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ORIGINAL RESEARCH

Has momentum lost its momentum?

Debarati Bhattacharya[1] · **Wei-Hsien Li**[2] · **Gokhan Sonaer**[1]

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Abstract We evaluate the robustness of momentum returns in the US stock market over the period 1965–2012. We find that momentum profits have become insignificant since the late 1990s. Investigations of momentum profits in high and low volatility months address the concerns about unprecedented levels of market volatility in this period rendering momentum strategy unprofitable. Momentum profits remain insignificant in tests designed to control for seasonality, up or down market conditions, firm size and liquidity. Past returns, can no longer explain the cross-sectional variation in stock returns, even following up markets. Investigation of post holding period returns of momentum portfolios and risk adjusted buy and hold returns of stocks in momentum suggests that investors possibly recognize that momentum strategy is profitable and trade in ways that arbitrage away such profits. These findings are partially consistent with Schwert (Handbook of the economics of finance. Elsevier, Amsterdam, 2003) that documents two primary reasons for the disappearance of an anomaly in the behavior of asset prices, first, sample selection bias, and second, uncovering of anomaly by investors who trade in the assets to arbitrage it away. In further analyses we find evidence that suggest two other possible explanations for the declining momentum profits, besides uncovering of the anomaly by investors, that involve decline in the risk premium on a macroeconomic factor, growth rate in industrial production in particular and relative improvement in market efficiency.

Keywords Momentum · Market efficiency · Market anomaly · Asset pricing

✉ Debarati Bhattacharya
bhattacharyad@duq.edu

Wei-Hsien Li
weihsienli@ncu.edu.tw

Gokhan Sonaer
sonaerg@duq.edu

[1] Palumbo Donahue School of Business, Duquesne University, Pittsburg, PA 15282, USA

[2] Department of Finance, National Central University, No. 300, Jung-da Rd., Jung-Li, Taoyuan 320, Taiwan, ROC

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1 Introduction

Momentum in stock prices has been shown to be a persistent market anomaly in the past. Jegadeesh and Titman (1993) were the first to document that a trading strategy that longs winner stocks and shorts loser stocks generates significant profits over a holding period of 3–12 months, later labeled in the literature as momentum. Some advocates of market efficiency, however, suspected these observed regularities in returns arise because of data snooping. In a follow up study, Jegadeesh and Titman (2001) respond to such skepticisms by showing that momentum strategy continues to generate abnormal returns in the 1990s. Momentum has grown in its popularity ever since in the finance community that includes both the academics and practitioners.[1] Some of the recent works in the area of market anomalies, such as McLean and Pontiff (2015) asks an interesting question of whether or not academic research could potentially destroy return predictability.[2] In this paper, we investigate whether momentum profits have been driven away or at the very least its pattern altered in the wake of growing knowledge about momentum strategy and competition amongst arbitrageurs who trade on it, if we were to believe momentum profits were caused in the first place due to delayed price reactions to firm-specific information as suggested by Jegadeesh and Titman (1993, 2001).

What if momentum is no longer profitable? The answer to this question makes this paper important. It is needless to say that the disappearance of momentum profits, if proven to be true would have an impact over a number of interest groups in the capital market, such as the traders in forming strategies, the investors on how to evaluate their money managers' performance, and academics on how they perceive and explain the disappearance of this flagrant affront to the idea of rational, efficient markets. This paper could potentially trigger an entirely different debate on why has momentum disappeared in the context of the rich literature that exists on its persistence and rationale, both behavioral and rational.

Our analyses span over the period between 1965 and 2012. We divide the entire time period into three subperiods. The first subperiod corresponds to the Jegadeesh and Titman (1993) sample period, 1965–1989, the second subperiod covers the Jegadeesh and Titman (2001) "out of sample period", 1990–1998, the third subperiod corresponds to the period 1999–2012. In our study, we choose to examine the persistence of momentum profits while avoiding concerns of data dredging by conducting tests in our out-of-sample period that starts at the beginning of 1999 immediately after Jegadeesh and Titman's (2001) "out of sample period" ends. Using the data over the 1999–2012 sample period, we find that Jegadeesh and Titman (1993) momentum strategies fail to yield profits in the more recent times. This period is particularly interesting as it witnessed the dot-com bust after catching the boom by its tail and also the financial crisis followed by the greatest stock market

[1] Many studies are devoted to explaining the phenomenon of momentum profit. Berk et al. (1999), Liu and Zhang (2008), and Wang et al. (2012) document evidence supporting the momentum profits as compensations for risk argument. On the other hand, Jegadeesh and Titman (2001), Wu (2011), Jiang et al. (2012), and Hur and Singh (2014) find evidence supporting behavioral explanations of momentum profits.

[2] Hwang and Rubesam (2015) build an inter-temporal model that explains momentum returns allowing for structural breaks over an extended sample period 1927–2006. They document that momentum profits have slowly started declining in the last two decades of their sample period, a process that began in the early 1990s but delayed by the occurrence of high-technology stock bubble.

meltdown since the great depression. One of our concerns in dealing with this unique period is what if the recent turbulence in the economy with a series of high-loss episodes in the US stock market and unprecedented levels of market volatility has rendered momentum strategy unprofitable?

We employ alternate methodologies to scrutinize whether the rapid decline of momentum profits to insignificant levels in this 14-year period is indeed an outcome of the marked rise in market volatility. For instance, we use controls for the periods of unusual volatilities in the capital market, 2007–2009 in particular and yet fail to reject the hypothesis that momentum profits have not declined to insignificant levels. Excluding the last financial crisis, 2007–2009 serves the additional purpose of excluding spring of 2009 that witnessed the biggest momentum crash in the history of stock market since the summer of 1932 as alluded to by Daniel and Moskowitz (2013). Next, we employ the daily median volatility index, VXO for the period 1986–1998 to classify months in the latest subperiod into high and low expected volatility months.[3] If momentum profits have declined because of increased volatility of the market, momentum strategy should be profitable at least in months when the implied volatility is as low as in low volatility months in the period 1986–1998, a period when momentum is profitable. However, what we document is that while momentum strategy is profitable in the period 1986–1998 no matter the implied volatility, it fails to generate profit for the period 1999–2012 even in the 60 months classified as low volatility months primarily clustered between November 2003 and July 2007.

We also investigate whether momentum profits resurface in this period following up markets as documented by Cooper et al. (2004). Not only are these momentum profits insignificant on average following up markets, their distribution also reveal visible and statistical difference from those in the periods 1965–1989 and 1990–1998, indicating a deeper and more fundamental change in the underlying process of generation of momentum profits, beyond huge market crashes. The distribution of up market momentum profits in this period is extremely volatile interspersed with huge negative returns that suggest that momentum as a strategy has become riskier in the latest subperiod compared to the two earlier subperiods. Further analysis indicates that the idiosyncratic volatility of momentum portfolio returns has increased compared to the previous periods.

We explore the possibility of momentum strategy remaining profitable among smaller and less liquid stocks, but fail to find any such evidence. Finally, we examine whether with declining momentum profits, past returns, measured over the recent and intermediate horizon, can explain cross-sectional variation in current stock returns. In the presence of return continuation, we expect past stock returns to be positively related to current stock returns, especially following up markets since momentum profits are essentially up market phenomena. As expected in the periods 1965–1989 and 1990–1998, current stocks returns are positively related to past returns exclusively following up markets. However, in the current subperiod, with decline in momentum profits past returns fail to explain current returns following up markets and show a reliably negative relation following down market.

We suggest three possible explanations for the declining momentum profits that involve uncovering of the anomaly by investors, decline in the risk premium on a macroeconomic factor, growth rate in industrial production in particular, and relative improvement in market efficiency. The first explanation proposes that momentum profits decline post 1998 because investors become increasingly aware about the profitability of implementing a

[3] We use VXO instead of VIX since the former that is computed using a different methodology and eventually revised by CBOE provides us with an additional 4 years' worth of data.

relatively simple momentum trading strategy, wherein they identify winner (loser) stocks and buy (sell) them. The growing awareness and competition amongst these investors would lead to an increasingly earlier identification and trading of momentum stocks. This explanation predicts intensified reaction to both winner and loser stocks in the identification period itself, which would result in either exhaustion or, at the least, a substantial reduction in return continuation in the holding period.[4] We find evidence consistent with this prediction.

The second explanation is based on the findings of Liu and Zhang (2008) who document that growth rate of industrial production, in various specifications, explains over half of the momentum profits. We find that in the latest subperiod although the momentum portfolio's returns continue to load on this industrial production factor, this particular risk factor is no longer priced.

The third explanation explores the possibility of relative improvement in market efficiency. Following Griffin et al. (2010), we compute their DELAY measure, that reflects the degree of response of stock returns to past market returns, and we record a fairly significant reduction in delay in all size portfolios but for the largest one.

The rest of the paper proceeds as follows. Section 2 provides the empirical evidences of declining momentum profit. Section 3 discusses the possible explanations. Section 4 concludes.

2 Disappearance of momentum profits since 1999

Our sample is constructed from all common stocks traded on New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and Nasdaq. We obtain the data related to the stock market from the Center for Research in Security Prices (CRSP) database, and accounting data from Standard and Poor's (S&P's) Compustat. We exclude all stocks priced below $5 at the beginning of the holding period and all stocks with market capitalizations smaller than that of the lowest NYSE size decile following Jegadeesh and Titman (2001).

Our analyses span over the period between 1965 and 2012. We divide the entire time period into three subperiods. The first subperiod corresponds to the Jegadeesh and Titman (1993) sample period, 1965–1989, the second subperiod covers the Jegadeesh and Titman (2001) "out of sample period", 1990–1998, and the third subperiod corresponds to the period 1999–2012. We choose our third sample subperiod adhering to standard model validation practice and testing the hypothesis of persistence of momentum profits in our out-of-sample period that starts at the beginning of 1999 immediately after Jegadeesh and Titman's (2001) "out of sample period" ends. Table 1 presents the summary statistics of our sample of stocks for these three subperiods. *ME* is the market capitalization (in billions USD) and *BM* is *BE* divided by *ME* where *BE* is the book value of equity and it is obtained for each firm's latest fiscal year ending in calendar year $t-1$. *Past_ret* is the past 6-month cumulative return for each stock-month. *Post_ret* is the future 6-month cumulative return for each stock-month. The mean and median *ME* (*BM*) of our sample of stocks increase

[4] Reducing underreaction or mispricing may also result in similar patterns of returns from loser and winner portfolios, if we were to believe momentum profits were caused in the first place due to delayed price reactions to firm-specific information as suggested by Jegadeesh and Titman (1993, 2001). The distinction between uncovering of anomaly by investors and reducing underreaction is beyond the scope of this paper.

