Can Investors Profit from Security Analyst Recommendations?*

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Abstract

This paper revisits the question of whether investors can benefit from consensus recommendations of stock market analysts in US equity markets. To examine the profitability net of transactions cost, we calculate transactions cost based on effective tick spread. We find that transactions cost becomes noticeably lower from 2001 and the strategy of purchasing 'strong buy' stocks and shorting 'strong sell' stocks yields the abnormal returns of 4.7–5.8% per year during the period of 2001–2016, even after accounting for transactions cost. We also find that 'strong buy (sell)' stocks are growth (value) firms and short-term winners (losers). We discuss our empirical results in the context of market efficiency.

JEL classification: G11, G12, G14

Keywords: consensus recommendations; transactions cost; asset pricing; market efficiency

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1. Introduction

Can investors profit from security analyst recommendations? In an influential study by Barber, Lehavy, McNichols, and Trueman (2001), after accounting for transactions cost, none of the strategies designed to take advantage of the consensus recommendations earns significant abnormal returns during the period of 1985–1996. By extending the sample period up to 2016 and considering a more precise transactions cost, we find that the strategy of 'long the most recommended stocks and short the least recommended stocks' earns the annualized abnormal return of 4.7–5.8 percent during the period of 2001–2016.[1]

To answer whether investors can benefit from consensus recommendations, we construct five portfolios (strong buy, buy, neutral, sell and strong sell) based on over 700,000 recommendations of 17,290 analysts from I/B/E/S database and form a zero-cost portfolio of 'long the most recommended stocks and short the least recommended stocks.' To measure the profitability net of trading costs, we calculate more realistic and precise trading costs based on Holden (2009) and Goyenko, Holden, and Trzcinka (2009). We obtain several empirical results that are not only different from the finding of Barber et al. (2001) but also interesting enough for future research venues. First, transactions cost has declined significantly from 2001 when decimal stock quotes started.[2] Second, the most recommended stocks earn positive alpha while the least recommended stocks earn negative alpha. Consequently, the strategy of purchasing 'strong buy' stocks and shorting 'strong sell' stocks earns the annualized abnormal return greater than four percent. This result still holds even after accounting for trading costs. We also find that the positive alpha of strong buy stocks is larger in absolute value and more statistically significant than the negative alpha of strong sell stocks. Third, in terms of firm characteristics, the most (least) recommended stocks behave like growth (value) firms and short-term winners (losers). In addition, the most recommended stocks are more sensitive to the market, compared to the least recommended stocks. And, small firms are more concentrated in the portfolio of most recommended stocks.

While our approach builds on Barber et al. (2001), ours are different in two aspects, at least. First, we apply a more realistic transactions cost. While Barber et al. (2001) use 1.31 percent of share value traded as a proxy of transactions cost for each trading, which do not vary across portfolios and over time, we calculate transactions cost based on Holden (2009) and Goyenko et al. (2009), which is a more precise measure of transactions cost. As existing

[1] We use the terms of transactions cost and trading cost interchangeably. And we use the terms of most (least) recommended stocks, strong buy (sell) stocks, stocks with the most (least) favorable consensus recommendations with the same meaning.

[2] The US Securities and Exchange Commission ordered all stock markets in the U.S. to convert from fractional quotes of 1/16 to decimal quotes by April 9, 2001.

literature shows that transactions cost are different with firm size and over time, addressing time-varying costs is important.[3] Second, we extend the sample period up to 2016. It is important because we have shown that transactions cost becomes noticeably lower from 2001.

The rest of the paper is structured as follows. Section 2 explains our data, key variables and portfolio construction. Section 3 applies factor pricing models and explains the empirical results. Section 4 summarizes our finding and discusses future research venues.

2. Data

2.1. Data

Our sample includes all the stocks listed in NYSE, AMEX, and Nasdaq from 1994 through 2016, for which at least one analyst has an outstanding recommendation. The analyst recommendations data is obtained from I/B/E/S database, which converts the original recommendations issued by analysts into 5-point numeric scale, ranging from 1 to 5 (1: strong buy, 2: buy, 3: hold, 4: sell, 5: strong sell).[4] During our sample period of January 1994–December 2016, there are 702,590 recommendations from 17,290 analysts of 1,008 brokerage houses. The average number of firms each year is 4,678. Our sample is quite comprehensive in that it covers 92.2% of firms in terms of market capitalization and 57.7% in terms of number of firms.[5] Appendix A.1 shows the number of firms and share of market capitalization covered in our sample for each year. We obtain daily stock prices from CRSP (Center for Research in Security Prices).

