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The Effect of Ex Ante Price on Momentum Profits

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We find a strong effect of component stock prices (as of one year before the returns–ranking period) on the magnitude and duration of momentum. Relative strength portfolios formed of high–priced stocks earn statistically significant momentum profits for any holding period in the first three to four years. The effective annual return of the high–priced momentum portfolio for the first year is economically significant at 18.4%, after controlling for the capitalization, trading volume, and unconditional mean effects. This return is considerably higher than the 11.3% earned by low–priced momentum portfolios. Although the price level is correlated with capitalization and trading volume, the price effect is not a mere manifestation of the capitalization and volume effects, as it endures even when the other factors are controlled for. We discuss several implications of our results for the existing behavioral and risk–based explanations of momentum, as none of these models have an explicit role for the price effect.

Since the original finding of momentum by Jegadeesh and Titman [1993], financial economists have been debating on its origins. The simplicity of momentum strategy accompanied by the fact that momentum profits were found by Jegadeesh and Titman [1993] to reverse after the first year naturally seemed to suggest that momentum must be a behavioral phenomenon. Consequently, a host of explanations that model behavioral biases and informational inefficiencies have been proposed. At the same time, several theoretical models of risk–based rational explanations of momentum have appeared as well. Several authors have uncovered empirical regularities that either disprove or further support behavioral explanations. We contribute to this debate by documenting an effect that provides a challenge for several theories of momentum. Specifically, the magnitude and duration of momentum profits can be varied by forming arbitrage portfolios of stocks in the appropriate lagged price range. This is not unlike the results in Lee and Swaminathan [2000], where past trading volume is shown to determine the duration and magnitude of momentum. This price effect is not subsumed by the volume, capitalization, or unconditional mean effects and persists when the other variables are controlled for.

The price ranking is performed based on prices that were in effect one year before it became known which stocks are winners and which are losers (the conclusions remain unchanged when alternative lags are used). Momentum portfolios formed of high–priced stocks, after controlling for capitalization, volume, and unconditional means, earn economically and statistically significant annual effective return of 18.4% in the first year, which is considerably higher than that earned by the low–priced stocks (11.3%). The duration of momentum is positively related to the price level of stocks in the portfolio.

Price can affect momentum profits due to several factors, including the discreteness of price movements imposed by the minimum tick size, proportional transaction costs and liquidity considerations, information dissemination, the overconfidence biases, business cycle, institutional trading, and stochastic growth rates. Because the implications of the price effect for these models are described in the fourth section in the context of our findings, we defer a more detailed discussion to that section.

We describe our data and methodology in the second section and present our results in the third section. In the fourth section, we describe how these results fit into the current literature on both behavioral and non–behavioral explanations of momentum. The paper is concluded in the final section.

Data and Methodology

We begin with all monthly returns for NYSE and AMEX stocks for the period 07/1965 – 12/2001 provided by the Center for Research in Security Prices (CRSP). The choice of the period and securities is affected by four main factors. First, using periods prior to 1965, results in rather small and undiversified decile portfolios when we sort stocks on other variables in addition to returns. Second, to better distinguish the price effect we find from the volume effect documented in Lee and Swaminathan [2000], we use similar time period

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and security set. Third, we follow Lee and Swaminathan [2000] and other authors in excluding NASDAQ stocks. It should be noted, however, that our main conclusions are insensitive to this, as the comparison of Tables 7 and 9 shows. Fourth, we include more recent data.

For every month between 12/1965 and 09/2001 (i.e., for every "formation month"), we exclude stocks with less than two years of data (as in Lee and Swaminathan [2000]) and stocks with any missing returns in the six months preceding and including the formation period.[1]

At the end of each formation month, the winner portfolio is formed by equally-weighting all securities in the top decile based on the effective monthly return over the past six months r_e. The loser portfolio includes the lowest 10% of stocks, based on r_e.[2] Consistent with the previous literature, we form the costless arbitrage portfolio by entering a long position in the winner portfolio and a short position in the loser portfolio so that the net investment into arbitrage portfolio is zero.

We compute post–formation effective holding period returns for the winner, loser, and arbitrage portfolios for 20 different periods over the subsequent five years. The shortest holding period is three months, the longest is sixty months, and the increment is three months. Taking up to 5–year holding period returns lets us observe a long time–section of momentum profits, including any possible reversal (hypothesized by several theories). The conclusions of the paper are unchanged by our allowing a one–month lag between the formation and holding periods. We report all results without the lag.

To be able to visualize the time evolution and decay of momentum profits with the length of the period during which the same portfolio is held, we use effective holding period returns for every stock without any intermediate portfolio rebalancing. Also, this approach helps us avoid the upward bias associated with using the cumulative average monthly returns (see Conrad and Kaul [1993]). For these two reasons, we do not apply the approach of Jegadeesh and Titman [1993] for treating overlapping holding periods.[3] Note, however, that this bias will affect only the magnitude of momentum profits, but the qualitative relations between momentum profits and other variables (price, capitalization, volume) are unlikely to be significantly affected by the presence or absence of such bias.

Two different methods are used to treat missing returns during holding periods. First approach involves simply eliminating all securities that have at least one missing return during a given holding period. The remaining securities are sorted into the winner, loser, and arbitrage portfolios. The second approach allows a certain number of missing returns, depending on the length of the holding period. In the computation of the 3–month holding period return (h.p.r.), the method excludes all securities that have at least one missing return over the next three months. For the 6–month h.p.r. and the 9–month h.p.r., it excludes all stocks that have at least two missing returns in the next six and nine months, respectively. For the 12–month h.p.r. and the 15–month h.p.r., all stocks that have at least three missing returns in the next 12 and 15 months, respectively are excluded. The treatment of other holding periods is analogous. Because both these methods yield similar results, we report numbers only using the first method.

It should be noted that both of the methods described above introduce a bias because a trader cannot predict the future while forming a portfolio. A practitioner does not know beforehand that some of the returns of the stocks he or she picks today will be missing in the future. To test the robustness of our results to this potential bias, we implement a third technique in which no a priori knowledge of missing returns is used. If a stock has a missing return in the given holding month, the stock is liquidated and the proceeds are reinvested in the remaining stocks in the same portfolio. This approach eliminates any possible look–ahead bias. None of our conclusions are changed when this latter method is used. We report the results in Table 9.

As a result of these procedures, we have one observation for each of the 20 holding period returns for each of the three portfolios (winners, losers, and arbitrage). Repeating this process for each month between 12/1965 and 09/2001 (ends included) produces a sample of more than 400 observations for each of the 20 h.p.r. for each of the three portfolios. Taking the average over these observations produces an estimate of expected momentum profit for each holding period for each portfolio. Because we use overlapping observations and consistent with the previous literature (e.g., Lo and MacKinlay [1990] and Conrad and Kaul [1998]), the autocorrelation–consistent standard errors for these estimates are computed according to Newey and West [1987] with the lag of 20. Because most statistically significant autocorrelations do not persist beyond lag 13 (the results of the autocorrelation study are available on request), using shorter lags (10 to 12) does not affect our results materially. Shortening the lag further does not alter our main conclusions, as the comparison of Tables 7 and 9 shows. In all tables, we present the effective annualized returns for the different holding periods.

We apply the procedures described above first to the entire sample. Next, we sort stocks into quintiles on one–year lagged price.[4] The winner, loser, and arbitrage portfolios are formed for each price quintile based on an independent sort (independent of the price sort) on past six–month returns. Various holding period effective returns are computed for each of the portfolios in each of the quintiles. The differences in mean returns between different quintile pairs are tested for significance using the paired t–statistic that accounts for different variances and for nonzero correlations among the various momentum strategies. Similar sorts are performed on one–year lagged capi-

talization (instead of price) and on the average monthly turnover over one year preceding and including the formation month. As in Lee and Swaminathan [2000], turnover is used as a measure of trading volume. We compute average monthly turnover as the average of the ratio of the number of shares traded in a given month to the total number of shares outstanding at the beginning of the month.

Because the price effect is likely to be positively correlated with capitalization and with trading volume, it is possible that the price sorts simply capture the capitalization and/or volume effects. We disentangle these effects using the methods described in Reinganum [1981], Basu [1983], Cook and Rozeff [1984], and Badrinath, Kale, and Noe [1995].

Specifically, to control for capitalization, we first sort stocks into quintiles based on one–year lagged capitalization. Within each of these quintiles, we sort stocks (conditional on capitalization quintile) into quintiles based on one–year lagged prices. Then, stocks in the lowest (highest) price quintiles from each of the capitalization quintiles are combined together to form the lowest–price (highest–price) quintile with widely dispersed capitalization. Similarly, stocks in the second (third, etc.) price quintiles from each of the capitalization quintiles are combined together to form the second (third, etc.) price quintile with widely dispersed capitalization. As previously, momentum portfolios are formed within each of these resulting quintiles based on an independent sort by past six–month returns, and momentum profits are computed for 20 different holding periods. As a result, any differences in momentum profits among these quintiles will be due to the differences in prices when capitalization is controlled for.

To control for both capitalization and volume, we first sort stocks into quintiles independently by capitalization and by turnover and assign each stock into one of the resulting 25 capitalization–turnover portfolios. Within each of these portfolios, we sort stocks (conditional on the capitalization–turnover portfolio) into one–year lagged price quintiles. Then stocks in the lowest (highest) price quintiles from all 25 portfolios are combined together to form a lowest–priced (highest–priced) portfolio with both dispersed capitalization and turnover. Similar procedure is repeated for the remaining price quintiles. Momentum portfolios are formed and holding period returns are computed as described previously. In this experiment, any differences in returns between the resulting quintiles are not attributed to capitalization or turnover, but are attributed to the lagged price levels.