Table 1 Summary statistics

Variables	Period	Mean	Median	SD	Min	Max
ME	1965–1989	597	143	2158	10	102,022
	1990–1998	1858	343	7169	28	342558
	1999–2012	5265	937	19,860	70	625,348
BM	1965–1989	0.882	0.730	0.707	0.00061	36.226
	1990–1998	0.586	0.474	0.595	0.00028	41.544
	1999–2012	0.574	0.451	0.611	0.00002	25.441
Past_ret	1965–1989	0.113	0.069	0.333	−0.869	16.391
	1990–1998	0.125	0.077	0.384	−0.889	21.133
	1999–2012	0.130	0.059	0.572	−0.949	37.533
Post_ret	1965–1989	0.070	0.045	0.289	−0.995	5.146
	1990–1998	0.074	0.052	0.338	−0.987	16.445
	1999–2012	0.044	0.029	0.384	−0.995	31.099

This table presents the summary statistics for the sample of stocks used in this study. Our sample includes all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below \$5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. *ME* is the market capitalization (in billions USD), *BM* is *BE*/*ME* where BE is the book value of equity and it is obtained for each firm's latest fiscal year ending in calendar year $t - 1$. *Past_ret* is the past 6-month cumulative return for each stock-month. *Post_ret* the post 6-month cumulative return for each stock-month. Mean, median, standard deviation, minimum and maximum of these variables are presented for the three periods, 1965–1989, 1990–1998, and 1999–2012

(decrease) over the three subperiods. The summary statistics also suggest that the average *Post_ret* decreases for our sample of stocks in the last subperiod.

2.1 Holding period returns: evidence from subperiods

In this section we examine whether momentum strategies continue to be profitable since the late 1990s. Jegadeesh and Titman (2001) document that their out of-sample tests designed to assess persistence of momentum profits in the 1990s performed at least as well as the ones conducted with the original sample in their earlier study in 1993. It has been a while since money managers and traders at large have acceded to the claims that momentum strategies generate substantial profits, and we have concurrently seen a phenomenal growth in the size of funds in their hands. Hedge funds managed about \$1.64 trillion in 2011 up from \$200 billion in 1998 and equity mutual funds managed about \$13 trillion at year-end 2012 up from \$5.5 trillion in 1998.[5] These developments raise a fairly obvious question. Has momentum survived this new era of the capital markets?

Our tests reveal strong evidence of momentum profits in the first, less strong evidence in the second consistent with the literature, and decline in momentum profits to insignificant levels in the third subperiod.

Following Jegadeesh and Titman (1993), we examine the profitability of 16 strategies that select stocks based on the their returns over the past 3, 6, 9, and, 12 (J) months and hold them for either 3, 6, 9, or 12 (K) months in each of our three subperiods. At the end of each month (t), we sort stocks into 10 equally weighted portfolios based on their

[5] Sourced from McKinsay's Global Institute forecasts, HedgeFundFacts.com and ICIFACTBOOK.ORG.

cumulative returns earned in the past J months ($t - J + 1$ to t). We hold these portfolios for K months ($t + 1$ to $t + K$). As a result we have K overlapping portfolios each of which is assigned an equal weight in the portfolio. We also construct a momentum strategy portfolio that buys the winner portfolio (top past return decile) and sells the loser portfolio (bottom past return decile). Similar to Jegadeesh and Titman (2001) we compute the portfolio returns using data from the CRSP monthly returns file.

Next, we compute the Fama–French three-factor alphas (Fama and French, 1993) earned by the winner, loser and momentum (winner-loser) portfolios for all the 16 (*J-month*/*K-month*) strategies.

Our investigation reveals that over the periods 1965–1989 and 1990–1998, the returns for all the momentum strategies are positive and statistically significant confirming the other known results in Jegadeesh and Titman (1993) and Jegadeesh and Titman (2001). However, for the 1999–2012 period none of the 16 momentum strategies delivers any returns different from zero. The risk adjusted profit analysis also confirms that for all the 16 (*J-month*/*K-month*) strategies with a few exceptions the alphas of the loser portfolios are negative whereas the alphas of the winner portfolios are positive for the periods 1965–1989 and 1990–1998. Momentum portfolios for all strategies earn statistically significant alphas for these two subperiods. In the period 1999–2012, none of the past return deciles earn alphas significantly different from zero and the alpha of momentum portfolio also disappears.[6]

Following Jegadeesh and Titman (1993) we now examine the 6-month formation/6-month holding strategy in more detail. Table 2 presents the average monthly raw returns for the 10 past return portfolios. At the end of each month (t), we sort stocks into 10 equally weighted portfolios based on their cumulative returns earned in the past 6 months ($t - 5$ to t). We hold these portfolios for the next 6 months ($t + 1$ to $t + 6$). This process presents us with six overlapping portfolios each of which is assigned an equal weight in the portfolio. We also construct a portfolio following momentum strategy that buys winner (top past return decile) and sells loser (bottom past return decile).

Table 2 shows that the average returns increase as we go from the lowest to the highest deciles for all the three subperiods. The momentum portfolio (P10–P1) on average earns a 1.10 % per month in the period 1965–1989 that continues in the period 1990–1998. Consistent with the findings of Jegadeesh and Titman (2001), the momentum portfolio in the second subperiod earns 1.37 % a month. However, as noted earlier in unreported results, the momentum returns decline to insignificant levels in the period 1999–2012.

Table 3 presents the alphas for the 10 past return portfolios. Past losers P1 earn negative alpha and past winners P10 earn positive alpha in the periods 1965–1989 and 1990–1998. The momentum portfolio (P10–P1) on average earns an alpha of 1.27 % per month in the period 1965–1989 and 1.35 % per month in the period 1990–1998. However, neither the past loser, or past winner or the momentum portfolios earn any alphas in the period 1999–2012 that are significantly different from zero.[7]

[6] These results are not reported for the sake of brevity, but they are available upon request.

[7] We reexamine both raw momentum profits and three-factor alphas generated by 6-month/6-month momentum strategy after skipping a month between the formation and holding periods and find similar results. These results are available upon request.

Table 2 Momentum portfolios' raw returns for 6-month/6-month strategy

	1965–1989	1990–1998	1999–2012
P1 (past losers)	0.0053	0.0044	0.0044
P2	0.0097	0.0087	0.0065
P3	0.0107	0.0112	0.0075
P4	0.0113	0.0119	0.0082
P5	0.0116	0.0120	0.0082
P6	0.0121	0.0125	0.0083
P7	0.0124	0.0124	0.0084
P8	0.0132	0.0132	0.0088
P9	0.0140	0.0143	0.0093
P10 (past winners)	0.0162	0.0181	0.0113
P10–P1 (winners–losers)	0.0110	0.0137	0.0069
p value	0.00001	0.00006	0.28821

This table presents the average monthly returns earned by momentum portfolios constructed with all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below \$5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. At the end of each month (t) stocks are sorted into 10 equally weighted portfolios based on their cumulative returns earned in the past 6 months ($t - 5$ to t). This table reports the mean of monthly average returns to these ten portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months for the three periods, 1965–1989, 1990–1998, and 1999–2012. The bottom two rows of this table present the average returns and the corresponding p values to the winner–loser portfolios that buy winners (highest past return decile) and sells losers (lowest past return decile). All the portfolios are equal weighted

2.2 Seasonality and holding period returns

We examine whether the January effect on momentum profits reported by Jegadeesh and Titman (1993, 2001) have become pronounced in the period 1999–2012 so much so that the momentum profits in the non-January months are overshadowed. The momentum profits in January for our sample are no different from zero over the period 1965–2012. The momentum profits for the non-January months are, however, positive and significant for the periods 1965–1989 and 1990–1988 but significantly in the period 1999–2012. The evidence indicates that there has not been any significant change in the absence of momentum profits.[8]

2.3 Extreme volatility and holding period returns since 1999

The post 1998 period, during which we document significant decline in momentum profits, experienced stretches of extreme stock market volatility as it witnessed the dot-com bust after catching the boom by its tail and also the financial crisis followed by the greatest stock market meltdown since the great depressions. We acknowledge the importance of controlling for these periods of unusual volatilities. Table 4 presents the monthly average returns for 10 portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months, earned in six separate time periods post 1998. The first two columns report the returns for the periods 1999–2005, and 2006–2012, dividing the post

[8] These results are not reported for the sake of brevity, but are available upon request.

Table 3 Fama–French three-factor alphas of momentum portfolios for 6-month/6-month strategy

	1965–1989	1990–1998	1999–2012
P1 (past losers)	−0.0076 (0.00000)	−0.0086 (0.00026)	−0.0038 (0.3726)
P2	−0.0026 (0.01312)	−0.0037 (0.00657)	−0.0009 (0.71179)
P3	−0.0014 (0.08885)	−0.0010 (0.30714)	0.0002 (0.90889)
P4	−0.0007 (0.28627)	−0.0003 (0.67969)	0.0010 (0.43469)
P5	−0.0003 (0.56747)	−0.0002 (0.69823)	0.0011 (0.31824)
P6	0.0004 (0.33207)	0.0002 (0.75546)	0.0012 (0.23665)
P7	0.0009 (0.05875)	−0.0003 (0.65804)	0.0010 (0.20557)
P8	0.0017 (0.00442)	0.0006 (0.34575)	0.0012 (0.25047)
P9	0.0027 (0.00111)	0.0013 (0.18517)	0.0010 (0.52526)
P10 (past winners)	0.0050 (0.00020)	0.0049 (0.00641)	0.0022 (0.3628)
P10–P1 (winners–losers)	0.0127 (0.00000)	0.0135 (0.00014)	0.0060 (0.3315)

This table presents the Fama–French three-factor alphas earned by momentum portfolios constructed with all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below $5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. This table reports the alphas earned by the ten portfolios formed on the basis of the past 6 months returns and held for another 6 months in a Fama–French three-factor OLS regression for the three periods, 1965–1989, 1990–1998, and 1999–2012. The bottom two rows of this table present the alphas and the corresponding p values to the winner–loser portfolios that buys winners (highest past return decile) and sells losers (lowest past return decile). All the portfolios are equal weighted. p values are in parentheses

1998 period into two halves. The first two columns of the table reveal that the momentum portfolios (P10–P1) earn no profit in the first as well as the second half of our last subperiod. The third column reports the returns for the period 2002–2005, a period with no extreme capital market events. The fourth column reports the returns for the period 1999–2012 excluding the last financial crisis, 2007–2009, a period that also includes spring of 2009, the biggest momentum crash in the history of stock market since the summer of 1932 as alluded to by Daniel and Moskowitz (2013). The fifth column reports the returns for the period 2004–2012, excluding the tech boom and bust, 1999–2003 as well as the last financial crisis. The sixth column reports the returns for the period 2002–2012, excluding the effect of dot-com bubble 1999–2001, as well as the last financial crisis (excluding 1 year before and 1 year after 2008; 2006–2010). These columns do not reveal any resurfacing of momentum profits, and it is especially interesting to find no momentum in the period 2004 to 2012 (excluding 2007–2009) since the market showed an upward trend in these years, a condition favorable for generating momentum profit.