2.2. Calculating Transactions Costs and Portfolio Returns

In constructing portfolios, we assume daily portfolio rebalancing and an immediate end-of-day investor reaction to analyst consensus recommendation changes. As purchasing and selling stocks under these assumptions requires a great deal of trading, it is important to take into account transactions costs, such as the bid-ask spread and the market impact of trading. Barber et al. (2001) estimate the size-weighted average of round-trip transactions cost at 1.31 percent of share value traded and use it as a proxy of transactions cost for

[3] Existing literature such as Keim and Madhavan (1998), Lesmond, Ogden, and Trzcinka (1999), Hasbrouck (2009), Holden (2009), Goyenko et al. (2009) shows that market capitalization is closely related to the cost. Hasbrouck (2009) and Corwin and Schultz (2012) also show that transactions cost varies over time.

[4] Ratings of 4 and 5 are also referred to as 'underperform' and 'sell', respectively

[5] Barber et al. (2001) use over 360,000 recommendations from 269 brokerage houses and 4,340 analysts. They cover 90.1% of all listed firms in terms of market capitalization and 46.1% in terms of number of firms.

each trading. However, transactions cost varies for each stock and over time, we calculate transactions cost based on Holden (2009) and Goyenko et al. (2009). Corwin and Schultz (2012) and Chen, Eaton, and Paye (2018) show that the performance of this measure based on effective spread is superior to the alternatives particularly from the late 1990's, which coincide with most of the sample period of this paper.[6] We briefly describe how to calculate transactions costs of daily stock-level, daily portfolio-level, and monthly portfolio-level in Appendix B.[7]

In regard to constructing portfolios, following Barber et al. (2001), five portfolios are constructed based on the consensus recommendation ratings of the analysts. Consensus recommendation for stock i on date $\tau - 1$, denoted by $C_{i\tau-1}$, is defined as the average of the outstanding recommendations for stock i as of date $\tau - 1$:

$$C_{i\tau-1} = \frac{1}{N_{i\tau-1}} \sum_{j=1}^{N_{i\tau-1}} Rec_{ij\tau-1}, \tag{1}$$

where $Rec_{ij\tau-1}$ is the outstanding recommendation for stock i as of date $\tau - 1$ issued by analyst j, and $N_{i\tau-1}$ is the number of outstanding recommendations for stock i as of date $\tau-1$. Any recommendations issued within 180 days from date $\tau - 1$ are considered as outstanding. If an analyst has issued more than 1 recommendation within 180 days, then only the most recent recommendation is regarded as outstanding.

Using these average ratings, each covered firm is placed into one of five portfolios as of the close of trading on date $\tau - 1$. The first portfolio consists of the most highly recommended stocks, those for which $1 \leq C_{i\tau-1} \leq 1.5$. We call this portfolio P1 (strong buy); the second is comprised of firms for which $1.5 < C_{i\tau-1} \leq 2$; the third contains firms for which $2 < C_{i\tau-1} \leq 2.5$; the fourth is comprised of firms for which $2.5 < C_{i\tau-1} \leq 3$; and the fifth portfolio consists of the least favorably recommended stocks, those for which $3 < C_{i\tau-1} \leq 5$. We call this P5 (strong sell). Others are called P2, P3, and P4, respectively. And a zero-cost portfolio of purchasing strong buy and shorting strong sell is denoted by (P1-P5). Then the daily value-weighted return for each portfolio is calculated and the monthly return is calculated based

[6] Goyenko et al. (2009) compare several measures of transactions cost and conclude that the performance of the effective tick spread measure is better than other alternatives, especially when one takes computational burden into consideration.