The technique for controlling for both capitalization and unconditional means is analogous to that used to control for the capitalization and volume. Unconditional means are computed as the average monthly return over the entire life of the stock.

Results

On Existence of Momentum and Reversal

We begin with identifying momentum and reversal documented in the previous literature. Panel A of Table 1 shows different holding period returns (per dollar long, annualized) of a costless arbitrage portfolio formed by buying top 10% of stocks based on past six–month performance and shorting the bottom 10% of stocks. Consistent with momentum, returns increase with the length of the holding period up to 12 months, at which point they become 10.9% per year. This is statistically different from zero and is similar in magnitude to momentum returns documented in previous literature (effective monthly return of 0.8%–1.0%).

Table 1 shows that after the first year, momentum returns are a decreasing function of the holding period, becoming negative soon after the third year. This is consistent with the evidence on reversal in Lee and Swaminathan [2000] and Jegadeesh and Titman [2001]. The negative profits, however, are statistically insignificant. Most of the momentum appears to be driven by the winners and the reversal is driven by the losers.

In DeBondt and Thaler [1985], DeBondt and Thaler [1987], Jegadeesh and Titman [1993], Conrad and Kaul [1993], Grundy and Martin [2001]) the January seasonal appears to be responsible for most or all of the reversal. In Panel B of Table 1, therefore, we replicate the same experiment but without Januaries.[5] As expected, the elimination of Januaries results in an increase of momentum profits in the first 12 months and in the weakening of reversal. Momentum profits reach 15% per year for the 12–month holding period (i.e., monthly effective return greater than 1%) and then decrease to economically insignificant (although statistically significant) levels of 3%–5% per year. The elimination of Januaries, therefore, does not eliminate the reversal effect, although it does eliminate negative momentum profits. The persistence of reversal even after adjusting for the January effect is consistent with behavioral theories that require momentum to be followed by reversal, but is inconsistent with some risk–based explanations, such as that in Conrad and Kaul [1998]. Because the January effect and its tax–based explanations are not the main focus of this study, all results reported below exclude January returns. However, our main conclusions are insensitive to this, as the comparison of Tables 7 and 9 shows.

Price vs. Capitalization

As mentioned in the Introduction and discussed in detail in the fourth section, momentum returns may depend on the stock price levels before stocks are classified into winners and losers. To determine the magnitude of this effect, we independently sort stocks into

Table 1. *Annualized Momentum Returns*

Holding Period in Months	Sample	Winners		Losers		Winners Minus Losers	
		HPR	SE	HPR	SE	HPR	SE
Panel A: Januaries Included							
3	429	0.201***	0.009	0.110***	0.012	0.085***	0.008
6	426	0.215***	0.019	0.092***	0.023	0.118***	0.013
9	423	0.220***	0.028	0.087***	0.032	0.131***	0.016
12	420	0.208***	0.037	0.099**	0.042	0.109***	0.020
15	417	0.186***	0.045	0.122**	0.052	0.066***	0.023
18	414	0.174***	0.052	0.138**	0.062	0.039	0.025
21	411	0.170***	0.060	0.145**	0.071	0.028	0.028
24	408	0.166**	0.067	0.149*	0.082	0.020	0.036
27	405	0.161**	0.074	0.151*	0.090	0.012	0.043
30	402	0.160**	0.081	0.151	0.097	0.011	0.045
33	399	0.162*	0.087	0.150	0.103	0.016	0.052
36	396	0.157*	0.094	0.149	0.112	0.010	0.059
39	393	0.155*	0.102	0.153	0.121	0.003	0.067
42	390	0.153	0.111	0.154	0.127	-0.002	0.073
45	387	0.152	0.119	0.157	0.134	-0.008	0.081
48	384	0.151	0.127	0.157	0.143	-0.010	0.084
51	381	0.152	0.139	0.155	0.148	-0.005	0.088
54	378	0.152	0.152	0.153	0.158	-0.002	0.100
57	375	0.148	0.157	0.156	0.177	-0.014	0.098
60	372	0.147	0.170	0.152	0.186	-0.009	0.105
Panel B: Januaries excluded							
3	429	0.188***	0.009	0.028**	0.012	0.156***	0.007
6	426	0.190***	0.019	0.006	0.023	0.184***	0.011
9	423	0.188***	0.028	0.011	0.034	0.177***	0.016
12	420	0.177***	0.037	0.026	0.044	0.151***	0.020
15	417	0.161***	0.044	0.045	0.052	0.117***	0.023
18	414	0.152***	0.051	0.060	0.061	0.094***	0.026
21	411	0.147**	0.058	0.073	0.071	0.078**	0.032
24	408	0.141**	0.064	0.078	0.079	0.068*	0.036
27	405	0.137**	0.069	0.082	0.085	0.061	0.038
30	402	0.136*	0.076	0.082	0.090	0.060	0.037
33	399	0.140*	0.084	0.085	0.097	0.062	0.043
36	396	0.138*	0.091	0.088	0.106	0.057	0.052
39	393	0.133	0.098	0.095	0.116	0.045	0.059
42	390	0.130	0.106	0.098	0.123	0.039	0.066
45	387	0.130	0.115	0.100	0.132	0.038	0.071
48	384	0.132	0.127	0.101	0.141	0.040	0.078
51	381	0.134	0.144	0.102	0.148	0.042	0.090
54	378	0.135	0.160	0.101	0.155	0.045	0.102
57	375	0.131	0.161	0.102	0.167	0.039	0.094
60	372	0.138	0.207	0.102	0.175	0.051	0.144

Note: For every month between 12/1965 and 09/2001 stocks are sorted on effective monthly returns over the past six months. Top 10% are included in the Winners portfolio, bottom 10% are in the Losers portfolio. The costless arbitrage portfolio buys Winners and shorts Losers. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorrelation consistent. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

quintiles based on their prices 12 months before the portfolio formation month. The results for the 6–month and 18–month lag are qualitatively similar. Longer lags result in lower informativeness of the price level, but shorter lags introduce a bias due to the fact that losers, by definition, tend to be priced lower than winners.

The sorting procedure is described in the second section, and the results are presented in Table 2. As seen in the table, momentum profits exhibit a statistically signficant inverted–U shape as a function of the stock price one year before portfolio formation. However, this observation may be just another manifestation of the capitalization effect studied in previous papers (e.g., DeBondt and Thaler [1987], Rouwenhorst [1998], Lee and Swaminathan [2000]). This is addressed in Tables 3 and 4.

Table 2. *Annualized Arbitrage Returns By One–Year Lagged Price Quintiles*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	0.098***	0.226***	–6.346	0.187***	1.902	0.175***	0.758	0.116***	3.145
		(0.009)	(0.007)	(0.000)	(0.006)	(0.058)	(0.008)	(0.449)	(0.008)	(0.002)
6	426	0.136***	0.223***	–6.120	0.227***	–0.318	0.204***	1.850	0.157***	3.672
		(0.015)	(0.011)	(0.000)	(0.011)	(0.751)	(0.012)	(0.065)	(0.013)	(0.000)
9	423	0.133***	0.203***	–5.339	0.212***	–0.843	0.205***	0.698	0.175***	2.642
		(0.021)	(0.013)	(0.000)	(0.015)	(0.400)	(0.016)	(0.486)	(0.019)	(0.009)
12	420	0.104***	0.177***	–3.529	0.180***	–0.214	0.183***	–0.417	0.157***	2.622
		(0.031)	(0.017)	(0.000)	(0.018)	(0.831)	(0.018)	(0.677)	(0.024)	(0.009)
15	417	0.061**	0.144***	–7.254	0.146***	–0.044	0.150***	–0.742	0.125***	2.871
		(0.027)	(0.019)	(0.000)	(0.022)	(0.965)	(0.021)	(0.458)	(0.028)	(0.004)
18	414	0.034	0.122***	–9.014	0.122***	0.145	0.127***	–0.919	0.103***	2.945
		(0.032)	(0.021)	(0.000)	(0.026)	(0.885)	(0.025)	(0.359)	(0.031)	(0.003)
21	411	0.015	0.109***	–6.878	0.111***	–0.037	0.114***	–0.704	0.094***	2.479
		(0.045)	(0.022)	(0.000)	(0.028)	(0.970)	(0.027)	(0.482)	(0.034)	(0.014)
24	408	0.014	0.097***	–8.324	0.098***	0.076	0.102***	–0.810	0.085**	2.200
		(0.050)	(0.026)	(0.000)	(0.029)	(0.939)	(0.030)	(0.419)	(0.033)	(0.028)
27	405	0.013	0.090***	–8.132	0.087***	0.481	0.091***	–0.590	0.072**	2.359
		(0.053)	(0.028)	(0.000)	(0.031)	(0.631)	(0.033)	(0.556)	(0.033)	(0.019)
30	402	0.023	0.088***	–6.890	0.083**	0.781	0.085**	–0.403	0.067*	2.432
		(0.053)	(0.031)	(0.000)	(0.035)	(0.435)	(0.036)	(0.687)	(0.036)	(0.015)
33	399	0.040	0.085**	–2.881	0.080**	0.935	0.083**	–0.545	0.067*	2.063
		(0.088)	(0.035)	(0.004)	(0.039)	(0.350)	(0.041)	(0.586)	(0.040)	(0.040)
36	396	0.034	0.079*	–2.595	0.072	1.024	0.075	–0.453	0.064	1.513
		(0.103)	(0.044)	(0.010)	(0.051)	(0.306)	(0.050)	(0.651)	(0.045)	(0.131)
39	393	0.002	0.059	–6.670	0.054	1.061	0.058	–0.264	0.050	1.392
		(0.074)	(0.045)	(0.000)	(0.059)	(0.289)	(0.050)	(0.792)	(0.049)	(0.165)
42	390	–0.006	0.068	–7.975	0.060	1.139	0.064	–0.554	0.048	1.966
		(0.084)	(0.056)	(0.000)	(0.076)	(0.255)	(0.069)	(0.580)	(0.064)	(0.050)
45	387	–0.005	0.064	–7.244	0.059	0.856	0.061	–0.372	0.039	2.234
		(0.090)	(0.064)	(0.000)	(0.087)	(0.393)	(0.082)	(0.710)	(0.070)	(0.026)
48	384	0.017	0.060	–2.198	0.058	0.455	0.059	–0.298	0.036	2.387
		(0.156)	(0.071)	(0.029)	(0.092)	(0.649)	(0.086)	(0.766)	(0.080)	(0.017)
51	381	0.034	0.057	–1.086	0.050	1.092	0.055	–0.636	0.029	2.312
		(0.228)	(0.067)	(0.278)	(0.094)	(0.275)	(0.093)	(0.525)	(0.094)	(0.021)
54	378	0.037	0.058	–1.041	0.044	1.937	0.056	–1.559	0.032	2.508
		(0.230)	(0.066)	(0.299)	(0.100)	(0.054)	(0.097)	(0.120)	(0.086)	(0.013)
57	375	0.024	0.057	–2.557	0.042	2.155	0.053	–1.379	0.032	2.063
		(0.177)	(0.070)	(0.011)	(0.107)	(0.032)	(0.105)	(0.169)	(0.092)	(0.040)
60	372	0.064	0.056	0.230	0.038	2.382	0.053	–1.671	0.031	2.131
		(0.391)	(0.078)	(0.818)	(0.114)	(0.018)	(0.117)	(0.096)	(0.097)	(0.034)