We employ an alternate methodology to scrutinize whether the rapid decline of momentum profits to insignificant levels in this 14-year period is indeed an outcome of the

Table 4 Momentum portfolios' returns over various subperiods within the period 1999–2012

	1999–2005	2006–2012	2002–2005	1999–2012 excluding 2007–2009	2004–2012 excluding 2007–2009	2002–2012 excluding 2006–2010
Panel A: Raw returns						
P1 (past losers)	0.0031	0.0057	0.0062	0.0055	0.0090	0.0046
P2	0.0058	0.0072	0.0075	0.0085	0.0116	0.0077
P3	0.0079	0.0070	0.0090	0.0098	0.0121	0.0088
P4	0.0093	0.0072	0.0102	0.0105	0.0121	0.0094
P5	0.0094	0.0069	0.0104	0.0104	0.0116	0.0093
P6	0.0094	0.0071	0.0101	0.0104	0.0116	0.0091
P7	0.0107	0.0061	0.0110	0.0110	0.0113	0.0095
P8	0.0122	0.0054	0.0120	0.0121	0.0122	0.0101
P9	0.0139	0.0046	0.0111	0.0133	0.0126	0.0094
P10 (past winners)	0.0188	0.0038	0.0114	0.0169	0.0132	0.0099
P10–P1 (winners–losers)	0.0157	−0.0019	0.0052	0.0113	0.0042	0.0053
p value	0.16534	0.76922	0.51317	0.12445	0.21272	0.34651
Panel B: Three factor alphas						
P1 (past losers)	−0.0039 (0.61402)	−0.0022 (0.56938)	−0.0027 (0.50499)	−0.0045 (0.36944)	−0.0036 (0.09561)	−0.0050 (0.11864)
P2	−0.0026 (0.57177)	0.0003 (0.90782)	−0.0025 (0.33541)	−0.0014 (0.63879)	0.0006 (0.63478)	−0.0015 (0.45033)
P3	−0.0012 (0.69376)	0.0005 (0.76846)	−0.0011 (0.49513)	−0.0003 (0.89804)	0.0015 (0.17249)	−0.0002 (0.8658)
P4	−0.0004 (0.84265)	0.0010 (0.44695)	0.0004 (0.77377)	0.0004 (0.79911)	0.0019 (0.03197)	0.0008 (0.3976)
P5	−0.0003 (0.87033)	0.0010 (0.30702)	0.0005 (0.64248)	0.0002 (0.86322)	0.0014 (0.04254)	0.0007 (0.41783)
P6	−0.0006 (0.6819)	0.0011 (0.11662)	−0.0003 (0.77855)	0.0001 (0.9618)	0.0011 (0.05639)	0.0003 (0.76045)
P7	0.0004 (0.72019)	0.0002 (0.81471)	0.0003 (0.80436)	0.0005 (0.5543)	0.0008 (0.21261)	0.0005 (0.56606)
P8	0.0016 (0.29765)	−0.0007 (0.56347)	0.0005 (0.70784)	0.0011 (0.30468)	0.0013 (0.1489)	0.0007 (0.51579)
P9	0.0027 (0.29304)	−0.0018 (0.25189)	−0.0012 (0.53839)	0.0018 (0.28732)	0.0011 (0.37606)	−0.0005 (0.70588)
P10 (past winners)	0.0074 (0.07625)	−0.0033 (0.20674)	−0.0027 (0.32048)	0.0044 (0.1086)	−0.0001 (0.97379)	−0.0013 (0.499)

Table 4 continued

	1999–2005	2006–2012	2002–2005	1999–2012 excluding 2007–2009	2004–2012 excluding 2007–2009	2002–2012 excluding 2006–2010
P10–P1 (winners–losers)	0.0113 (0.30598)	−0.0011 (0.85694)	0.0000 (0.99906)	0.0088 (0.2132)	0.0035 (0.29435)	0.0037 (0.41399)

This table presents the average monthly returns earned by momentum portfolios constructed with all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below $5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. At the end of each month (t) stocks are sorted into 10 equally weighted portfolios based on their cumulative returns earned in the past 6 months ($t - 5$ to t). Panel A reports the monthly average returns for these ten portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months for the following periods: 1999–2005, 2006–2012, 2002–2005, 1999–2012 excluding 2007–2009, 2004–2012 excluding 2007–2009, and 2002–2012 excluding 2006–2010. The bottom two rows of this table present the average returns and the corresponding p values to the winner–loser portfolios that buy winners (highest past return decile) and sells losers (lowest past return decile). All the portfolios are equal weighted. Panel B reports the three factor alphas and the corresponding p values to these ten portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months for the same periods

marked rise in market volatility. We obtain daily levels of volatility index, VXO available for the period 1986–2012 from the website of Chicago Board of Options Exchange, CBOE. The daily median implied volatility for the period 1999–2012 jumps to 21.72 from 18.35 in the period 1986–1998 consistent with the common knowledge that market volatility in the latest subperiod reached higher levels compared to the previous two subperiods. We classify months in the latest subperiod into high (low) volatility months if the monthly mean volatility, VXO is above (below) the daily median VXO for the period 1986–1998. 60 months get classified as low volatility months primarily clustered between November 2003 and July 2007 and 108 months get classified as high volatility months. If momentum profits have declined because of increased volatility, momentum strategy should be profitable at least in months when the implied volatility is as low as in low volatility months in the period 1986–1998, a period when momentum is profitable. However, what we document in Table 5 is that while momentum strategy is profitable in the period 1986–1998 no matter the implied volatility, it fails to generate profit for the period 1999–2012 even in all of the 60 months classified as low volatility months. This evidence suggests it is not the unprecedented levels of market volatility that has rendered momentum strategy unprofitable in the last 14 years.

2.4 Holding period return in a 14-year rolling window analysis: evidence from 1965–1999

Presented with all the initial evidence of disappearing momentum profits, a well-founded question in the reader's mind maybe: Has there been any other 14-year stretch in the past over which the momentum strategy has not been profitable?

We perform a 14-year rolling window analysis in which we compute the average raw and risk-adjusted momentum returns for every 14 years starting at the beginning of each year from 1965 to 1999. In Table 6 we document that starting from 1965 for no other 14-year period until 1996, momentum strategy was ever unprofitable. The momentum

Table 5 Momentum portfolios' returns following periods of low and high volatility

	Low volatility		High volatility	
	1986–1998	1999–2012	1986–1998	1999–2012
Panel A: Raw returns				
P1 (past losers)	0.0023	0.0052	0.0061	0.0040
P10 (past winners)	0.0155	0.0104	0.0164	0.0118
P10–P1 (winners–losers)	0.0132	0.0052	0.0102	0.0079
p value	0.00011	0.12727	0.01419	0.43083
Panel B: Three-factor alphas				
P1 (past losers)	−0.0101 (0.00002)	−0.0037 (0.07099)	−0.0047 (0.12227)	−0.0030 (0.64902)
P10 (past winners)	0.0020 (0.22431)	0.0014 (0.46185)	0.0040 (0.05376)	0.0020 (0.59428)
P10–P1 (winners–losers)	0.0122 (0.00051)	0.0051 (0.13526)	0.0088 (0.03527)	0.0050 (0.60353)

Panel A of this table presents the average monthly returns earned by momentum portfolios constructed with all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below $5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. At the end of each month (t) stocks are sorted into 10 equally weighted portfolios based on their cumulative returns earned in the past 6 months ($t - 5$ to t). Panel A of this table reports the mean of monthly average returns to the P1 (losers), P10 (winners), and P10–P1 (winners–losers) portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months for the two time periods, 1986–1998, and 1999–2012. These superiods are further segregated into high and low volatility periods based on the median daily VIX of the 1986–1998 period (18.35). Panel B of this table presents the Fama–French three-factor alphas earned by the P1 (losers), P10 (winners), and P10–P1 (winners–losers) portfolios over the low and high liquidity periods for the two time periods, 1986–1998, and 1999–2012. All the portfolios are equal weighted. p values are presented in parentheses

profits are not significantly different from zero only over the 14-year periods starting in 1996, 1997, 1998, and 1999.

Figure 1 plots the monthly average returns for each year to the momentum portfolio from 1965 to 2012. Post the tech bubble, other than 2002, 2005, and 2007 the momentum return is either negative or close to zero.[9] For those who would still like to ascribe the disappearance of momentum profits to housing crisis of 2008–2009 we would like to point out that the period 1999–2012 was as good and as bad for momentum strategy, as is evident from the figure, if one were to concentrate only on the highest and lowest return years, 2000 and 2009 respectively. Moreover, as shown in Table 4 earlier excluding these years make no difference to our inference that there is no more any momentum effect in stock prices.

2.5 Market cycles and holding period returns

Cooper et al. (2004) document that momentum profits are significant following up market conditions. In this section we examine whether momentum profits reappear once controlled

[9] We are aware that momentum returns peaked during 1999 and 2000 riding on the internet bubble. In spite of that we include these years in our last subsample since Jegadeesh and Titman (2001)'s out-of-sample period ends in 1998, after which our out-of-sample period begins.