[7] In regard to various measures of transactions cost, see Corwin and Schultz (2012) and Chen et al. (2018). Corwin and Schultz (2012) provide a succinct explanation on various estimators of trading costs such as spread estimators derived from return covariances, transaction price tick size, frequency of zero returns, and others. Chen et al. (2018) calculate various measures of trading costs that reflect illiquidity in US equity markets and show that these measures predict stock market returns and real economic activity. Their measures are based on Roll (1984), Lesmond et al. (1999), Amihud (2002), Holden (2009), Goyenko et al. (2009), Corwin and Schultz (2012), Fong, Holden, and Trzcinka (2017), and others.

on the number of trading day. Net return is defined as gross return net of transactions cost. We explain how to calculate monthly returns from daily returns in Appendix B

2.3. Summary Statistics

Figure 1 shows how two kinds of transactions costs have been changing over time for each portfolio, P1 through P5, and (P1−P5). Since Barber et al. (2001) use a fixed 1.31 percent of share value traded, fluctuations in transactions cost based on Barber et al. (2001) reflect only the changes in turnover. Note that transactions cost based on Holden (2009) has been lower from 2001 when decimal stock price quoting started. This result is also consistent with Hasbrouck (2009).

Figure 2 shows the annualized average returns of five portfolios (P1 trough P5) and market excess return. It clearly shows that P1 (strong buy) records the highest average return and P5 gives the lowest return, regardless of return type (gross and net) and sample periods. If we compare the gross and net returns of two periods (January 1994–December 2016 and January 2001–December 2016), one can easily see that the role of transactions cost becomes less significant after 2001. In panel (a) and (b), the magnitudes of transactions cost ranges from 0.9 percent point (P2) to 1.5 percent point (P5). They are not negligible because the annualized return of P5 becomes negative from 0.5 percent to −1.0 percent after accounting for transactions cost. When we compare panel (c) and (d), the magnitude of trading cost becomes far smaller, ranging from 0.3 percent point to 0.4 percent point. For P1 portfolio, transactions cost takes only 2.8 percent (= (10.5−10.2)/10.5) of gross return. That is, if one earns 1 percent of gross return, net return is 0.972 percent.

Table 1 reports the average monthly returns, standard deviations, and Sharpe ratios. For returns of P1, P5, and (P1-P5), we report net returns. During the period of January 1994–December 2016, the average monthly return of P1 (strong buy) is highest at 0.84 percent while P5 (strong sell) is the only portfolio that records the negative return of −0.09 percent. The market excess return records 0.63 percent and the zero-cost portfolio of (P1−P5) records the third-highest return of 0.47 percent. In terms of Sharpe ratio, P1 gives the highest Sharpe ratio of 0.17 and those of market excess return and (P1−P5) are 0.14. During the period after 2000, the Sharpe ratio of P1 is highest at 0.18 and that of (P1−P5) is 0.13. Figure 3 also shows the attractiveness of P1 and (P1−P5) portfolio in terms of cumulative returns. After 2003, P1 starts to outperform market excess return. (P1−P5) also starts to show positive cumulative return from 1999. In the following section, we examine if these portfolios can earn excess returns even after accounting for risk factors (or styles).

3. Results and Discussion

Based on Fama and French (1996), Carhart (1997), and Fama and French (2015), we consider four models: (1) CAPM, (2) Fama-French three-factor model (FF3 model), (3) Fama-French three-factor model with momentum factor (four-factor model), and (4) Fama-French five-factor model (FF5 model), as shown in equations (2)–(5):

$$r_{it} - r_{ft} = \alpha_i + b_i(r_{Mt} - r_{ft}) + e_{it}, \tag{2}$$

$$r_{it} - r_{ft} = \alpha_i + b_i(r_{Mt} - r_{ft}) + s_i SMB_t + h_i HML_t + e_{it}, \tag{3}$$

$$r_{it} - r_{ft} = \alpha_i + b_i(r_{Mt} - r_{ft}) + s_i SMB_t + h_i HML_t + m_i WML_t + e_{it}, \tag{4}$$

$$\begin{aligned} r_{it} - r_{ft} = \alpha_i &+ b_i(r_{Mt} - r_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t \\ &+ c_i CMA_t + e_{it}, \end{aligned} \tag{5}$$

where r_{it} is the monthly return of portfolio formed on consensus recommendations, r_{ft} is the risk-free rate, and (r_{Mt}-r_{ft}) is the monthly value-weighted market return minus the risk-free rate. The terms SMB_t (small minus big), HML_t (high minus low), WML_t (winner minus loser), RMW_t (robust minus weak), and CMA_t (conservative minus aggressive) are the monthly returns on zero-investment factor-mimicking portfolios designed to capture size, B/M, momentum, operating profitability, and investment, respectively. If one interprets the above factors as "styles" and factor models as a method of performance attribution, a positive alpha (α) implies the abnormal return in excess of what could have been achieved by passive investments in those factors.