Note: For every month between 12/1965 and 09/2001 stocks are independently sorted on effective monthly returns over the past six months and on prices one year ago. Quintiles are formed on prices; Winner and Loser portfolios are formed on effective returns deciles. Returns of a costless arbitrage portfolio, which buys Winners and shorts Losers, are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorrelation consistent. Januaries are excluded. ***, **, * indicate significance at 1%, 5%, and 10% level, respectively.

Unlike the previously mentioned papers, we find a humped relation between momentum returns and capitalization as evident from Table 3. This is because all previous studies have measured capitalization at the time of portfolio formation, i.e., after it is known which stocks are losers and which are winners. Therefore, by the definition of being a loser, these stocks are more likely to be assigned lower capitalization ranks than winners are. This bias explains the finding by Lee and Swaminathan [2000] that winners are usually larger stocks with higher prices. We avoid this bias by ranking stocks on their capitalization not as of the returns–based ranking date, but as of the date that is in effect one year before returns ranking period (i.e., at the same time as the price rankings were performed for Table 2). That is, we rank stocks on their capitalizations before market values of losers have gone down and market values of winners have gone up. The result is the humped functional form in Table 3, which is similar to that observed with price sorts in Table 2.

To disentangle the price and capitalization effects, we form quintiles that differ only in their price levels and not capitalization, following the approach of Badrinath, Kale, and Noe [1995], as described in the

Table 3. *Annualized Arbitrage Returns By One–Year Lagged Capitalization Quintiles*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	t-test (p-val.)	HPR (SE)	t-test (p-val.)	HPR (SE)	t-test (p-val.)	HPR (SE)	t-test (p-val.)
3	429	0.090***	0.258***	–8.657	0.214***	2.421	0.157***	3.035	0.063***	1.482
		(0.009)	(0.008)	(0.000)	(0.008)	(0.016)	(0.008)	(0.003)	(0.010)	(0.139)
6	426	0.135***	0.239***	–7.104	0.227***	0.924	0.194***	2.605	0.126***	1.511
		(0.013)	(0.013)	(0.000)	(0.013)	(0.356)	(0.013)	(0.010)	(0.015)	(0.132)
9	423	0.131***	0.212***	–5.751	0.216***	–0.411	0.199***	1.643	0.144***	1.535
		(0.020)	(0.017)	(0.000)	(0.016)	(0.681)	(0.018)	(0.101)	(0.020)	(0.126)
12	420	0.099***	0.186***	–3.773	0.189***	–0.402	0.174***	1.740	0.139***	1.522
		(0.030)	(0.021)	(0.000)	(0.018)	(0.688)	(0.023)	(0.083)	(0.025)	(0.129)
15	417	0.058**	0.150***	–7.467	0.152***	–0.259	0.135***	2.178	0.116***	1.797
		(0.025)	(0.025)	(0.000)	(0.019)	(0.796)	(0.028)	(0.030)	(0.032)	(0.073)
18	414	0.040	0.113***	–7.317	0.130***	–2.401	0.115***	2.033	0.097***	1.807
		(0.030)	(0.030)	(0.000)	(0.020)	(0.017)	(0.031)	(0.043)	(0.036)	(0.071)
21	411	0.021	0.100***	–5.222	0.111***	–1.644	0.109***	0.306	0.088**	1.831
		(0.047)	(0.032)	(0.000)	(0.023)	(0.101)	(0.033)	(0.760)	(0.041)	(0.068)
24	408	0.027	0.085**	–6.242	0.092***	–0.950	0.097***	–0.789	0.081**	1.820
		(0.048)	(0.038)	(0.000)	(0.027)	(0.343)	(0.031)	(0.431)	(0.041)	(0.069)
27	405	0.026	0.077**	–5.474	0.083***	–0.990	0.085**	–0.196	0.070*	1.818
		(0.054)	(0.039)	(0.000)	(0.031)	(0.323)	(0.034)	(0.845)	(0.038)	(0.070)
30	402	0.031	0.077*	–4.953	0.078**	–0.095	0.077**	0.189	0.068	1.787
		(0.055)	(0.040)	(0.000)	(0.034)	(0.925)	(0.038)	(0.850)	(0.045)	(0.075)
33	399	0.048	0.076*	–1.715	0.075*	0.124	0.071*	0.561	0.068	1.754
		(0.094)	(0.039)	(0.087)	(0.040)	(0.901)	(0.042)	(0.575)	(0.046)	(0.080)
36	396	0.045	0.068	–1.222	0.071	–0.432	0.065	0.897	0.061	1.759
		(0.112)	(0.042)	(0.222)	(0.050)	(0.666)	(0.051)	(0.370)	(0.050)	(0.079)
39	393	0.014	0.047	–3.662	0.056	–1.072	0.048	1.620	0.051	1.741
		(0.078)	(0.048)	(0.000)	(0.052)	(0.284)	(0.052)	(0.106)	(0.054)	(0.082)
42	390	0.007	0.055	–4.460	0.062	–1.172	0.049	1.977	0.044	1.768
		(0.089)	(0.060)	(0.000)	(0.064)	(0.242)	(0.068)	(0.049)	(0.069)	(0.078)
45	387	0.010	0.049	–3.693	0.058	–1.228	0.050	1.249	0.033	1.884
		(0.093)	(0.067)	(0.000)	(0.073)	(0.220)	(0.076)	(0.212)	(0.076)	(0.060)
48	384	0.033	0.048	–0.753	0.056	–1.007	0.052	0.600	0.024	2.006
		(0.171)	(0.062)	(0.452)	(0.076)	(0.314)	(0.080)	(0.549)	(0.086)	(0.046)
51	381	0.051	0.046	0.202	0.054	–1.117	0.051	0.525	0.017	2.078
		(0.265)	(0.048)	(0.840)	(0.077)	(0.265)	(0.085)	(0.600)	(0.094)	(0.038)
54	378	0.053	0.047	0.265	0.054	–0.806	0.047	0.975	0.019	2.038
		(0.265)	(0.048)	(0.791)	(0.080)	(0.421)	(0.093)	(0.330)	(0.088)	(0.042)
57	375	0.034	0.049	–1.112	0.050	–0.120	0.045	0.809	0.022	2.227
		(0.198)	(0.061)	(0.267)	(0.084)	(0.905)	(0.101)	(0.419)	(0.089)	(0.027)
60	372	0.077	0.052	0.634	0.046	0.814	0.044	0.281	0.025	2.180
		(0.452)	(0.051)	(0.526)	(0.091)	(0.416)	(0.107)	(0.779)	(0.094)	(0.030)

Note: For every month between 12/1965 and 09/2001 stocks are independently sorted on effective monthly returns over the past six months and on capitalizations one year ago. Quintiles are formed on capitalizations; Winner and Loser portfolios are formed on effective returns deciles. Returns of a costless arbitrage portfolio, which buys Winners and shorts Losers, are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorrelation consistent. Januaries are excluded. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

second section. As seen from Table 4, controlling for capitalization does not eliminate the price effect: momentum profits are mostly an increasing function of the one–year lagged price level, especially for holding periods longer that 12 months. Most of the differences among quintiles are statistically significant.

The results in Table 4 indicate that one–year lagged price level contains some information, in excess of that conveyed by capitalization, that determines the magnitude and duration of significant momentum profits. If this were not so, we would expect to see no difference among the five quintiles. As a robustness check for this conclusion, we perform a similar analysis, but instead of sorting by capitalization and price, we sort by capitalization and a random number realization for each stock. The random sort resulted in no statistically or economically significant differences among the quintiles, and the specific tables are available from the authors.