Table 6 Momentum profits over 14-year rolling window for the period 1965–1999

Starting year	P1	P10	P10–P1	Starting year	P1	P10	P10–P1
Panel A: Raw returns							
1965	0.0040 (0.50097)	0.0138 (0.01057)	0.0097 (0.00891)	1983	0.0048 (0.29677)	0.0156 (0.00109)	0.0108 (0.00001)
1966	0.0048 (0.42999)	0.0138 (0.01098)	0.0090 (0.01459)	1984	0.0040 (0.40991)	0.0154 (0.00139)	0.0115 (0.0000)
1967	0.0067 (0.28104)	0.0170 (0.00246)	0.0102 (0.00503)	1985	0.0048 (0.34635)	0.0173 (0.00087)	0.0125 (0.0000)
1968	0.0038 (0.53288)	0.0129 (0.0199)	0.0091 (0.01023)	1986	0.0053 (0.30777)	0.0192 (0.00045)	0.0139 (0.0000)
1969	0.0026 (0.67227)	0.0131 (0.01562)	0.0105 (0.00354)	1987	0.0018 (0.74192)	0.0195 (0.0037)	0.0176 (0.00014)
1970	0.0063 (0.29939)	0.0154 (0.00416)	0.0091 (0.01085)	1988	0.0041 (0.54303)	0.0203 (0.00164)	0.0162 (0.00425)
1971	0.0054 (0.34804)	0.0161 (0.00185)	0.0107 (0.001)	1989	0.0003 (0.96781)	0.0178 (0.00681)	0.0175 (0.00344)
1972	0.0055 (0.33145)	0.0168 (0.00105)	0.0114 (0.00048)	1990	0.0033 (0.65656)	0.0192 (0.00373)	0.0159 (0.008)
1973	0.0053 (0.35019)	0.0169 (0.0012)	0.0116 (0.00036)	1991	0.0064 (0.38144)	0.0206 (0.00159)	0.0142 (0.01764)
1974	0.0086 (0.11252)	0.0179 (0.00129)	0.0093 (0.00154)	1992	0.0042 (0.55932)	0.0182 (0.00468)	0.0140 (0.01905)
1975	0.0119 (0.02073)	0.0208 (0.00012)	0.0089 (0.00147)	1993	0.0040 (0.57812)	0.0184 (0.00415)	0.0145 (0.01522)
1976	0.0084 (0.07709)	0.0201 (0.00016)	0.0117 (0.0000)	1994	0.0026 (0.72011)	0.0175 (0.00644)	0.0149 (0.0123)
1977	0.0039 (0.42485)	0.0174 (0.00131)	0.0135 (0.0000)	1995	−0.0001 (0.99184)	0.0144 (0.03133)	0.0145 (0.01825)
1978	0.0063 (0.21134)	0.0196 (0.00042)	0.0132 (0.0000)	1996	0.0031 (0.70168)	0.0126 (0.0636)	0.0095 (0.14944)
1979	0.0065 (0.20054)	0.0187 (0.00041)	0.0122 (0.0000)	1997	0.0044 (0.59441)	0.0133 (0.05278)	0.0089 (0.17594)
1980	0.0049 (0.31504)	0.0174 (0.00073)	0.0125 (0.0000)	1998	0.0031 (0.70708)	0.0118 (0.0888)	0.0087 (0.18691)
1981	0.0029 (0.53803)	0.0139 (0.00385)	0.0110 (0.00001)	1999	0.0044 (0.58208)	0.0113 (0.08742)	0.0069 (0.28821)
1982	0.0042 (0.36802)	0.0166 (0.0005)	0.0123 (0.0000)				
Panel B: Three-factor alphas							
1965	−0.0058 (0.00413)	0.0056 (0.00953)	0.0114 (0.00258)	1983	−0.0081 (0.00000)	0.0032 (0.01393)	0.0113 (0.00001)
1966	−0.0056 (0.00514)	0.0053 (0.01132)	0.0110 (0.00324)	1984	−0.0081 (0.00000)	0.0034 (0.01174)	0.0115 (0.00000)
1967	−0.0068 (0.00064)	0.0060 (0.00268)	0.0128 (0.00041)	1985	−0.0079 (0.00001)	0.0040 (0.00441)	0.0118 (0.00001)
1968	−0.0059 (0.00185)	0.0054 (0.00665)	0.0113 (0.0012)	1986	−0.0085 (0.00003)	0.0052 (0.00027)	0.0136 (0.00000)
1969	−0.0068 (0.00077)	0.0055 (0.00342)	0.0123 (0.00046)	1987	−0.0124 (0.00002)	0.0078 (0.00005)	0.0202 (0.00000)

Table 6 continued

Starting year	P1	P10	P10–P1	Starting year	P1	P10	P10–P1
1970	−0.0069 (0.00096)	0.0051 (0.00667)	0.0121 (0.00073)	1988	−0.0111 (0.00698)	0.0078 (0.00041)	0.0189 (0.00111)
1971	−0.0080 (0.00003)	0.0056 (0.00217)	0.0136 (0.00004)	1989	−0.0121 (0.00445)	0.0078 (0.00054)	0.0199 (0.00089)
1972	−0.0083 (0.00002)	0.0057 (0.00154)	0.0140 (0.00003)	1990	−0.0111 (0.00916)	0.0072 (0.00172)	0.0183 (0.00242)
1973	−0.0083 (0.00003)	0.0057 (0.00166)	0.0140 (0.00004)	1991	−0.0107 (0.01419)	0.0060 (0.01104)	0.0167 (0.00691)
1974	−0.0072 (0.00007)	0.0037 (0.02196)	0.0109 (0.00032)	1992	−0.0100 (0.01948)	0.0064 (0.0058)	0.0164 (0.00685)
1975	−0.0073 (0.00004)	0.0034 (0.02276)	0.0106 (0.00026)	1993	−0.0100 (0.01827)	0.0064 (0.00544)	0.0165 (0.00631)
1976	−0.0084 (0.00000)	0.0029 (0.02074)	0.0113 (0.00001)	1994	−0.0108 (0.0094)	0.0068 (0.00272)	0.0176 (0.00287)
1977	−0.0099 (0.00000)	0.0036 (0.00404)	0.0135 (0.00000)	1995	−0.0098 (0.01908)	0.0063 (0.0083)	0.0161 (0.00753)
1978	−0.0095 (0.00000)	0.0039 (0.00236)	0.0134 (0.00000)	1996	−0.0076 (0.08537)	0.0039 (0.11538)	0.0115 (0.07024)
1979	−0.0095 (0.00000)	0.0039 (0.00252)	0.0134 (0.00000)	1997	−0.0066 (0.13718)	0.0036 (0.14604)	0.0102 (0.11026)
1980	−0.0094 (0.00000)	0.0038 (0.00409)	0.0132 (0.00000)	1998	−0.0052 (0.23098)	0.0036 (0.14742)	0.0087 (0.16447)
1981	−0.0092 (0.00000)	0.0030 (0.01866)	0.0122 (0.00000)	1999	−0.0038 (0.3726)	0.0022 (0.3628)	0.0060 (0.3315)
1982	−0.0097 (0.00000)	0.0037 (0.00471)	0.0134 (0.00000)				

This table presents the results a 14-year rolling window analysis in which we compute the average raw and risk-adjusted momentum returns for every 14 years starting at the beginning of each year from 1965 to 1999. Panel A reports the raw returns and Panel B reports the Fama-French three-factor alphas. *p* values are presented in parentheses

for the up and down market cycles. Following Cooper et al. (2004), we classify the months following a phase of 36 months of positive (negative) value weighted CRSP index returns as up (down) markets. Table 7 presents the monthly average returns for 10 portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months earned following up and down market conditions. The results indicate that momentum portfolios (P10–P1) earn significant profits following up markets but they earn no profits reliably different from zero following down markets in the periods 1965–1989 and 1990–1998 confirming earlier findings. The period 1990–1998 experienced no down market conditions and this can partially explain, the larger momentum profit in this period recorded above compared to the period 1965–1989. However, in the period 1999–2012, momentum portfolios do not earn any profit significantly different from zero, regardless of market conditions. Not only are these momentum profits insignificant on average following up markets, their distribution also turns out of to be visibly and statistically very different from those in the first and the second subperiods indicating a deeper and more fundamental

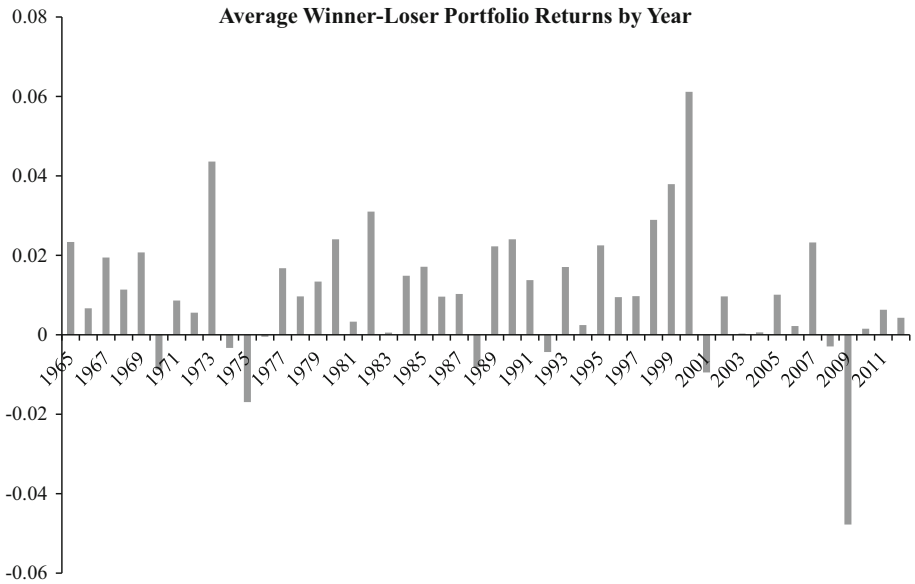


Fig. 1 Average winner–loser portfolio returns by year. This figure plots the average monthly returns of winner–loser portfolios for each year during the 1965–2012. Winner–loser portfolios are constructed using the methodology as described in Table 2

change in the underlying process of generation of momentum profits, beyond huge market crashes.

Figure 2 plots and compares the distribution of monthly returns of momentum portfolios (winners–losers), following up-markets. The solid line represents a fitted normal distribution and the dashed line represents fitted kernel density, estimated with bandwidth parameter of 0.79. Panel A plots the distributions of monthly returns of these momentum portfolios in the periods 1965–1989 and 1999–2012 and Panel B plots the same for the periods 1990–1998 and 1999–2012. Momentum profits in the last subperiod show larger dispersion as compared to the two previous subperiods that may explain the lack of statistical significance of the average momentum returns following up markets in this subperiod. Momentum as a strategy seems to have become riskier in the most recent subperiod. Kuiper two sample tests that are used to assess the uniformity of a set of distributions show that these distributions are significantly different from each other. Panel C plots the distributions of monthly returns of momentum portfolios following up markets in the periods 1965–1989 and 1990–1998. The distributions look similar indicating comparable riskiness of the momentum strategy in the first two subperiods. The Kuiper tests confirm that these two distributions are not significantly different from one another. The idiosyncratic volatility of the momentum portfolio has increased in the latest subperiod compared to the previous two subperiods combined which may be contributing towards the overall rise in volatility of momentum returns. We calculate the variance of the residuals from Fama–French 3-Factor model regression of momentum returns for each subperiod and conduct an F test to compare the statistical significance of the difference.