Table 2 shows the main results. While we run four kinds of pricing models in (2)–(5), we report only the result of four-factor model for brevity. It is because four-factor model gives the most conservative estimates of alpha, compared to other models. In addition, in terms of R^2, four-factor model has more explanatory power.[8] Appendix table C.1–C.4 show all other results. We report four results in panel (a)–(d) depending on return type (gross and net) and sample period (January 1994–December 2016 and January 2001–December 2016). Panel (a) shows that, in terms of gross return, P1 (strong buy) gives a positive alpha while P5 (strong sell) gives a negative alpha during the period of January 1994–December 2016. And, if one exploits a strategy of purchasing strong buy and shorting strong sell, one can earn the abnormal return of 0.626 percent, which amounts to the annualized return of 7.51 percent. However, once accounted for transactions cost, the returns become lower. Panel (b) shows that the alpha of P1, net of trading costs, becomes statistically insignificant. And the alpha of (P1−P5) portfolio becomes lower from 0.626 percent to 0.398 percent. A different

[8] While we report R^2 in the table, we also confirm this in terms of the adjusted R^2.

result from panel (a) and (b) highlights the importance of considering transactions cost.

Panel (c) and (d) show the result during the period of January 2001–December 2016 when transactions cost becomes noticeably lower. For both gross and net returns, P1 outperforms and P5 underperforms. And the alphas of (P1−P5) are 0.457 percent and 0.395 percent for gross and net return, respectively. Recall that, when we consider the period before 2001, alpha of (P1−P5) becomes remarkably lower from 0.626 percent to 0.398 percent when accounting for transactions cost. Meanwhile, when we consider the period of low transactions cost from 2001 onward, transactions cost takes only a small part of net returns, which is 0.062 percent point (=0.457−0.395). In terms of the annualized abnormal return, our four-factor model in table 2 earns 4.74% ($= 0.395 \times 12$) and FF5 model in Appendix C.4 earns 5.84% ($= 0.487 \times 12$) even after accounting for transactions cost.

Table 2 reports another interesting result. When we examine the patterns of factor loadings, we find that portfolio P1 behaves like growth firms and short-term winners while P5 behaves like value firms and short-term losers. In panel (d), the factor loading for HML increases as we move from P1 to P5. For WML, it declines as we move from P1 to P5. Consequently, (P1−P5) behaves like growth firms and short-term winners. In addition, the factor loading on market excess return (that is, beta) declines as we move from P1 to P5, suggesting that P1 moves more closely with the market itself.[9]

Another thing to note is that small firms are concentrated more in P1 (strong buy). Figure 4 shows the relative share of firms in each portfolio in terms of number of firms and market capitalization. Panel (a) shows that, except the early 2000s, the relative number of firms in P1 is consistently higher that the relative share of market capitalization in P1. During the sample period, P1 takes 17.9 percent in terms of number of firms while it takes only 8.1 percent of market capitalization. Panel (e) shows that the relative share of P5 is relatively low both in terms of number and market capitalization. It reflects the conventional wisdom that analysts are reluctant to make strong sell recommendations.

4. Conclusion

While Barber et al. (2001) show that their investment strategies based on consensus recommendations do not earn positive alpha to investors after a reasonable accounting for transactions costs, they also mention that "the strategies studied here, but applied to different time periods or different stock recommendation data, will be able to generate positive abnormal net returns." By extending the sample period up to 2016 and considering a more

[9] Barber et al. (2001) also report that less favorable analyst ratings are associated with forms of lower market risk and high book-to-market ratios.

precise transactions cost, we show that the strategy of 'purchasing strong buy and shorting strong sell' can earn the annualized abnormal return greater than four percent.