As an additional test of the relation between capitalization and price effects, we sort into quintiles which differ only in capitalization and not in price (i.e., the reverse of Table 4). As shown in the comparison of Table 5 and 3, controlling for the price level results in a considerable weakening of the capitalization effect docu-

Table 4. *Annualized Arbitrage Returns By One–Year Lagged Price Quintiles Controlled For One–Year Lagged Capitalization*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	0.087***	0.142***	–2.821	0.179***	–1.973	0.211***	–1.994	0.185***	1.532
		(0.010)	(0.008)	(0.005)	(0.007)	(0.049)	(0.007)	(0.047)	(0.007)	(0.126)
6	426	0.116***	0.181***	–4.394	0.199***	–1.328	0.239***	–3.175	0.219***	1.509
		(0.015)	(0.012)	0.000	(0.012)	(0.185)	(0.010)	(0.002)	(0.011)	(0.132)
9	423	0.117***	0.177***	–3.830	0.193***	–1.260	0.229***	–3.360	0.209***	1.843
		(0.020)	(0.018)	0.000	(0.015)	(0.208)	(0.014)	(0.001)	(0.016)	(0.066)
12	420	0.108***	0.140***	–1.499	0.166***	–2.647	0.192***	–2.377	0.185***	0.648
		(0.032)	(0.018)	(0.135)	(0.019)		(0.018)	(0.018)	(0.019)	(0.517)
15	417	0.060**	0.108***	–4.333	0.138***	–3.182	0.154***	–1.776	0.158***	–0.381
		(0.030)	(0.021)	0.000	(0.024)	(0.002)	(0.022)	(0.076)	(0.023)	(0.703)
18	414	0.033	0.084***	–5.570	0.120***	–3.849	0.129***	–0.944	0.135***	–0.728
		(0.033)	(0.023)	0.000	(0.029)	0.000	(0.027)	(0.346)	(0.025)	(0.467)
21	411	0.020	0.065	–2.572	0.100***	–2.083	0.119***	–2.355	0.119***	–0.051
		(0.037)	(0.041)	(0.011)	(0.033)	(0.038)	(0.031)	(0.019)	(0.028)	(0.959)
24	408	0.008	0.064*	–5.818	0.085**	–2.250	0.109***	–2.937	0.107***	0.274
		(0.045)	(0.036)	0.000	(0.038)	(0.025)	(0.037)	(0.004)	(0.031)	(0.784)
27	405	0.010	0.055	–4.541	0.077*	–2.380	0.101**	–2.824	0.092***	1.215
		(0.047)	(0.040)	0.000	(0.042)	(0.018)	(0.041)	(0.005)	(0.032)	(0.225)
30	402	0.023	0.050	–2.735	0.074	–2.786	0.097**	–3.135	0.085***	1.604
		(0.046)	(0.039)	(0.007)	(0.046)	(0.006)	(0.046)	(0.002)	(0.030)	(0.110)
33	399	0.045	0.048	–0.154	0.072	–2.700	0.092*	–2.502	0.082**	1.295
		(0.091)	(0.041)	(0.877)	(0.054)	(0.007)	(0.053)	(0.013)	(0.033)	(0.196)
36	396	0.040	0.040	0.006	0.066	–2.942	0.083	–2.054	0.079*	0.428
		(0.108)	(0.042)	(0.996)	(0.064)	(0.003)	(0.067)	(0.041)	(0.042)	(0.669)
39	393	0.014	0.031	–1.468	0.056	–2.952	0.076	–2.757	0.071	0.640
		(0.077)	(0.052)	(0.143)	(0.071)	(0.003)	(0.075)	(0.006)	(0.051)	(0.523)
42	390	0.009	0.025	–1.608	0.046	–2.359	0.072	–3.000	0.064	0.956
		(0.075)	(0.062)	(0.109)	(0.086)	(0.019)	(0.083)	(0.003)	(0.060)	(0.340)
45	387	0.014	0.021	–0.840	0.042	–2.273	0.069	–2.876	0.057	1.332
		(0.078)	(0.070)	(0.401)	(0.096)	(0.024)	(0.089)	(0.004)	(0.070)	(0.184)
48	384	0.039	0.018	1.033	0.039	–2.330	0.065	–2.904	0.050	1.599
		(0.148)	(0.070)	(0.302)	(0.104)	(0.020)	(0.090)	(0.004)	(0.077)	(0.111)
51	381	0.062	0.013	1.868	0.035	–2.440	0.062	–3.079	0.040	2.067
		(0.250)	(0.062)	(0.063)	(0.100)	(0.015)	(0.100)	(0.002)	(0.082)	(0.039)
54	378	0.066	0.016	2.000	0.037	–2.459	0.059	–2.475	0.041	1.671
		(0.264)	(0.059)	(0.046)	(0.096)	(0.014)	(0.110)	(0.014)	(0.091)	(0.096)
57	375	0.046	0.020	1.723	0.037	–2.002	0.057	–2.158	0.038	1.831
		(0.181)	(0.073)	(0.086)	(0.099)	(0.046)	(0.126)	(0.032)	(0.090)	(0.068)
60	372	0.098	0.024	1.567	0.034	–1.179	0.057	–2.428	0.036	1.892
		(0.501)	(0.076)	(0.118)	(0.109)	(0.239)	(0.141)	(0.016)	(0.094)	(0.059)

Note: For every month between 12/1965 and 09/2001 stocks are independently grouped into deciles on past 6–month effective monthly returns and into quintiles on 1–year lagged capitalizations. Within each quintile, stocks are divided into sub–quintiles on 1–year lagged prices. Then, all sub–quintiles 1 are combined, all sub–quintiles 2 are combined, etc., to form the quintiles reported. Returns of a costless arbitrage portfolio (long in top returns decile and short in bottom decile), are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorrelation consistent. T–tests and p–values are for the paired test for significance from the previous quintile's HPR. Januaries are excluded. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

mented earlier. This again indicates that price and capitalization, although related, have distinct impacts on momentum returns.

Price vs. Volume and Unconditional Means

The previous section indicates that the price effect is not a mere manifestation of the capitalization effect. However, as Lee and Swaminathan [2000] show, momentum profits are positively correlated with trading volume (as measured by turnover), which is confirmed by our turnover–based sort results in Table 6. Therefore, it is possible that the price effect is simply picking up the trading volume result because trading volume and price are likely to be positively correlated. We, therefore, form quintiles that differ only in the price level and are equally dispersed in both capitalization and turnover. This procedure, described in the second section, yields price quintiles in which both volume and capitalization are controlled for. The predominantly significant positive relation between momentum returns and lagged

Table 5. *Annualized Arbitrage Returns By One–Year Lagged Capitalization Quintiles Controlled For One–Year Lagged Prices*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	0.095***	0.208***	-5.312	0.134***	3.063	0.187***	-2.487	0.159***	1.382
		(0.007)	(0.008)	(0.000)	(0.007)	(0.002)	(0.009)	(0.013)	(0.010)	(0.168)
6	426	0.147***	0.211***	-3.699	0.193***	1.306	0.194***	-0.032	0.173***	1.537
		(0.013)	(0.013)	(0.000)	(0.011)	(0.192)	(0.014)	(0.974)	(0.015)	(0.125)
9	423	0.152***	0.195***	-2.166	0.187***	0.685	0.191***	-0.325	0.169***	1.850
		(0.024)	(0.018)	(0.031)	(0.015)	(0.494)	(0.017)	(0.746)	(0.021)	(0.065)
12	420	0.131***	0.161***	-1.028	0.158***	0.323	0.169***	-1.149	0.148***	2.159
		(0.038)	(0.022)	(0.304)	(0.019)	(0.747)	(0.021)	(0.251)	(0.027)	(0.031)
15	417	0.077**	0.131***	-4.049	0.132***	-0.098	0.130***	0.216	0.111***	2.079
		(0.031)	(0.026)	(0.000)	(0.023)	(0.922)	(0.025)	(0.829)	(0.031)	(0.038)
18	414	0.054	0.108***	-4.776	0.110***	-0.208	0.103***	0.880	0.089**	1.699
		(0.035)	(0.031)	(0.000)	(0.024)	(0.835)	(0.028)	(0.379)	(0.035)	(0.090)
21	411	0.041	0.075	-1.535	0.099***	-1.206	0.089**	1.352	0.079**	1.358
		(0.041)	(0.054)	(0.126)	(0.029)	(0.229)	(0.030)	(0.177)	(0.039)	(0.175)
24	408	0.031	0.074*	-4.045	0.086***	-1.468	0.078	1.161	0.065	1.670
		(0.049)	(0.040)	(0.000)	(0.033)	(0.143)	(0.036)	(0.247)	(0.042)	(0.096)
27	405	0.031	0.064	-3.538	0.077**	-1.630	0.066	1.440	0.060	0.723
		(0.052)	(0.040)	(0.000)	(0.038)	(0.104)	(0.042)	(0.151)	(0.042)	(0.470)
30	402	0.040	0.064	-2.446	0.067	-0.452	0.062	0.735	0.061	0.083
		(0.050)	(0.040)	(0.015)	(0.043)	(0.651)	(0.042)	(0.463)	(0.042)	(0.934)
33	399	0.054	0.071	-0.996	0.062	0.879	0.058	0.447	0.057	0.212
		(0.077)	(0.046)	(0.320)	(0.046)	(0.380)	(0.045)	(0.655)	(0.044)	(0.832)
36	396	0.057	0.064	-0.392	0.053	1.279	0.051	0.298	0.048	0.458
		(0.100)	(0.045)	(0.695)	(0.059)	(0.202)	(0.054)	(0.766)	(0.052)	(0.647)
39	393	0.033	0.057	-2.480	0.045	1.530	0.041	0.544	0.038	0.300
		(0.085)	(0.052)	(0.014)	(0.068)	(0.127)	(0.068)	(0.587)	(0.061)	(0.764)
42	390	0.025	0.048	-2.518	0.039	1.054	0.041	-0.335	0.030	1.462
		(0.085)	(0.067)	(0.012)	(0.078)	(0.292)	(0.072)	(0.737)	(0.070)	(0.144)
45	387	0.025	0.046	-2.173	0.036	1.169	0.040	-0.448	0.029	1.438
		(0.084)	(0.074)	(0.030)	(0.086)	(0.243)	(0.078)	(0.654)	(0.074)	(0.151)
48	384	0.047	0.046	0.057	0.033	1.344	0.036	-0.244	0.028	1.018
		(0.152)	(0.065)	(0.955)	(0.095)	(0.180)	(0.084)	(0.808)	(0.077)	(0.309)
51	381	0.067	0.042	0.953	0.027	1.583	0.035	-0.939	0.025	1.326
		(0.264)	(0.046)	(0.341)	(0.101)	(0.114)	(0.082)	(0.348)	(0.081)	(0.186)
54	378	0.076	0.046	1.135	0.024	2.449	0.038	-1.659	0.024	1.945
		(0.299)	(0.045)	(0.257)	(0.099)	(0.015)	(0.085)	(0.098)	(0.084)	(0.053)
57	375	0.051	0.042	0.554	0.024	2.166	0.044	-2.436	0.023	2.803
		(0.209)	(0.062)	(0.580)	(0.104)	(0.031)	(0.093)	(0.015)	(0.090)	(0.005)
60	372	0.110	0.039	1.271	0.026	1.439	0.047	-2.533	0.027	2.707
		(0.607)	(0.047)	(0.205)	(0.112)	(0.151)	(0.104)	(0.012)	(0.090)	(0.007)

