4.075%
	(0.0043)	(0.0152)	(0.5102)	(0.0306)	(0.0128)	(0.0003)
	[0.0949]	[0.1899]	[0.7181]	[0.2414]	[0.1756]	[0.0213]
	Hedged returns using realized beta					
	Equally Weighted			Value Weighted		
Holding Period/Formation Period	12-2	12-7	6-2	12-2	12-7	6-2
1 month	0.637%	0.505%	0.300%	0.596%	0.715%	0.609%
	(0.1771)	(0.2570)	(0.4440)	(0.2719)	(0.1405)	(0.1955)
	[0.1436]	[0.2843]	[0.4994]	[0.2356]	[0.2402]	[0.1762]
3 months	1.678%	1.069%	0.664%	1.121%	1.864%	0.845%
	(0.0442)	(0.2155)	(0.4280)	(0.2193)	(0.0493)	(0.2924)
	[0.1870]	[0.4387]	[0.6152]	[0.3986]	[0.2240]	[0.4249]
6 months	2.367%	1.404%	-0.221%	1.687%	2.517%	3.156%
	(0.0586)	(0.3518)	(0.8786)	(0.2219)	(0.0726)	(0.0048)
	[0.2691]	[0.6152]	[0.9333]	[0.5082]	[0.3285]	[0.0745]

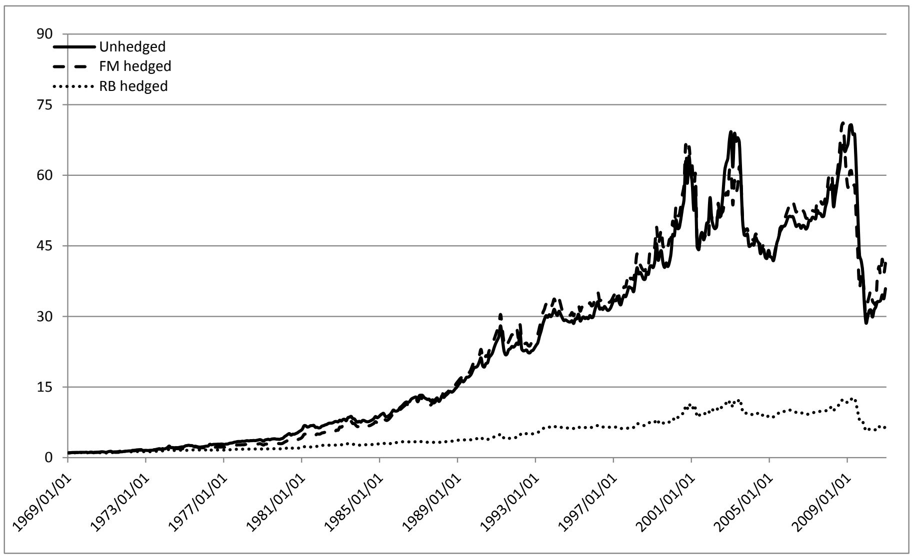
Note: This table displays holding period returns for momentum portfolios constructed from industry portfolios. P-values are presented in parentheses immediately below returns. The second set of p-values in parentheses are Newey-West corrected.