There are several potential explanations for our finding: (1) random chance (data snooping), (2) market inefficiency, and (3) incorrect multi-factor pricing models. In relation to (1), if our estimated abnormal returns are the result of mispricing, they should disappear out-of-sample as the sophisticated investors and traders learn about this mispricing and invest accordingly. Mclean and Pontiff (2016) study the out-of-sample and post-publication return predictability of 97 variables and find that portfolio returns are 26% lower out-of-sample and 58% lower post-publication. Their finding strongly suggests that investors are informed by academic publications. Since our result suggests that prices do not immediately incorporate the information related to analysts' consensus stock recommendations, our finding is related to (2) as well. To examine the persistence of alpha that we find, it would be best to wait for more data to be accumulated over time. In relation to (3), it would be an interesting topic to examine how analysts pick stocks and why strong-buy (sell) firms are growth (value) firms and short-term winners (losers). Research on the relationship between analysts' stock-picking and sentiments (or business cycles) such as Kaplanski and Levy (2017) would help answer these questions.

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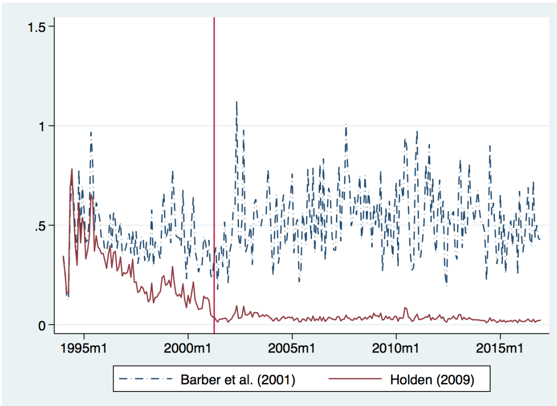
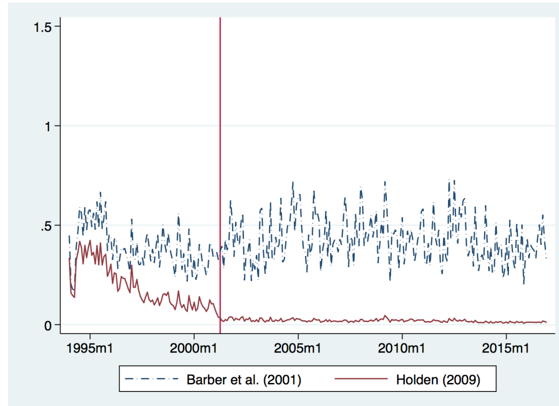
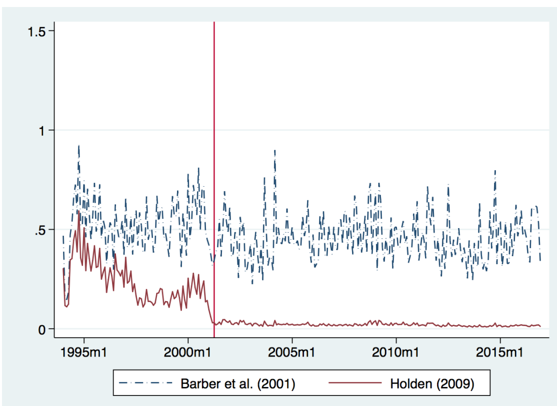


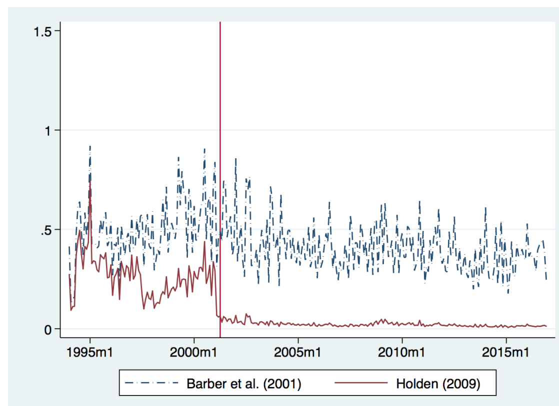
(a) P1 (strong buy)