Note: For every month between 12/1965 and 09/2001 stocks are independently grouped into deciles on past 6–month effective monthly returns and into quintiles on 1–year lagged prices. Within each quintile, stocks are divided into sub–quintiles on 1–year lagged capitalizations. Then, all sub–quintiles 1 are combined, all sub–quintiles 2 are combined, etc., to form the quintiles reported. Returns of a costless arbitrage portfolio (long in top returns decile and short in bottom decile), are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorrelation consistent. T–tests and p–values are for the paired test for significance from the previous quintile's HPR. Januaries are excluded. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

prices remains robust even after both volume and capitalization are controlled for, as seen from Table 7.

It is possible those higher–priced stocks are characterized by a greater cross-sectional dispersion in expected returns, and that the price effect simply captures the differences in means. To test this, we compute the results in Table 8. The procedure is analogous to that employed for Table 7, except that instead of volume we use the average monthly return over a stock's entire life. As evident from Table 8, the significant positive relation between momentum returns and lagged stock prices endures (and becomes slightly stronger).

Furthermore, consistent with Grundy and Martin [2001] and Chordia and Shivakumar [2002] and contrary to Moskowitz and Grinblatt [1999], industry adjustments result in a trivial impact (tables available). Also, the inclusion of NASDAQ stocks and January returns in the sample, altering the treatment of missing values, and using alternative lags for the Newey–West statistic does not affect our main conclusions, as seen in Table 9. It appears, therefore, that the pre–formation

Table 6. *Annualized Arbitrage Returns by Past–year Volume Quintiles*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	0.054***	0.115***	–1.883	0.143***	–1.216	0.182***	–1.963	0.224***	–2.028
		(0.009)	(0.010)	(0.060)	(0.010)	(0.225)	(0.008)	(0.050)	(0.008)	(0.043)
6	426	0.126***	0.151***	–1.204	0.186***	–1.908	0.214***	–1.607	0.223***	–0.682
		(0.016)	(0.018)	(0.229)	(0.018)	(0.057)	(0.010)	(0.109)	(0.012)	(0.496)
9	423	0.141***	0.169***	–0.798	0.172***	–0.126	0.206***	–2.148	0.205***	0.077
		(0.026)	(0.034)	(0.425)	(0.027)	(0.899)	(0.012)	(0.032)	(0.015)	(0.939)
12	420	0.183**	0.116***	–0.678	0.147***	–2.301	0.183***	–2.71	0.17***	1.296
		(0.077)	(0.025)	(0.498)	(0.034)	(0.022)	(0.016)	(0.007)	(0.016)	(0.196)
15	417	0.102**	0.084***	–1.336	0.116*	–2.636	0.15***	–3.22	0.133***	2.181
		(0.044)	(0.029)	(0.182)	(0.039)	(0.009)	(0.018)	(0.001)	(0.020)	(0.030)
18	414	0.076**	0.058*	–1.659	0.09	–2.654	0.127***	–3.609	0.108***	2.399
		(0.037)	(0.034)	(0.098)	(0.046)	(0.008)	(0.020)	0.000	(0.023)	(0.017)
21	411	0.022	0.051	–1.832	0.078	–2.516	0.111***	–3.409	0.096***	2.037
		(0.078)	(0.039)	(0.068)	(0.051)	(0.012)	(0.023)	(0.001)	(0.025)	(0.042)
24	408	0.039	0.045	–2.034	0.068	–2.159	0.095***	–2.812	0.079***	2.058
		(0.060)	(0.046)	(0.043)	(0.059)	(0.032)	(0.026)	(0.005)	(0.027)	(0.040)
27	405	0.043	0.039	–1.987	0.06	–2.191	0.083***	–2.251	0.068**	2.011
		(0.058)	(0.051)	(0.048)	(0.062)	(0.029)	(0.028)	(0.025)	(0.029)	(0.045)
30	402	0.052	0.041	–1.947	0.058	–1.869	0.075**	–1.869	0.065**	1.571
		(0.060)	(0.051)	(0.052)	(0.060)	(0.062)	(0.031)	(0.062)	(0.031)	(0.117)
33	399	0.082	0.039	–1.735	0.056	–1.693	0.073*	–1.956	0.062*	1.771
		(0.120)	(0.051)	(0.084)	(0.061)	(0.091)	(0.038)	(0.051)	(0.034)	(0.077)
36	396	0.072	0.037	–2.025	0.051	–1.394	0.069	–2.095	0.059	1.532
		(0.130)	(0.066)	(0.044)	(0.061)	(0.164)	(0.049)	(0.037)	(0.040)	(0.126)
39	393	0.04	0.029	–2.394	0.045	–1.496	0.064	–2.299	0.052	1.858
		(0.088)	(0.080)	(0.017)	(0.061)	(0.135)	(0.059)	(0.022)	(0.048)	(0.064)
42	390	0.028	0.021	–2.421	0.044	–2.112	0.06	–1.999	0.047	2.108
		(0.088)	(0.090)	(0.016)	(0.065)	(0.035)	(0.068)	(0.046)	(0.054)	(0.036)
45	387	0.024	0.026	–2.468	0.042	–1.439	0.057	–1.858	0.043	2.214
		(0.092)	(0.102)	(0.014)	(0.073)	(0.151)	(0.074)	(0.064)	(0.061)	(0.027)
48	384	0.023	0.06	–2.674	0.04	0.723	0.055	–1.743	0.039	2.563
		(0.099)	(0.199)	(0.008)	(0.059)	(0.470)	(0.082)	(0.082)	(0.063)	(0.011)
51	381	0.058	0.065	–2.394	0.041	0.715	0.05	–1.035	0.034	2.516
		(0.206)	(0.242)	(0.017)	(0.040)	(0.475)	(0.086)	(0.301)	(0.069)	(0.012)
54	378	0.103	0.043	–1.771	0.04	0.177	0.047	–0.818	0.034	2.004
		(0.435)	(0.128)	(0.077)	(0.067)	(0.860)	(0.094)	(0.414)	(0.069)	(0.046)
57	375	0.061	0.034	–2.409	0.04	–0.486	0.046	–0.691	0.037	1.298
		(0.231)	(0.123)	(0.017)	(0.082)	(0.627)	(0.106)	(0.490)	(0.072)	(0.195)
60	372	0.126	0.028	–1.511	0.039	–1.059	0.047	–0.96	0.038	1.342
		(0.653)	(0.130)	(0.132)	(0.093)	(0.290)	(0.116)	(0.338)	(0.083)	(0.180)

Note: For every month between 12/1965 and 09/2001 stocks are independently sorted on effective monthly returns over the past six months and on average turnover over the past year. Quintiles are formed on turnover; Winner and Loser portfolios are formed on effective returns deciles. Returns of a costless arbitrage portfolio, which buys Winners and shorts Losers, are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorrelation consistent. Januaries are excluded. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

price level has its own impact on the magnitude and duration of momentum profits, independent of capitalization, volume, unconditional means, and industry effects. The next section examines implications of our results, and specifically the price effect, for various behavioral and risk–based theories of momentum.

Implications

In this section, we discuss how the observed ex ante price effect is related to some behavioral and risk–based explanations of momentum that have appeared in the literature. Because none of those explanations has an explicit role for the price effect, we do not directly test any hypotheses related to those theories. Instead, we discuss the possible indirect relation between the observed price effect and implications of those theories of momentum.