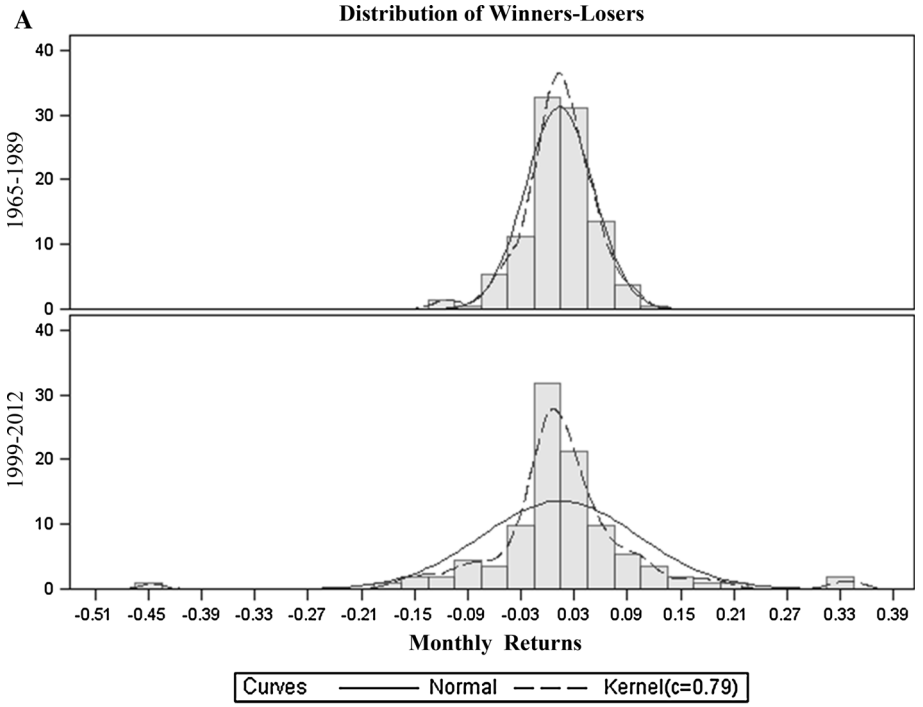
Table 7 Momentum portfolios' raw returns following up and down markets

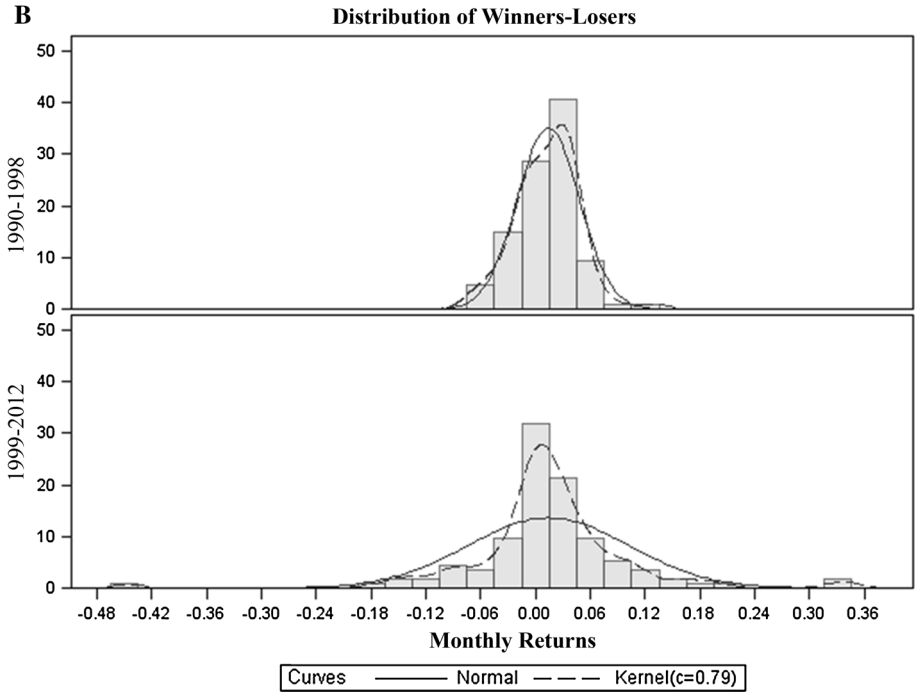
	1965–1989	1990–1998	1999–2012
Panel A: Up markets			
P1 (past losers)	0.0032	0.0044	−0.0036
P2	0.0083	0.0087	0.0010
P3	0.0098	0.0112	0.0028
P4	0.0105	0.0119	0.0038
P5	0.0109	0.0120	0.0043
P6	0.0115	0.0125	0.0045
P7	0.0121	0.0124	0.0050
P8	0.0129	0.0132	0.0059
P9	0.0139	0.0143	0.0073
P10 (past winners)	0.0162	0.0181	0.0104
P10–P1 (winners–losers)	0.0130	0.0137	0.0140
p value	0.00000	0.00006	0.09439
Panel B: Down markets			
P1 (past losers)	0.0214		0.0208
P2	0.0205		0.0178
P3	0.0181		0.0171
P4	0.0173		0.0174
P5	0.0169		0.0161
P6	0.0164		0.0160
P7	0.0149		0.0154
P8	0.0150		0.0148
P9	0.0147		0.0134
P10 (past winners)	0.0168		0.0132
P10–P1 (winners–losers)	−0.0046		−0.0076
p value	0.66024		0.45452

This table presents the average monthly returns earned by momentum portfolios constructed with all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below $5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. At the end of each month (t) stocks are sorted into 10 equally weighted portfolios based on their cumulative returns earned in the past 6 months ($t - 5$ to t). Positive (negative) returns of the value weighted CRSP index over the past 36 months define UP (DOWN) markets as in Cooper et al. (2004). Panel A and B report monthly average returns to these ten portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months for the three periods, 1965–1989, 1990–1998, and 1999–2012 following UP and DOWN markets, respectively. The bottom two rows of this table present the average returns and the corresponding p values to the winner–loser portfolios that buy winners (highest past return decile) and sells losers (lowest past return decile). All the portfolios are equal weighted

2.6 Holding period returns for small firms, large firms, low liquidity, and high liquidity firms

It is quite possible that momentum strategy continues to be profitable among smaller and lower liquidity stocks for the simple reason that they are more expensive to trade. To address this possibility, in this subsection we separately examine the momentum returns


A
Distribution of Winners-Losers
1965-1989
1999-2012
0
10
20
30
40
-0.51 -0.45 -0.39 -0.33 -0.27 -0.21 -0.15 -0.09 -0.03 0.03 0.09 0.15 0.21 0.27 0.33 0.39
Monthly Returns
Curves Normal Kernel(c=0.79)


B
Distribution of Winners-Losers
1990-1998
1999-2012
0
10
20
30
40
50
-0.48 -0.42 -0.36 -0.30 -0.24 -0.18 -0.12 -0.06 0.00 0.06 0.12 0.18 0.24 0.30 0.36
Monthly Returns
Curves Normal Kernel(c=0.79)

◀**Fig. 2** Comparison of distribution of momentum portfolios' returns following up markets. **a** 1965–1989 and 1999–2012. This figure plots the distribution of monthly returns of winner- loser portfolios, constructed as described in Table 2 following up-markets as defined in Table 7 for the first and the most recent subperiods. The *solid line* represents a fitted normal distribution and the *dashed line* represents fitted kernel density, estimated with bandwidth parameter of 0.79. **b** 1990–1998 and 1999–2012. This figure plots the distribution of monthly returns of winner–loser portfolios, constructed as described in Table 2 following up-markets as defined in Table 7 for the second and the most recent subperiods. The *solid line* represents a fitted normal distribution and the *dashed line* represents fitted kernel density, estimated with bandwidth parameter of 0.79. **c** 1965–1989 and 1990–1998. This figure plots the distribution of monthly returns of winner–loser portfolios, constructed as described in Table 2 following up-markets as defined in Table 7 for the first and the second subperiods. The *solid line* represents a fitted normal distribution and the *dashed line* represents fitted kernel density, estimated with bandwidth parameter of 0.79

generated by small and large stocks, and also by high and low liquidity stocks. Following Jegadeesh and Titman (2001), the Small Cap group (Large Cap) comprises of stocks that are smaller (larger) than the median NYSE stock by market capitalization at the beginning of the holding period.[10] Illiquidity is estimated as ratio of absolute 1 day return to dollar volume in that particular day, a measure proposed by Amihud (2002). Low (High) Liquidity stocks have higher (lower) average illiquidity than the median illiquidity stock in the month preceding the identification period ($t - 6$). We use the liquidity measure as of the sixth month before the holding period to make liquidity sorting process independent from the past return sorting process.

The results in Table 8 indicate that the momentum effect that was prevalent in all size and liquidity categories till 1998, decline uniformly across all these groups of stocks in the period 1999–2012.

2.7 Cross-sectional variation in returns explained by past returns

To investigate whether or not with decline in momentum profits, the explanatory power of past stock returns in explaining cross-sectional variation in current stock returns have weakened, we adopt the methodology employed by Fama and French (1992). We carry out Fama–MacBeth regressions of monthly returns of individual stocks on its past cumulative returns ($t - 12$ to $t - 2$) controlling for post ranking beta, size, and book-to-market equity. The only accounting ratio used in the regressions is the natural logarithm of book-to-market equity, ln(*BE*/*ME*). *BE* is the book value of common equity plus balance-sheet deferred taxes, and *ME* is the market equity. *BE* is obtained for each firm's latest fiscal year ending in calendar year $t - 1$ and *BE*/*ME* is computed using market equity (*ME*) in December of year $t - 1$. However, firm size, the natural logarithm of market equity ln(*ME*) is measured in June of year *t*. The explanatory variables for individual stocks are matched with CRSP returns for the months from July of year *t* to June of year $t + 1$. The gap between the accounting data and the returns ensures that the accounting data are available prior to the return. Following Fama and French (1996), the cumulative past returns for each stock, each month are computed by cumulating their returns from $t - 12$ to $t - 2$ months. Individual stocks are assigned post-ranking β of the size-β portfolio that they are in at the end of June of year *t*. We compute the post-ranking βs as in Fama and French (1992). Each June all NYSE stocks are sorted based on market equity to determine NYSE size decile cut

[10] We repeat our analysis with size subsamples formed on the basis of the market capitalization at the beginning of the identification period to make the size sorting process more independent from the past return sorting process and this has no effect on inferences.