Figure 1: Cumulative gain of equal-weighted stock momentum, 12-2



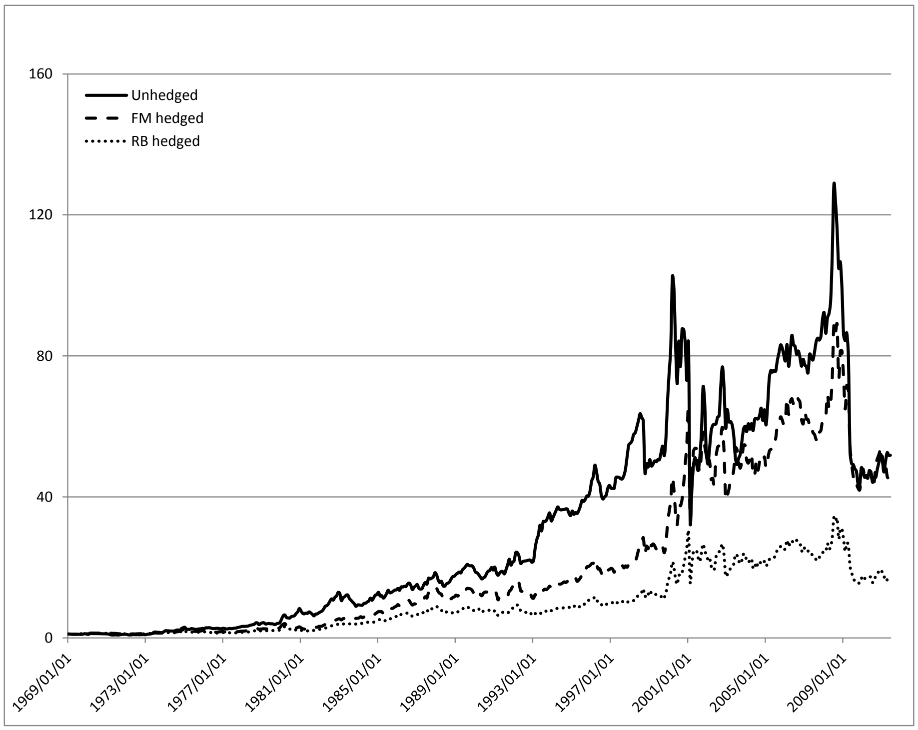
Note: This figure displays the cumulative gain from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for unhedged 12-2 stock momentum, Fama-MacBeth hedged 12-2 stock momentum and realized beta hedged 12-2 stock momentum, for equal-weighted portfolios.

Figure 2: Cumulative gain of equal-weighted stock momentum, 12-7



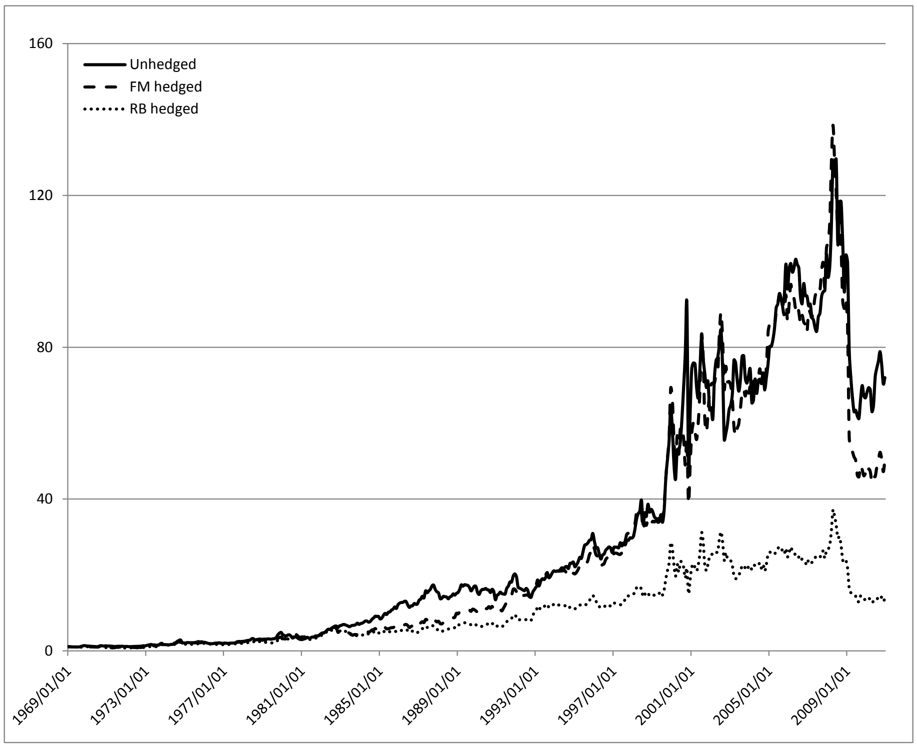
Note: This figure displays the cumulative gain from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for unhedged 12-7 stock momentum, Fama-MacBeth hedged 12-7 stock momentum and realized beta hedged 12-7 stock momentum, for equal-weighted portfolios.