Consistent with the previous empirical and theoretical literature on momentum and reversal, (e.g., DeBondt and Thaler [1985], DeBondt and Thaler [1987], Jegadeesh and Titman [1993], Chan, Jegadeesh, and Lakonishok [1996], Rouwenhorst

Table 7. *Annualized Arbitrage Returns By One–Year Lagged Price Quintiles Controlled For One–Year Lagged Capitalization And Past–Year Volume*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	0.079***	0.158***	–3.969	0.176***	–0.902	0.213***	–2.285	0.18***	1.776
		(0.010)	(0.009)	(0.000)	(0.007)	(0.368)	(0.006)	(0.023)	(0.007)	(0.076)
6	426	0.116***	0.181***	–4.452	0.203***	–1.669	0.233***	–2.442	0.215***	1.328
		(0.015)	(0.013)	(0.000)	(0.011)	(0.096)	(0.010)	(0.015)	(0.011)	(0.185)
9	423	0.126***	0.168***	–2.939	0.195***	–2.152	0.222***	–2.374	0.208***	1.225
		(0.020)	(0.018)	(0.003)	(0.014)	(0.032)	(0.014)	(0.018)	(0.015)	(0.221)
12	420	0.113***	0.136***	–1.11	0.167***	–3.113	0.189***	–2.242	0.184***	0.461
		(0.031)	(0.021)	(0.267)	(0.018)	(0.002)	(0.018)	(0.026)	(0.019)	(0.645)
15	417	0.063**	0.107***	–4.016	0.139***	–3.46	0.15***	–1.335	0.154***	–0.366
		(0.028)	(0.025)	(0.000)	(0.021)	(0.001)	(0.022)	(0.182)	(0.023)	(0.715)
18	414	0.036	0.083***	–5.112	0.119***	–4.069	0.128***	–1.103	0.132***	–0.423
		(0.032)	(0.027)	(0.000)	(0.026)	(0.000)	(0.028)	(0.271)	(0.024)	(0.672)
21	411	0.024	0.062	–1.949	0.099***	–1.999	0.118***	–2.398	0.115***	0.464
		(0.036)	(0.044)	(0.052)	(0.032)	(0.046)	(0.031)	(0.017)	(0.027)	(0.643)
24	408	0.009	0.066*	–6.121	0.084**	–2.131	0.107***	–2.983	0.104***	0.404
		(0.045)	(0.034)	(0.000)	(0.039)	(0.034)	(0.035)	(0.003)	(0.030)	(0.686)
27	405	0.01	0.059	–5.165	0.074*	–1.663	0.100***	–3.254	0.091***	1.117
		(0.046)	(0.040)	(0.000)	(0.043)	(0.097)	(0.039)	(0.001)	(0.031)	(0.265)
30	402	0.018	0.056	–3.694	0.072	–1.693	0.096**	–3.42	0.085***	1.42
		(0.042)	(0.045)	(0.000)	(0.046)	(0.091)	(0.044)	(0.001)	(0.030)	(0.156)
33	399	0.027	0.065	–2.039	0.07	–0.391	0.093*	–3.154	0.081**	1.47
		(0.048)	(0.071)	(0.042)	(0.050)	(0.696)	(0.051)	(0.002)	(0.034)	(0.142)
36	396	0.012	0.067	–2.641	0.065	0.079	0.084	–2.489	0.080*	0.499
		(0.053)	(0.102)	(0.009)	(0.059)	(0.937)	(0.065)	(0.013)	(0.043)	(0.618)
39	393	0.005	0.037	–3.048	0.056	–1.979	0.077	–2.924	0.072	0.666
		(0.066)	(0.065)	(0.002)	(0.066)	(0.049)	(0.075)	(0.004)	(0.053)	(0.506)
42	390	0.009	0.021	–1.344	0.049	–3.055	0.073	–3.028	0.063	1.209
		(0.072)	(0.071)	(0.180)	(0.075)	(0.002)	(0.086)	(0.003)	(0.060)	(0.228)
45	387	0.017	0.017	–0.07	0.043	–2.971	0.069	–3.092	0.057	1.417
		(0.078)	(0.073)	(0.944)	(0.088)	(0.003)	(0.091)	(0.002)	(0.070)	(0.157)
48	384	0.042	0.013	1.461	0.041	–3.362	0.066	–2.932	0.049	1.744
		(0.145)	(0.071)	(0.145)	(0.094)	(0.001)	(0.095)	(0.004)	(0.076)	(0.082)
51	381	0.065	0.01	2.053	0.037	–3.285	0.061	–2.865	0.042	1.81
		(0.252)	(0.062)	(0.041)	(0.091)	(0.001)	(0.101)	(0.004)	(0.084)	(0.071)
54	378	0.067	0.015	2.122	0.036	–2.532	0.058	–2.532	0.043	1.499
		(0.263)	(0.058)	(0.035)	(0.096)	(0.012)	(0.107)	(0.012)	(0.091)	(0.135)
57	375	0.048	0.019	1.948	0.036	–2.106	0.055	–2.327	0.042	1.395
		(0.181)	(0.067)	(0.052)	(0.104)	(0.036)	(0.116)	(0.021)	(0.089)	(0.164)
60	372	0.093	0.024	1.636	0.035	–1.421	0.054	–2.126	0.04	1.365
		(0.464)	(0.068)	(0.103)	(0.116)	(0.156)	(0.132)	(0.034)	(0.090)	(0.173)

Note: For every month between 12/1965 and 09/2001 stocks are independently grouped into deciles on past 6-month effective monthly returns and into independent quintiles on 1–year lagged capitalizations and on past–year turnover. Within each of the 25 portfolios, 1-year lagged price sub–quintiles are formed. Then, all sub-quintiles 1 are combined, all sub–quintiles 2 are combined, etc., to form the quintiles reported. Returns of a costless arbitrage portfolio (long in top returns decile and short in bottom decile), are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorr. consistent. T-tests and p-values are for the paired test for significance from the previous quintile's HPR. Januaries are excluded. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

[1998], Daniel, Hirshleifer, and Subrahmanyam [1998], Barberis, Shleifer, and Vishny [1998], Hong and Stein [1999], Hong, Lim, and Stein [2000], Jegadeesh and Titman [2001], Jegadeesh and Titman [2002]), we find momentum in the short–run and reversal in the long–run. Although reversal is strong in the earlier samples (DeBondt and Thaler [1985], DeBondt and Thaler [1987]), our initial evidence of reversal is weak, consistent with the more recent studies in Chan, Jegadeesh, and Lakonishok [1996], Rouwenhorst [1998], and Jegadeesh and Titman [2001].[6] Also consistent with the previous literature, most of the reversal is driven by the loser stocks. In our initial results, reversal occurs between the first and the third post–ranking years. Specifically, momentum profits begin declining after the 12th month and become (and remain) negative after the 36th month. These time frames are consistent with those suggested by the Hong and Stein [1999] model. In several papers (e.g., DeBondt and Thaler [1985],

Table 8. *Annualized Arbitrage Returns By One–Year Lagged Price Quintiles Controlled For One–Year Lagged Capitalization And Unconditional Mean*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	0.066***	0.125***	–2.868	0.191***	–3.184	0.236***	–2.351	0.242***	–0.332
		(0.010)	(0.008)	(0.004)	(0.008)	(0.002)	(0.007)	(0.019)	(0.008)	(0.740)
6	426	0.104***	0.157***	–3.417	0.220***	–3.936	0.247***	–1.99	0.265***	–1.349
		(0.015)	(0.012)	(0.001)	(0.013)	(0.000)	(0.012)	(0.047)	(0.012)	(0.178)
9	423	0.105***	0.16***	–3.683	0.205***	–2.815	0.231***	–2.093	0.250***	–1.811
		(0.021)	(0.018)	(0.000)	(0.016)	(0.005)	(0.015)	(0.037)	(0.016)	(0.071)
12	420	0.083***	0.149***	–3.205	0.160***	–0.561	0.200***	–3.833	0.218***	–1.837
		(0.026)	(0.027)	(0.001)	(0.019)	(0.575)	(0.019)	(0.000)	(0.020)	(0.067)
15	417	0.054*	0.105***	–4.564	0.128***	–2.018	0.163***	–3.804	0.184***	–2.406
		(0.029)	(0.023)	(0.000)	(0.024)	(0.044)	(0.022)	(0.000)	(0.025)	(0.017)
18	414	0.032	0.082***	–5.733	0.105***	–2.519	0.136***	–3.588	0.160***	–3.06
		(0.032)	(0.025)	(0.000)	(0.029)	(0.012)	(0.023)	(0.000)	(0.028)	(0.002)
21	411	0.024	0.057	–1.804	0.093***	–1.963	0.118***	–3.203	0.145***	–3.726
		(0.038)	(0.044)	(0.072)	(0.033)	(0.050)	(0.028)	(0.001)	(0.030)	0.000
24	408	0.01	0.061	–5.458	0.078**	–1.923	0.107***	–3.956	0.129***	–3.23
		(0.047)	(0.037)	(0.000)	(0.037)	(0.055)	(0.032)	(0.000)	(0.033)	(0.001)
27	405	0.009	0.055	–4.853	0.072*	–2.008	0.098***	–3.313	0.112***	–2.021
		(0.049)	(0.042)	(0.000)	(0.039)	(0.045)	(0.037)	(0.001)	(0.032)	(0.044)
30	402	0.015	0.056	–3.889	0.069	–1.301	0.096**	–3.705	0.103***	–1.069
		(0.044)	(0.047)	(0.000)	(0.043)	(0.194)	(0.042)	(0.000)	(0.030)	(0.286)
33	399	0.026	0.065	–2.063	0.065	–0.051	0.094**	–3.895	0.098***	–0.607
		(0.053)	(0.069)	(0.040)	(0.048)	(0.959)	(0.048)	(0.000)	(0.034)	(0.544)
36	396	0.02	0.059	–1.935	0.062	–0.162	0.086	–3.331	0.095**	–1.249
		(0.062)	(0.076)	(0.054)	(0.060)	(0.871)	(0.061)	(0.001)	(0.041)	(0.212)
39	393	0.004	0.038	–2.977	0.053	–1.677	0.077	–3.37	0.087*	–1.289
		(0.067)	(0.066)	(0.003)	(0.070)	(0.094)	(0.070)	(0.001)	(0.048)	(0.198)
42	390	0.001	0.03	–3.116	0.044	–1.586	0.072	–3.397	0.079	–0.832
		(0.074)	(0.072)	(0.002)	(0.085)	(0.114)	(0.076)	(0.001)	(0.053)	(0.406)
45	387	0.006	0.025	–2.038	0.047	–2.795	0.062	–1.811	0.071	–0.915
		(0.076)	(0.081)	(0.042)	(0.089)	(0.005)	(0.087)	(0.071)	(0.061)	(0.361)
48	384	0.026	0.027	–0.094	0.043	–1.777	0.059	–2.079	0.063	–0.404
		(0.127)	(0.082)	(0.925)	(0.095)	(0.076)	(0.091)	(0.038)	(0.068)	(0.687)
51	381	0.041	0.027	0.596	0.039	–1.401	0.057	–2.205	0.054	0.297
		(0.195)	(0.075)	(0.551)	(0.095)	(0.162)	(0.098)	(0.028)	(0.072)	(0.766)
54	378	0.042	0.03	0.552	0.042	–1.206	0.053	–1.187	0.055	–0.176
		(0.195)	(0.078)	(0.581)	(0.093)	(0.229)	(0.112)	(0.236)	(0.078)	(0.860)
57	375	0.029	0.028	0.134	0.04	–1.66	0.055	–1.747	0.052	0.28
		(0.147)	(0.087)	(0.893)	(0.099)	(0.098)	(0.119)	(0.082)	(0.080)	(0.779)
60	372	0.076	0.031	1.105	0.037	–0.799	0.058	–2.453	0.049	0.874
		(0.409)	(0.093)	(0.270)	(0.107)	(0.425)	(0.133)	(0.015)	(0.084)	(0.382)