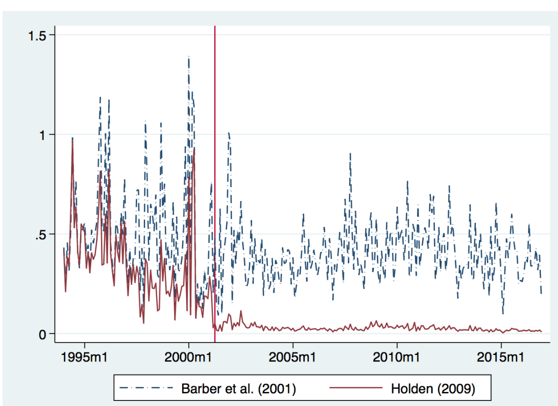
(b) P2



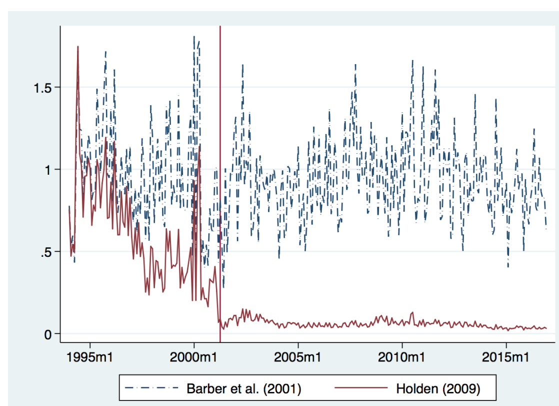
(c) P3



(d) P4

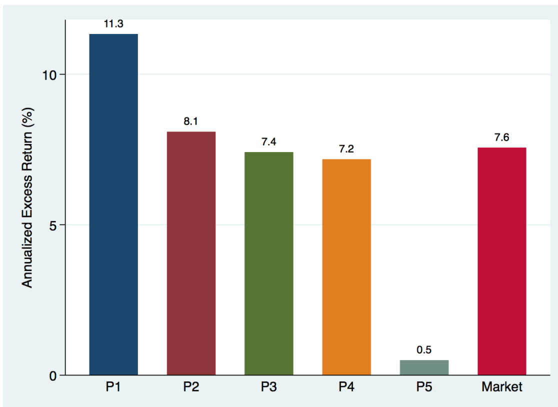


(e) P5 (strong sell)

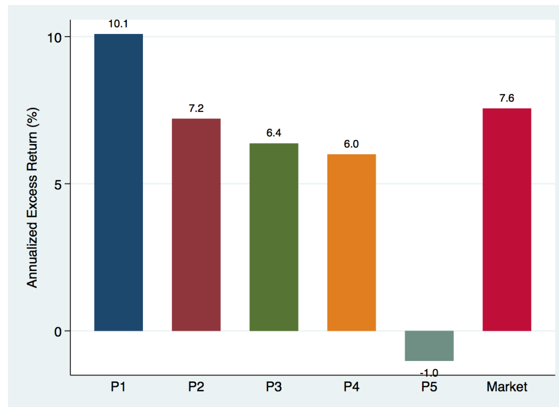


(f) (P1-P5)

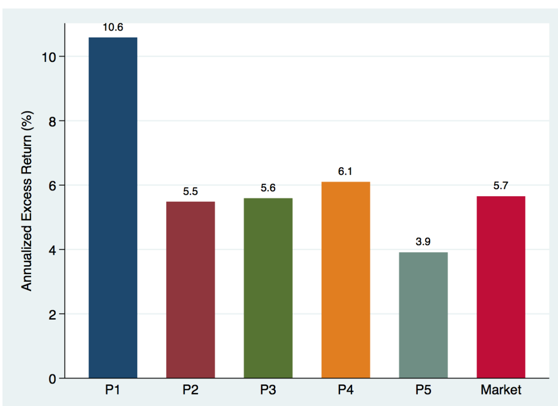
Fig. 1. Comparison of transactions costs
Panel (a)–(f) show the time series of two kinds of transactions cost. Barber et al. (2001) uses the fixed round-trip transactions cost of 1.31 percent of share value traded. Holden (2009), jointly with Goyenko et al. (2009), develops a proxy of transactions cost based on effective tick spreads.