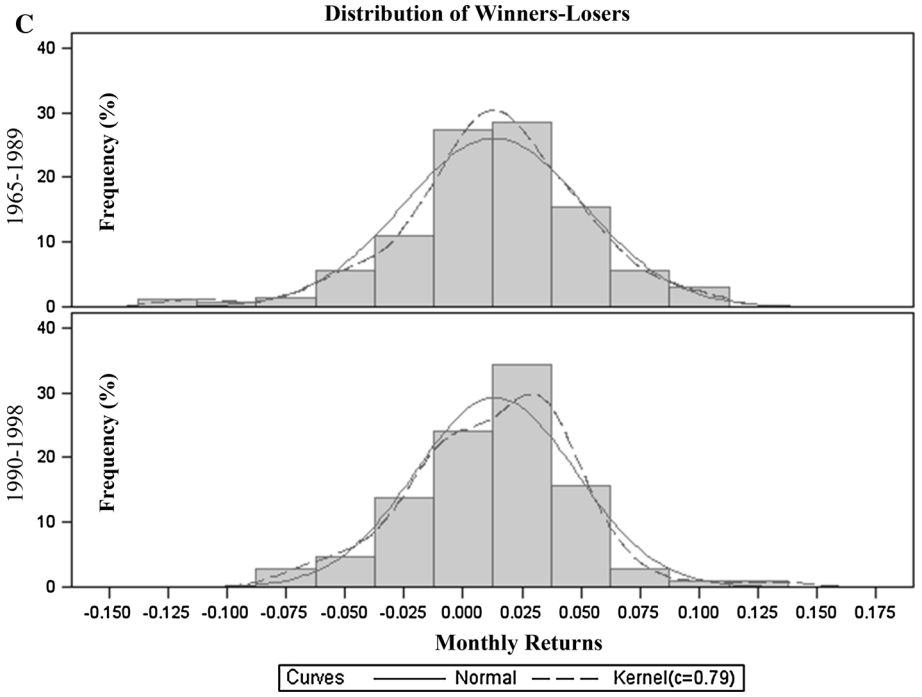


Fig. 2 continued

-off points. Then, all NYSE, AMEX and NASDAQ stocks that have data both on CRSP and COMPUSTAT are assigned to these size deciles based on NYSE cut-off points. We sort stocks in each size decile, based on their pre-ranking βs. The pre-ranking βs are estimated using $t-24$ to $t-60$ monthly stock returns. The equal weighted average monthly returns of the 100 size-β portfolios are computed over 12 months following June of each year and the post-ranking βs for these 100 size-β portfolios are estimated for the full period. We use Fowler and Rorke (1983) correction in estimating the βs.

Table 9 presents the results of these Fama–MacBeth regressions. These results clearly demonstrate that a positive relation between current and past stocks returns exists for the periods 1965–1989 and 1990–1998, but is no longer significant in the period 1990–2012.[11] This confirms our postulate that as momentum returns decline to insignificant levels, past returns can no more explain cross-sectional variation in stock returns. The regressions also show that market β does not help explain average stock returns for the entire sample period confirming the results of Fama and French (1992). The small firm effect prevails through the first two subperiods, though relatively weaker in the post 1989 period. However, it is subsumed by the book-to-market. The value stocks on the other hand continue to outperform growth stocks over the entire sample period. The results are consistent with the existing literature on widely known stock market anomalies.

[11] We also include natural logarithm of asset-to-market and asset-to-book ratios as explanatory variables instead of natural logarithm of book-to-market in the regressions and this does not have bearing on our inferences.

Table 8 Momentum portfolios' raw returns for 6-month/6-month strategy—size and liquidity

	1965–1998				1999–2012			
	Small Cap	Large Cap	Low Liquidity	High Liquidity	Small Cap	Large Cap	Low Liquidity	High Liquidity
P1 (past losers)	0.0045	0.0070	0.0060	0.0046	0.0059	0.0018	0.0050	0.0045
P2	0.0096	0.0098	0.0103	0.0092	0.0068	0.0049	0.0063	0.0061
P3	0.0114	0.0104	0.0120	0.0104	0.0082	0.0058	0.0080	0.0066
P4	0.0120	0.0110	0.0126	0.0111	0.0095	0.0069	0.0093	0.0075
P5	0.0123	0.0110	0.0129	0.0110	0.0094	0.0069	0.0092	0.0075
P6	0.0131	0.0112	0.0134	0.0114	0.0099	0.0067	0.0099	0.0073
P7	0.0134	0.0112	0.0140	0.0112	0.0101	0.0068	0.0102	0.0071
P8	0.0141	0.0120	0.0144	0.0121	0.0104	0.0075	0.0103	0.0080
P9	0.0150	0.0128	0.0155	0.0127	0.0111	0.0080	0.0104	0.0089
P10 (past winners)	0.0171	0.0159	0.0175	0.0159	0.0128	0.0108	0.0126	0.0114
P10–P1 (winners–losers)	0.0126	0.0088	0.0114	0.0114	0.0069	0.0090	0.0076	0.0069
p value	0.00000	0.00013	0.00000	0.00000	0.34524	0.28351	0.25872	0.39777

This table presents the average monthly returns earned by momentum portfolios for Small Cap, Large Cap, Low Liquidity and High Liquidity stocks. Sample includes all NYSE, AMEX and NASDAQ stocks after excluding stocks priced below $5 at the beginning of the holding period and stocks with market capitalizations less than the cut-off level of lowest NYSE decile. At the end of each month (t) stocks are sorted into 10 equally weighted portfolios based on their cumulative returns earned in the past 6 months ($t - 5$ to t). This table reports the mean of monthly average returns to these ten portfolios formed on the basis of the past 6 months' cumulative returns and held for another 6 months for the 1965–1998 and 1999–2012 periods. The bottom two rows of this table present the average returns and the corresponding p values to the winner–loser portfolios that buy winners (highest past return decile) and sells losers (lowest past return decile). All the portfolios are equal weighted. Small Cap (Large Cap) comprises of stocks that have market cap smaller (larger) than median market cap NYSE stock. Illiquidity is estimated as ratio of absolute 1 day return to dollar volume in that particular day. Low (High) Liquidity stocks have higher (lower) average illiquidity than the median illiquidity stock in the month $t - 6$

Momentum profits have been linked to market states in the literature. We earlier presented evidence that momentum profits are insignificant on average following 3-year up markets in the 1999–2012 period, in contrast to the two previous subperiods. We also examine whether past returns explain stock returns in the cross-section after controlling for market states. We carry out Fama–MacBeth regressions of monthly returns of individual stocks as in Table 9, splitting the subperiods into up and down market states this time. The results confirm all our previous findings. In the periods 1965–1989 and 1990–1998, past stocks return is positively related to current stocks returns exclusively following up markets. However, in the current subperiod, past returns fail to explain current returns following up markets and show a reliably negative relation following down market. So with decline in momentum profits, past returns do not show the expected positive relation with current stock returns.[12]

[12] These results not presented for the sake of brevity, but they are available upon request.

Table 9 Fama–MacBeth regressions of stock returns on past 11 months cumulative returns, β, size, and BE/ME

	1965–1989			1990–1998			1999–2012		
	1	2	3	1	2	3	1	2	3
CUM_RETURN	0.00895*** (0.00060)	0.00758*** (0.00043)	0.00738*** (0.00070)	0.00381** (0.03104)	0.00404** (0.02292)	0.00397** (0.02408)	−0.00483 (0.21966)	−0.00483 (0.17721)	−0.00479 (0.17314)
POST BETA	–	−0.00430 (0.11551)	−0.00236 (0.35366)	– –	0.00007 (0.98706)	0.00209 (0.60016)	–	0.00198 (0.72634)	0.00209 (0.68630)
LNME	–	−0.00197*** (0.00023)	−0.00142*** (0.00594)		−0.00218** (0.01131)	−0.00172* (0.05288)	–	−0.00192*** (0.00844)	−0.00149* (0.08282)
LNBM	–	–	0.00331*** (0.00001)	–	–	0.00264** (0.01451)	–	–	0.00226* (0.08015)
Number of observations	300	300	300	108	108	108	168	168	168

This table presents the average slopes from month-by-month regressions of stock returns on *cumulative past returns, beta, size, and book-to-market* for each subperiod. We consider all NYSE, AMEX and NASDAQ stocks that have data available both on CRSP and COMPUSTAT. Following Fama and French (1996), the cumulative past returns for each stock, each month are computed by cumulating their returns from $t - 12$ to $t - 2$ months. Stocks are assigned post-ranking β of the *size-*β portfolio they are in at the end of June of year *t*. *BE* is the book value of common equity plus balance-sheet deferred taxes. BE is obtained for each firm's latest fiscal year ending in calendar year $t - 1$. The accounting ratio is computed using market equity *ME* in December of year $t - 1$. Firm size ln(*ME*) is measured in June of year *t*. In the regressions, these values of the explanatory variables for individual stocks are matched with CRSP returns for the months from July of year t to June of year $t + 1$. The gap between the accounting data and the returns ensures that the accounting data are available prior to the returns. *LNBM* is natural logarithm of *BE/ME*. *p* values are in parentheses. *, **, *** indicate significance at the 10, 5, and 1 % levels, respectively

2.8 Cross sectional variation in returns explained by past returns in the intermediate horizon

Novy-Marx (2012) concludes that the recent past performance does not matter as much as the past performance within the intermediate horizon, in particular the cumulative returns 12–7 months prior to formation ($t - 12$, $t - 7$). We carry out Fama–MacBeth regressions of monthly returns of individual stocks as in Table 9, only this time using the cumulative returns of stock over the intermediate horizon. In the periods 1965–1998, intermediate past stocks return is positively related to current stocks returns. However, in the 1999–2012 period, past intermediate returns fail to explain current returns. Hence, with decline in momentum profits, past returns, no matter whether measured over the recent past or the intermediate horizon do not show the expected positive relation with current stock returns.[13]

3 Possible explanations for the declining momentum profits since 1999

We suggest three possible explanations for the declining momentum profits that involve uncovering of anomaly by investors, disappearance of the risk premium on industrial production factor, and improvement in relative market efficiency. The first explanation proposes that momentum profits decline post 1998 because investors learn about the benefits of implementing a naive strategy called momentum thereby correcting mispricing if any in the firms identified as winners and losers within the identification or the formation period faster in the last subperiod compared to the earlier subperiods. This explanation predicts intensified reaction to both winner and loser stocks in the identification period itself, which would result in either exhaustion or, at the least, a substantial reduction in return continuation in the holding period, and weakened return reversal (under the scenario of possible overreaction in the holding period perpetrated by behavioral biases) in the post holding period. We find evidence consistent with all these predictions. However, a caveat is order here; reducing underreaction or mispricing may also result in similar patterns of returns from loser and winner stocks, if we were to believe momentum profits were caused in the first place due to delayed price reactions to firm-specific information as suggested by Jegadeesh and Titman (1993, 2001). The distinction between the two is beyond the scope of this paper.