Note: For every month between 12/1965 and 09/2001 stocks are independently grouped into deciles on past 6-month effective monthly returns and into independent quintiles on 1-year lagged capitaliz. and on uncondit. mean monthly returns (over entire life of a stock). Within each of the 25 portfolios, 1-year lagged price sub-quintiles are formed. Then all sub-quintiles are combined to form the quintiles reported. Returns of a costless portfolio (long in top returns decile and short in bottom decile) are reported. Holding period returns (HPR) are the averages over all observations. The Newey–West (1987) standard errors (SE) are autocorr. consistent. T-tests and p-values are for the paired test for significance from the previous quintile's HPR. Jan. excluded. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

DeBondt and Thaler [1987], Jegadeesh and Titman [1993], Conrad and Kaul [1993], Grundy and Martin [2001]) the January seasonal is shown to be responsible for most of the reversal effect. We find abnormally positive statistically and economically significant January return for both the winner (4%) and loser (5.8%) portfolios. There is also some evidence of abnormal positive performance in June, July, November, and December (not reported, but available). When we eliminate Januaries, momentum profits become strictly positive over the entire 5–year holding period, which results from the weakening of reversal in the losers portfolio. Thus, the January effect with its tax–based interpretations appears to be responsible for a great portion of reversal. At the same time, reversal is not completely explained by the January effect. January–adjusted momentum profits become significantly lower after the first holding year and eventually drop to economically insignificant levels. This subsequent correction in momentum returns is

Table 9. *Annualized Arbitrage Returns By One–Year Lagged Price Quintiles Controlled For One–Year Lagged Capitalization And Past Year Volume Under Alternative Assumptions*

			Quintile 2		Quintile 3		Quintile 4		Quintile 5	
HP	Sample	Quintile 1 HPR (SE)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)	HPR (SE)	*t*-test (*p*-val.)
3	429	–0.045	0.038***	–5.323	0.098***	–3.985	0.173***	–5.186	0.175***	–0.158
		(0.009)	(0.008)	(0.000)	(0.008)	(0.000)	(0.007)	(0.000)	(0.008)	(0.874)
6	426	–0.01	0.074***	–6.299	0.125***	–4.123	0.187***	–5.458	0.203***	–1.38
		(0.014)	(0.013)	(0.000)	(0.012)	(0.000)	(0.010)	(0.000)	(0.011)	(0.168)
9	423	0.024	0.081***	–4.919	0.137***	–4.67	0.178***	–3.985	0.196***	–1.781
		(0.018)	(0.018)	(0.000)	(0.017)	(0.000)	(0.014)	(0.000)	(0.015)	(0.076)
12	420	0.007	0.059**	–4.877	0.107***	–4.464	0.143***	–3.97	0.172***	–3.017
		(0.022)	(0.023)	(0.000)	(0.019)	(0.000)	(0.016)	(0.000)	(0.018)	(0.003)
15	417	–0.031	0.012	–4.067	0.061**	–4.568	0.086***	–2.884	0.13***	–4.462
		(0.029)	(0.030)	(0.000)	(0.024)	(0.000)	(0.022)	(0.004)	(0.022)	0.000
18	414	–0.052	–0.013	–3.967	0.031	–4.3	0.057**	–2.868	0.092***	–3.764
		(0.035)	(0.033)	(0.000)	(0.028)	(0.000)	(0.025)	(0.004)	(0.025)	0.000
21	411	–0.048	–0.021	–2.746	0.013	–3.453	0.047	–3.921	0.075***	–3.116
		(0.036)	(0.036)	(0.006)	(0.031)	(0.001)	(0.029)	(0.000)	(0.029)	(0.002)
24	408	–0.061	–0.031	–2.608	–0.005	–2.753	0.041	–5.112	0.067**	–3.22
		(0.044)	(0.043)	(0.009)	(0.037)	(0.006)	(0.033)	(0.000)	(0.033)	(0.001)
27	405	–0.07	–0.033	–3.129	–0.011	–2.39	0.027	–4.518	0.055	–3.427
		(0.051)	(0.047)	(0.002)	(0.040)	(0.017)	(0.038)	(0.000)	(0.036)	(0.001)
30	402	–0.068	–0.035	–2.928	–0.014	–2.229	0.018	–3.91	0.045	–3.223
		(0.049)	(0.048)	(0.004)	(0.045)	(0.026)	(0.041)	(0.000)	(0.040)	(0.001)
33	399	–0.063	–0.032	–2.32	–0.018	–1.121	0.021	–4.601	0.038	–2.007
		(0.048)	(0.063)	(0.021)	(0.052)	(0.263)	(0.045)	(0.000)	(0.045)	(0.045)
36	396	–0.061	–0.045	–1.417	–0.018	–2.668	0.018	–4.15	0.043	–2.883
		(0.051)	(0.063)	(0.157)	(0.060)	(0.008)	(0.052)	(0.000)	(0.049)	(0.004)
39	393	–0.069	–0.052	–1.464	–0.023	–2.834	0.011	–3.755	0.036	–2.713
		(0.055)	(0.067)	(0.144)	(0.064)	(0.005)	(0.059)	(0.000)	(0.057)	(0.007)
42	390	–0.07	–0.058	–1.044	–0.021	–3.596	0.008	–3.159	0.031	–2.711
		(0.055)	(0.073)	(0.297)	(0.066)	(0.000)	(0.064)	(0.002)	(0.061)	(0.007)
45	387	–0.078	–0.059	–1.068	–0.026	–3.177	0.009	–3.858	0.031	–2.57
		(0.072)	(0.075)	(0.286)	(0.072)	(0.002)	(0.067)	(0.000)	(0.067)	(0.011)
48	384	–0.066	–0.059	–0.444	–0.026	–2.86	0.006	–3.481	0.027	–2.328
		(0.063)	(0.078)	(0.658)	(0.076)	(0.004)	(0.072)	(0.001)	(0.073)	(0.021)
51	381	–0.057	–0.051	–0.374	–0.033	–1.443	–0.001	–3.192	0.023	–2.496
		(0.069)	(0.088)	(0.708)	(0.079)	(0.150)	(0.080)	(0.002)	(0.078)	(0.013)
54	378	–0.058	–0.044	–1.003	–0.035	–0.687	–0.001	–3.363	0.02	–2.128
		(0.068)	(0.099)	(0.316)	(0.085)	(0.493)	(0.084)	(0.001)	(0.084)	(0.034)
57	375	–0.056	–0.047	–0.665	–0.036	–1.022	–0.005	–2.923	0.019	–2.37
		(0.075)	(0.100)	(0.507)	(0.094)	(0.307)	(0.091)	(0.004)	(0.092)	(0.018)
60	372	–0.054	–0.049	–0.384	–0.037	–1.076	–0.004	–2.978	0.017	–1.979
		(0.080)	(0.104)	(0.701)	(0.102)	(0.283)	(0.099)	(0.003)	(0.091)	(0.049)

Note: This table is constructed analogously to Table 7, but under alternative assumptions. The purpose is to test the sensitivity of the main results to those assumptions. The differences in assumptions are as follows. Unlike in Table 7, the sample here also includes Nasdaq stocks, as well as the month of January. Furthermore, if a stock has a missing return during a holding period, it is liquidated and the proceeds are equally distributed among the remaining stocks in the portfolio. Also, the Newey–West standard errors are computed using the lag of 5. Tables illustrating the individual effects of each of these adjustments are available on request. The remaining notes are as in Table 7. For every month between 12/1965 and 09/2001 stocks are independently grouped into deciles on past 6-month effective monthly returns and into independent quintiles on 1-year lagged capitalizations and on past year turnover. Within each of the 25 portfolios, 1-year lagged price sub-quintiles are formed. Then, all sub-quintiles 1 are combined, all sub-quintiles 2 are combined, etc., to form the quintiles reported. Returns of a costless arbitrage portfolio (long in top returns decile and short in bottom decile), are reported. Holding period returns (HPR) are computed by averaging over all observations. The Newey–West (1987) standard errors (SE) are autocorr. consistent. T-tests and p-values are for the paired test for significance from the previous quintile's HPR. ***, **, * indicate significance at 1%, 5%, and 10% level respectively.

consistent with the notion of over– and under–reaction, present in most behavioral models (e.g., Barberis, Shleifer, and Vishny [1998], Daniel, Hirshleifer, and Subrahmanyam [1998] and Hong and Stein [1999].) At the same time, reversal is inconsistent with some risk–based explanations that require constant loadings on various risk factors and, therefore, constant unconditional means. For example reversal is inconsistent with the explanation by Conrad and Kaul [1998], in which momentum is observed because stocks with high unconditional means tend to be classified as winners and low–mean stocks

are classified as losers, which implies that momentum simply captures the difference in (constant) unconditional means.