Figure 3: Cumulative gain of value-weighted stock momentum, 12-2



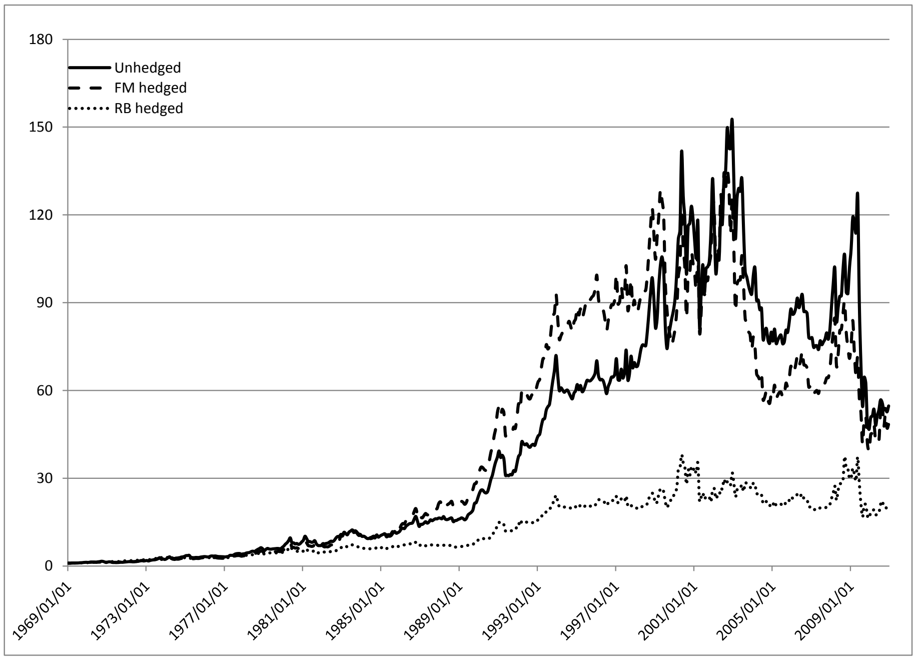
Note: This figure displays the cumulative gain from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for unhedged 12-2 stock momentum, Fama-MacBeth hedged 12-2 stock momentum and realized beta hedged 12-2 stock momentum, for value-weighted portfolios.

Figure 4: Cumulative gain of value-weighted stock momentum, 12-7



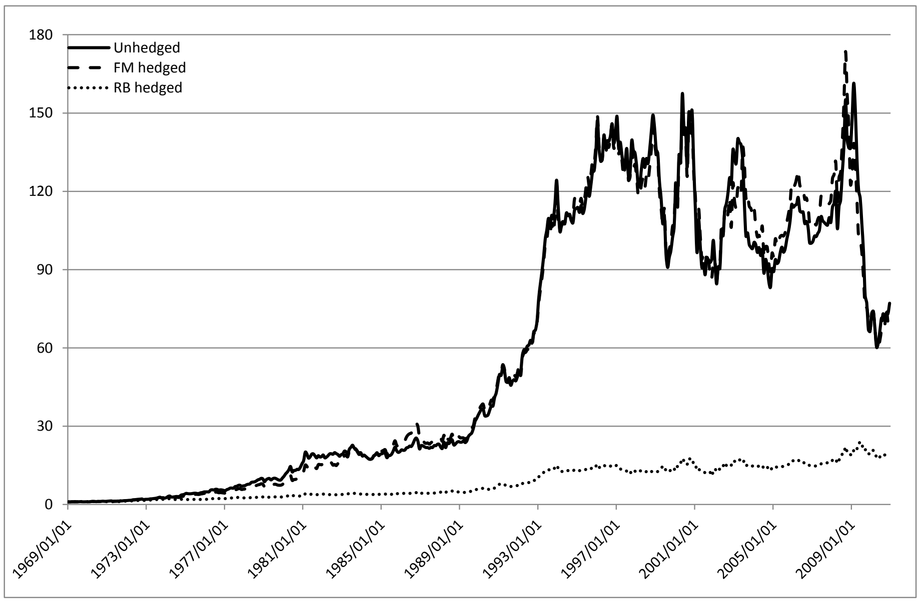
Note: This figure displays the cumulative gain from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for unhedged 12-7 stock momentum, Fama-MacBeth hedged 12-7 stock momentum and realized beta hedged 12-7 stock momentum, for value-weighted portfolios.

Figure 5: Cumulative gain of equal-weighted industry momentum, 12-2



Note: This figure displays the cumulative gain from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for unhedged 12-2 industry momentum, Fama-MacBeth hedged 12-2 industry momentum and realized beta hedged 12-2 industry momentum, for equal-weighted portfolios.

Figure 6: Cumulative gain of equal-weighted industry momentum, 12-7



Note: This figure displays the cumulative gain from $1 invested at the beginning of 1969 (compounded at the monthly frequency) for unhedged 12-7 industry momentum, Fama-MacBeth hedged 12-7 industry momentum and realized beta hedged 12-7 industry momentum, for equal-weighted portfolios.