The second explanation is based on the findings of Liu and Zhang (2008) who show that macroeconomic factors such as growth rate of industrial production are priced and in various specifications explains over a half of the momentum profits. We however, find that in the latest subperiod the marginal productivity factor is no longer priced.

The third explanation explores the possibility of improvement in relative market efficiency. Following Griffin et al. (2010), we use the delay in order to assess the improvement in market efficiency that measures the degree of response of stock returns to past market returns. We record a fairly significant reduction in delay in all size portfolios but for the largest one that suggests improvement in relative market efficiency.

[13] These results are not tabulated for the sake of brevity, but they are available upon request.

3.1 Identification period buy and hold returns for winner and loser stocks

The first explanation proposes that investors simply recognize that momentum strategy is profitable and trade in ways that arbitrage away such profits partially consistent with Schwert (2003) that documents two primary reasons for the disappearance of an anomaly in the behavior of asset prices, first, sample selection bias, and second, uncovering of anomaly by investors who trade in the assets to arbitrage it away. Competition amongst arbitrageurs to buy the winners and short the losers would induce them to try to identify the winners and losers earlier and earlier. Earlier identification and execution of the momentum strategy in the latter part of the identification period itself would reduce, and eventually eliminate the abnormal returns in the holding period. Moreover, the incentive and the competition amongst the arbitrageurs to unwind the long and short trades before any losses due to any possible over-reaction in the holding period would eventually eliminate any systematic over-reaction and subsequent reversals. It is also interesting to note that Brav and Heaton (2002) point out even if irrationality perpetrates financial anomalies, their disappearance hinges on rational learning, an ability of rational arbitrageurs to identify observed price patterns and wipe out any return potential in excess of risk based expectations.

This explanation predicts intensified reaction to winner and loser stocks in the identification period itself, exhaustion or, at the least, a substantial reduction in return continuation in the holding period, and weakened return reversal (under possible overreaction in the holding period perpetrated by behavioral biases) in the post holding period.

To test these implications of growing investor awareness, we compute the buy and hold abnormal returns of new winner and loser stocks during the identification period and in the following 24 months in event time similar to the post-holding period analyses performed in Jegadeesh and Titman (1993, 2001). The event in this analysis is the identification of a stock as a winner or a loser. New winners (losers) are the stocks that enter the winner (loser) portfolio in month t (event month 0). Abnormal return for each event month is the average of the mean abnormal returns of all stocks with monthly return data for 30 months, $t - 5$ (event month -5) to $t + 24$ (event month 24), across all calendar months. Buy and hold abnormal return is the difference between the compounded raw return and compounded expected return for each stock for each event month.[14] The expected returns are computed using the loadings on Fama–French three factors over the 5-year period between $t - 71$ (event month -71) to $t - 13$ (event month -13). Stocks with less than 24 monthly observations are excluded for the purpose of estimation of the three factor loadings. Figure 3 presents the plots of the average buy and hold abnormal returns for each event month.

The buy and hold returns for the winner stocks in the identification period, months $t - 5$ (event month -5) to t (event month 0) show that in the post 1998 period they reach substantially higher levels on average spiraling at a much faster rate compared to the pre 1999 period and they eventually flatten out in the holding and post holding periods, months $t + 1$ (event month 1) to $t + 24$ (event month 24). Even though the graph for the buy and hold return of winner stocks in the post 1998 period may suggest return continuation for a few months in the post holding periods, months $t + 3$ (event month 3) to $t + 10$ (event

[14] Abnormal returns are defined as the intercepts from Fama–French three-factor regressions since the momentum portfolio returns are computed in calendar time in all tables with the exception of the analysis presented in Fig. 3. In this section, momentum portfolio returns are computed in event time and therefore the abnormal returns are calculated as the difference between the raw and expected returns.

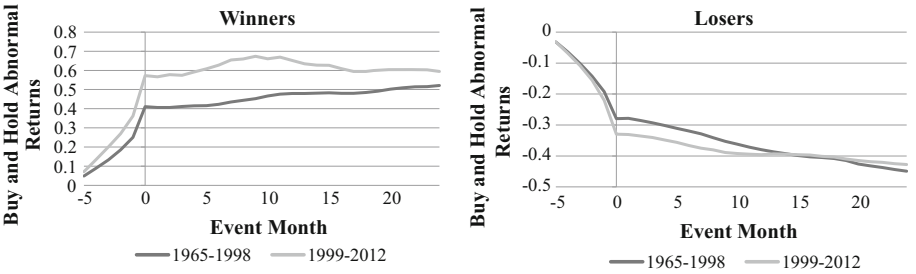


Fig. 3 Buy and hold abnormal returns of new entrants to winner and loser portfolios-event time analysis. This figure plots the abnormal buy and hold returns of new entrants to winner and loser portfolios (constructed as in Table 2) over $t - 5$ to $t + 24$. Our initial sample includes all NYSE, AMEX and NASDAQ stocks priced above $5 at the beginning of the holding period and with market capitalizations above the cut-off level of lowest NYSE decile. New winners (losers) are the stocks that enter the winner (loser) portfolio in month t and are not included in the winner (loser) portfolios in any of the months $t - 5$ to $t - 1$. Abnormal return for each event month is the average of the mean abnormal returns of all stocks with monthly return data for 30 months, $t - 5$ to $t + 24$, across all calendar months. Buy and hold abnormal return is the difference between the cumulative raw return and cumulative expected return for each stock for each event month. The expected returns are computed using the loadings on Fama–French three factors over the 5-year period between $t - 71$ and $t - 13$. Stocks with less than 24 monthly observations are excluded for the purpose of estimation of the loadings on the three factors

month 10) in particular, none of these returns are statistically significant. Very similar pattern is exhibited by the returns of loser stocks. However, front running the traditional momentum traders on the short end seems more difficult to implement. This is not a surprising finding in light of the existing literature that associates higher asymmetry of information, transaction costs and other short trade restrictions.[15]

3.2 Reduced risk premium on macroeconomic variable

As mentioned earlier Liu and Zhang (2008) show that macroeconomic factors such as growth rate of industrial production are priced and in various specifications explains over a half of the momentum profits. If however, in the last subperiod the marginal productivity factor is no more a priced risk factor then that could provide an explanation to the disappearance of momentum profits.

To that end, we first compute the loadings of loser, winner, and winner-loser portfolios' returns on the growth rate of industrial production. We use monthly regressions of these portfolio returns for estimating the loadings on the Fama–French three factors and the growth rate of industrial production (MP). $MP_t = \log IP_t - \log IP_{t-1}$, as defined in Liu and Zhang (2008), where IP_t is the index of industry production in month t from the Federal Reserve Bank of St. Louis. Momentum portfolio continue to load significantly positive on this factor in the 1999–2012 period as in the 1965–1998 period.

Next, we the estimate of the risk premium of MP from two-stage Fama–MacBeth (1973) cross-sectional regressions. Following Liu and Zhang (2008) in the first stage, we estimate factor loadings using sixty-month rolling-window regressions and extending-window regressions. For the rolling window, the starting month for the estimation is $t - 60$ and the

[15] We also analyze the risk-adjusted 24 month post holding period returns of the winner and loser portfolios that show substantial reversal consistent with overreaction and subsequent price correction hypothesis until 1998. Post 1998, there is no evidence for either return continuation or subsequent reversal.

ending month is t. For the extending window the starting month for the estimation is always January 1965 and the ending month is t. In the first stage, we run regressions of monthly excess returns of 30 testing portfolios on Fama–French three factors and the MP. Following Liu and Zhang (2008), 30 testing portfolios consist of ten size, ten book-to-market, and ten six/six momentum portfolios.[16] In the second stage, we perform cross-sectional regressions of 30 testing portfolios $t + 1$ month excess returns on the factor loadings estimated in the first stage using information up to month t. We start the second-stage regressions in January 1965. The risk premium of MP is computed by taking the average of the coefficients on the MP loadings from the second-stage cross-sectional regressions. The MP risk premium is positive and significant in the first two subperiods combined (0.31 % significant at the 5 % level for the rolling window and 1.12 % significant at the 1 % level for the extending window). However, neither for the rolling window nor for the extending window analysis is the MP risk premium significantly different from zero (at the 5 % level) in the last subperiod indicating that the industrial growth rate factor is no longer priced, a plausible cause for disappearing momentum profits.[17]

3.3 Relative market efficiency pre and post 1999 periods

Post 1998, neither of the winner or the loser portfolios earn returns that are reliably different from zero in the post identification period. The lack of return continuation and subsequent reversal in the post identification period can be interpreted as an evidence of improvement of market efficiency in the period 1999–2012. The markets might have become more efficient because information gets impounded into prices faster in this period. Following Griffin et al. (2010), we examine improvement in relative market efficiency using the DELAY measure that reflects the degree of response of stock returns to past market returns. DELAY is widely adapted measure of stock price efficiency and is found to be strongly related to other stock price efficiency measures, for instance, Bramante et al. (2015) document that DELAY is negatively related to the R-square of the market model.

DELAY is computed by subtracting the adjusted R^2 of unrestricted market model from the adjusted R^2 of the restricted market model ($Delay = adjR^2_{unrestricted} - adjR^2_{restricted}$). The unrestricted model uses four lags of weekly market returns:

[16] The ten size and ten book-to-market portfolio data are from Kenneth French's web site.