On the other hand, the observed behavior of January–adjusted momentum returns is consistent with the risk–based partial equilibrium model in Berk, Green, and Naik [1999]. In this model, a firm's optimal investment leads to predictable changes in its assets, investment options, and as a result in systematic risk and expected returns. Specifically, a firm's accepting (rejecting) an investment opportunity with low systematic risk, results in the increase (decrease) of its value and decrease (increase) in its risk, which reduces (increases) future expected return. The result is that future expected returns are positively related to past expected returns because asset composition, interest rates, and therefore systematic risk are persistent. This persistence produces the evidence of momentum in medium–term. At longer time horizons, asset composition changes and momentum profits asymptotically decrease to zero.

We analyze a factor that has not been explicitly considered in the momentum/reversal literature, namely the stock price. None of theories proposed in literature (behavioral or risk–based) offers an explicit explanation for the fact that when capitalization and trading volume are controlled for, the momentum effect is much stronger and longer–lived for arbitrage portfolios consisting of higher–priced winners and losers. This effect occurs when stocks are ranked based on prices that are in effect one year before the portfolio formation month, that is before it is known which of the stocks will become winners or losers.

One of the reasons the price effect is important is the discreteness of price movements (and returns) imposed by the minimum tick size. To become a winner (loser) based on returns, a low–priced stock needs to realize fewer upticks (downticks) than a high–priced stock does. Furthermore, it takes fewer upticks (downticks) for a low–priced loser (winner) to be erroneously classified as a winner (loser). Therefore, if the returns on winners and losers can be predicted based on past 6–month returns (as shown in all empirical momentum literature), we would expect to see less significant momentum returns in low–priced arbitrage portfolios. This is what we observe. Momentum profits for low–priced arbitrage portfolios are statistically significant for the first 12–15 months and positive but insignificant thereafter. In contrast, the arbitrage portfolio formed of the highest–priced stocks produces economically and statistically significant returns for the first three years.

The price effect we observe has some implications for the behavioral model of Hong and Stein [1999], in which various investors trade based on various information sets (since information may not be free and have the same interpretation). Trend–chasers, or momentum traders (or technical traders) act only based on past price performance. News–watchers (fundamental investors) trade based on news regarding firm fundamentals. When news arrives, the news is not spread immediately, but with a delay. Gradual information dissemination results in the initial underreaction by the news–watchers, which creates the evidence of momentum. This evidence is observed by the momentum traders who start trading based on this information and accelerate the momentum. Stronger momentum attracts more momentum traders, eventually resulting in overreaction that subsequently is corrected. One of the implications of their model is that momentum should last longer in stocks for which the holding period of momentum traders is longer, for example stocks with higher transaction costs. Because the proportional bid–ask spread is larger for lower–priced stocks, as numerous microstructure studies have shown, we would expect the momentum to dissipate later for these stocks. However, we find a diametrically opposite result: momentum profits become insignificant after the first 15 months for stocks in the lowest price quintile and they remain positive and significant during the first three years for the stocks in the higher price quintile.

Furthermore, stock price level is likely to be positively correlated with liquidity because proportional transaction costs are higher for low–priced stocks. [7] Interpreted this way, the price effect we find is at odds with the model of Hong and Stein [1999]. More liquid stocks are characterized by a faster information diffusion, which implies, according to the Hong and Stein [1999] model, that higher–priced stocks should exhibit weaker underreaction. However, we find the opposite result.

Our results on the price effect are consistent with the Daniel, Hirshleifer, and Subrahmanyam [1998] behavioral model, which conjectures that high growth firms are harder to value, are subject to stronger overconfidence bias, have larger continuing overreaction, and thus have larger momentum than do low growth firms. Because high–priced stocks are either established firms with large assets and capitalizations or high–growth companies with high price–to–value ratios, the price effect, after controlling for capitalization, must at least in part result from the effect of expected growth rates. If this is true then, according to the Daniel et al. [1998] model, high–priced stocks should have higher and longer–lasting momentum, just as we observe.

At the same time, our results are also consistent with the growth rate risk model by Johnson [2002], in which stocks with positive (negative) growth rate shocks in the formation period tend to be classified as winners (losers) and to have higher (lower) growth–rate risk that requires higher (lower) returns, thereby producing the evidence of momentum. Because controlling for capitalization, stocks with higher prices tend to be stocks with higher expected growth rates, we would expect that, according to Johnson's [2002] model, the higher–priced stocks will have stronger momentum, which is what we observe.

A potential non–behavioral explanation for the observed price effect is suggested by the results in Chordia and Shivakumar [2002]. In general, during the business cycle down–turns, prices of most stocks tend to be depressed. Chordia and Shivakumar [2002] show that almost all of momentum profit occurs during economic booms, implying that there should be a positive relation between the stock price and momentum profit. Our results are consistent with this implication of their model.[8]

The results of Badrinath and Wahal [2002], who study momentum trading by institutions, appear inconsistent with the price effect we find. Specifically, they separate changes to institutional holdings into position initiations, position liquidations, existing position adjustments, and unchanging positions. Their analysis indicates that initiations and liquidations account for a great portion of institutional position changes (around 25%) and most of initiations and liquidations occur after stock price increases. Price increases preceding initiations are greater than those preceding liquidations. From these results, Badrinath and Wahal [2002] conclude that institutions act as momentum traders upon initiation and as contrarians upon liquidation. One of the side results in Badrinath and Wahal [2002] is that position initiations and liquidations tend to occur in lower–priced stocks, indicating that more institutional momentum trading is concentrated in those stocks. Thus, we should observe stronger momentum in lower–priced stocks. This implication is opposite of what we find. A possible explanation for this difference is that for institutions to be momentum traders at the initiation, they must on average be profiting from this strategy. Just the fact that they buy more after a series of positive returns does not imply automatically that these trades are momentum–motivated. We show that momentum profits are lower in the lower–priced stocks. This implies that although institutions tend to initiate more positions in lower–priced stocks after high returns, they do that for reasons other than momentum trading (which is supported by Badrinath and Wahal's [2002] finding that entry–to–exit profit is negative or insignificantly positive).

The price effect we document appears consistent with some behavioral and some rational explanations of momentum and inconsistent with others. Since none of the momentum theories offered in literature have an explicit role for price level, our finding represents an additional piece of evidence that may be helpful in developing an explanation for this enduring phenomenon.

Conclusion

We show that the duration and magnitude of momentum profits depend on the price of stocks included in the relative strength portfolio. Sorting on price results in higher momentum returns than no sorting does. After controlling for capitalization, trading volume, and unconditional means, high–priced momentum portfolios continue to exhibit considerably higher one–year returns than the low–priced portfolios do. These findings have important implications for most existing models of momentum, including those based on liquidity considerations, information dissemination, the overconfidence biases, business cycle, institutional trading, and stochastic growth rates. More importantly, the price effect represents another empirical implication that should be generated by any newly developed behavioral or risk–based theory of momentum. This is an area of continuing research.

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Notes

1. Our results do not substantially change when we eliminate only companies for which there are two or more missing monthly returns in the previous six months. Similarly, eliminating stocks with prices below a certain threshold (e.g., $5 or $1) does not affect our results.
2. Using tercile portfolios (winners are the top 1/3 (ff 30%) of all stocks, and losers are the bottom 1/3) as in Hong, Stein, and Lim [2000] does not qualitatively affect our results, although the difference between being a winner and being a loser is smaller with terciles. Also, a momentum trader need not prefer terciles over deciles.
3. Their method, at any given month, groups together all momentum portfolios that have different terms until the end of the holding period. This method computes the arithmetic average monthly return across all these assets for that particular month and then arithmetic–averages these returns across the resulting time series. This procedure introduces the bias described in Conrad and Kaul [1993]. The basic relation between the arithmetic and geometric means will ensure that thus computed average return will be upward biased relative to the effective holding period returns for any series with non–zero returns variance. Whenever the effective returns over longer periods than one month are of interest (as in this study), this potential bias should not be ignored.
4. The results with a 6–month and an 18–month price lag are similar. Shorter lags may produce biased results because losers by definition will tend to have lower prices relative to winners. Longer lags, on the other hand, result in less information conveyed by the price.
5. When we compute average returns for individual months for each of the portfolios, we find that the average January return for losers is 5.8% and for winners it is 4%, which results in the

statistically and economically significant negative return of -1.8% for the arbitrage portfolio.

6. The weakening of reversal in the latter years may be associated with the technology–backed improvement in financial information dissemination, reduction in fixed trading costs (e.g., commissions), introduction and expansion of online trading, and increased market participation. However, this does not explain the persistence of momentum.
7. A full study of liquidity effects on momentum (using size, turnover, bid–ask spreads, etc. as liquidity proxies) is of interest, but is beyond the scope of this paper, as our goal here is to document the price effect and discuss its implications.
8. Note that taking contemporaneous prices (as opposed to 12–month lagged prices, as we do) would clearly indicate the correlation between price and momentum, because losers by definition will have lower contemporaneous prices than winners do. To avoid this bias introduced by using contemporaneous prices, we use 6-month, 12–month, and 18–month lagged prices. As results are similar, we report only the 12–month case.

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