[17] We also examine whether the change in exposure to the marginal productivity risk factor during the last subperiod is similar for both growth and value firms that constitute the momentum portfolio. To this end, we construct thirty portfolios by independently sorting stocks into ten groups based on their previous six months cumulative returns and into three groups based on their book-to market ratios. We calculate the book-to market ratio as in Sect. 2.7 for each firm at the end of December of each year and use it for sorting firms into three groups (growth, intermediate and value) for portfolio formation months from June of next year to May of the following year. We then estimate separately the loadings of low, intermediate, and high book-to-market momentum portfolios (the three difference portfolios which buy winners of particular book-to-market group and sell the corresponding losers) on the MP factor over the combined subperiod 1 and 2 and over the last subperiod. We indeed find that low book-to-market firms (growth) have higher loadings on the MP factor in 1965–1998 period. We further find that over the combined first two subperiods the momentum portfolio loads significantly on the MP factor except for the high book-to-market ratio (value) firms. In contrast, over the last subperiod none of these loadings on the MP factor are statistically significant. In sum, we report that there is a change in the significance of the loading on the MP factor especially for the growth firm. This evidence taken together with the finding that the risk premium on this factor decrease over the last subperiod suggest that the lack of the priced macroeconomic risk in the more recent period is a potential explanation for disappearance of momentum returns especially for the growth firms.

Table 10 Measures of delay for the three subperiods

	Small	2	3	4	Large
Panel A: Portfolio					
1965–1989	0.0403	0.0283	0.0218	0.0095	0.0003
1990–1998	0.0647	0.0380	0.0244	0.0080	0.0009
1999–2012	0.0074	0.0094	0.0049	0.0035	0.0004
Panel B: Individual stocks					
1965–1989	0.0119	0.0100	0.0102	0.0104	0.0049
1990–1998	0.0129	0.0114	0.0082	0.0105	0.0051
1999–2012	0.0082	0.0090	0.0092	0.0063	0.0056
Diff. Subperiod 1 and Subperiod 2	−0.0010	−0.0014	0.0020	−0.0001	−0.0002
p value	0.49998	0.37011	0.23147	0.93166	0.82985
Diff. Subperiod 1 and Subperiod 3	0.0037	0.0011	0.0010	0.0040	−0.0007
p value	0.01229	0.4901	0.54442	0.00247	0.48949
Diff. Subperiod 2 and Subperiod 3	0.0047	0.0024	−0.0010	0.0041	−0.0005
p value	0.00027	0.04416	0.48961	0.00053	0.64346

This table presents the delay for the 5 size quintiles (individual stocks) for our sample of stocks. Delay is computed by subtracting the adjusted R^2 of unrestricted market model from the adjusted R^2 of the restricted market model ($Delay = R\ adjR^2_{unrestricted} - adjR^2_{restricted}$). The unrestricted model uses four lags of weekly market returns:

$r_{i,t} = \alpha_i + \beta_{0i} r_{m,t} + \beta_{1i} r_{m,t-1} + \beta_{2i} r_{m,t-2} + \beta_{3i} r_{m,t-3} + \beta_{4i} r_{m,t-4} + \varepsilon_{i,t}$, where $r_{i,t}$ is the weekly portfolio (individual stock) return at time t and $r_{m,t}$ is the market return. In the restricted model, the coefficients on the lagged market returns are constrained to zero:

$r_{i,t} = \alpha_i + \beta_{0i} r_{m,t} + \varepsilon_{i,t}$

In Panel A, weekly returns of five size portfolio are the dependent variables in the market model. Weekly returns are the equal weighted portfolio returns for the size quintiles. All stocks in our sample are sorted into quintiles at the end of previous year. In Panel B, weekly returns of individual stock are the dependent variables in the market model. For each size quintile, we then compute the average delay. We also report the difference between the average delays of each subperiods and the corresponding *p* values

$r_{i,t} = \alpha_i + \beta_{0i} r_{m,t} + \beta_{1i} r_{m,t-1} + \beta_{2i} r_{m,t-2} + \beta_{3i} r_{m,t-3} + \beta_{4i} r_{m,t-4} + \varepsilon_{i,t}$, where $r_{i,t}$ is the weekly portfolio (individual stock) return at time t and $r_{m,t}$ is the market return. In the restricted model, the coefficients on the lagged market returns are constrained to zero:

$$r_{i,t} = \alpha_i + \beta_{0i} r_{m,t} + \varepsilon_{i,t}.$$

Table 10 presents the results for DELAY for the 5 size quintiles for our sample of stocks. In Panel A, weekly returns of five size portfolio are the dependent variables in the market model. Weekly returns are the equal weighted portfolio returns for the size quintiles. All stocks in our sample are sorted into quintiles at the end of previous year. DELAY across all size quintiles declines substantially except for the largest portfolio. The smallest size quintile experiences an 88 % reduction in delay between the second and the last subperiod. The numbers for the other quintiles are fairly large though they decrease monotonically from the smallest to the largest quintile. The results are not surprising since the larger stocks suffer a lot less from problems of information asymmetry, constitute a big

part of the market itself, hence their prices respond to market wide news a lot faster.[18] In Panel B, weekly returns of individual stock are the dependent variables in the market model. For each size quintile, we then compute the average DELAY. We also report the difference between the average DELAY of each subperiods and the corresponding p-values. We record a fairly significant reduction in DELAY in all size quintiles but between the second and the third subperiod in particular other than the third largest and largest portfolios.[19]

Supporting evidence on how the capital market has progressively become more efficient over time, especially over the past decade and a half can also be found in the literature. Gu and Finnerty (2002) find that autocorrelation in daily returns of the Dow 30 Index reveals a declining trend since World War II. Kadapakkam et al. (2015) examine the informational efficiency of US exchange traded funds (ETFs) and find improvement in market efficiency, more so in the recent decade. The capital market efficiency had been improved substantially during last period of our sample 1999–2012 due to decimalization (Bessembinder 2003; Chordia et al. 2008), high-frequency trading (Brogaard et al. 2014; Chaboud et al. 2014), increase in trading volume and liquidity (Chordia et al. 2011), and other changes in regulations like repeal of the uptick rule (Bertone et al. 2015). In a recent paper, Chordia et al. (2014) document that anomalies including size, momentum, idiosyncratic volatility, post-earnings-announcement-drift, etc. have attenuated in recent years, and the decline in anomaly-based trading strategy profit is driven by the growth in hedge funds, short interest, and aggregate share turnover.

In unreported analyses, we also find multiple evidence of weakening of other well-known anomalies in the period 1999–2012, particularly, earnings announcement returns widely recognized in the literature, 52-week high strategy documented by George and Hwang (2004).

The post-earnings announcement drift is a well-established phenomenon that challenges semi-strong efficiency. We examine whether there is evidence of weakening earnings momentum in the 1998–2012 period which would suggest relative improvement in market efficiency. Following Chordia and Shivakumar (2006), we construct equal-weighted portfolios based on standardized unexpected earnings (SUE). Each month, stocks are sorted into deciles based on the earnings in the current quarter less the earnings from four quarters before, standardized by the standard deviation of this difference in the prior eight quarters. Our results indicate that the difference between the highest and lowest SUE portfolios is statistically significant for the period 1965–1989 and 1990–1998 consistent with the literature. However, these returns become insignificant in the 1999–2012 period the same time around which momentum returns decline to insignificant levels.[20]

[18] We repeat the analysis using the percentage of Delay in unrestricted R-square as in Mech (1993). We compute *DELAY** by subtracting the ratio of adjusted R^2 of restricted market model to the adjusted R^2 of the unrestricted market model from 1 ($Delay^* = 1 - (adjR^2_{restricted}/adjR^2_{unrestricted})$). Similarly, the unrestricted model uses four lags of weekly market returns and in the restricted model the coefficients on these lagged market returns are constrained to zero. The results for the five size portfolios using *Delay** as the measure of delay is consistent with the results presented in Panel A of Table 10. There is improvement in delay in the last subperiod across all size quintiles except for the largest size quintile. These results are not reported for the sake of brevity, but they are available upon request.

[19] As indicated by Griffin et al. (2010), delay measures may be subject to larger estimation error noise for individual firms but in order test the statistical significance of delay measures across the three subperiods we have to use delay measure at the stock level.

[20] These are results are not presented but available upon request.

George and Hwang (2004) document that 52-week high price is a better predictor of future returns than past cumulative returns. Following their methodology we construct equal-weighted portfolios based on 52-week high ratios. Each month, stocks are sorted based on 52 week high ratio, the ratio of the current end month price divided by the 52 week highs. Equal-weighted portfolios are constructed with stocks in the bottom 30 % and top 30 % of 52-week high ratios. These portfolios are held for the subsequent 6 months. The winner minus loser portfolios classified by the 52-week high ratio earn significantly positive returns in the 1965–1989 and 1990–1998 periods which drop to insignificant levels in the period 1999–2012, the time period over which momentum returns disappear.[21]

All the above evidences put together indicate that improvements in capital market efficiency could drive the reduction in momentum profit in recent years.

4 Conclusion

In this paper we ask the question "what if momentum which has been shown to be a persistent market anomaly is no longer profitable?" The contribution of this paper lies in the answer to this question. It cannot be stressed enough that the disappearance of momentum profits, if proven to be true would have a significant impact over a number of interest groups in the capital market, such as the traders in forming strategies, the investors on how to evaluate their money managers' performance, and academics on how they perceive and explain the disappearance of such a persistent market anomaly. This paper evaluates the persistence of momentum or lack thereof over the last half a century.

We document that trading strategies, which buy past winners and sell past losers, though remarkably profitable up until 1998, fail to generate significant abnormal returns in the period 1999–2012. These results are robust across extreme size and liquidity subsamples of stocks, periods of unusual volatilities in the capital market, seasonality, and up and down market conditions. We also document that past returns either in the long run or within the intermediate horizon can no longer explain cross-sectional variation in stock returns in the post 1998 period.

We suggest three possible explanations for the declining momentum profits that involve uncovering of the anomaly by investors, decline in the risk premium on a macroeconomic factor, growth rate in industrial production in particular, and relative improvement in market efficiency. In support of these explanations, we conduct an event time analysis, the results of which hinge on investor learning. We document decline in risk premium of industrial growth to insignificant levels, and we also conduct traditional relative market efficiency tests, the results from which suggest that market information gets incorporated faster into stock prices.

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[21] These are results are not presented but available upon request.

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