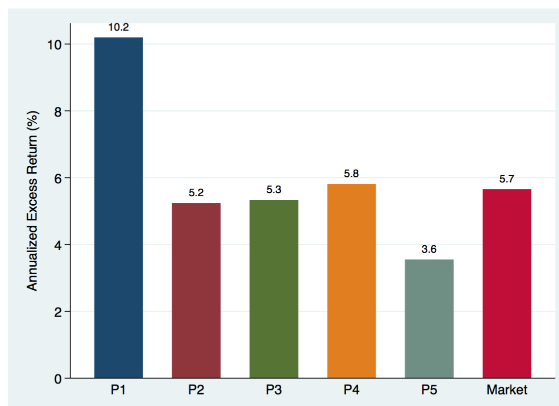
(a) gross returns, 1994m1–2016m12



(b) net returns, 1994m1–2016m12



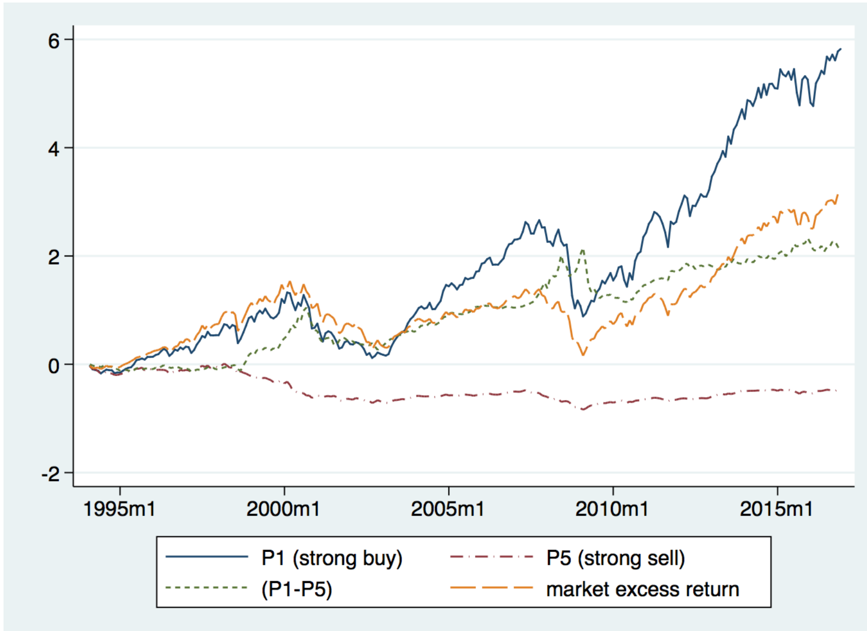
(c) gross returns, 2001m1–2016m12



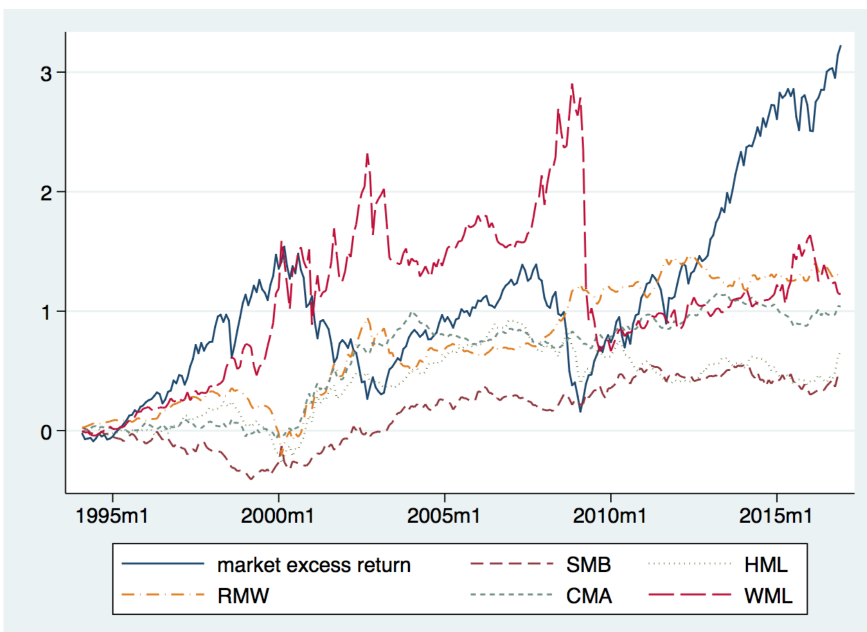
(d) net returns, 2001m1–2016m12

Fig. 2. Annualized portfolio returns

Panel (a)–(d) show the annualized mean percentage returns earned by portfolios formed on the basis of consensus analyst recommendations for two types of return (gross and net) and two sample periods (January1994–December 2016 and January 2001–December 2016). P1 is a portfolio of 'strong buy' stocks and P5 is a portfolio of 'strong sell' stocks. 'Market' denotes the market excess return.

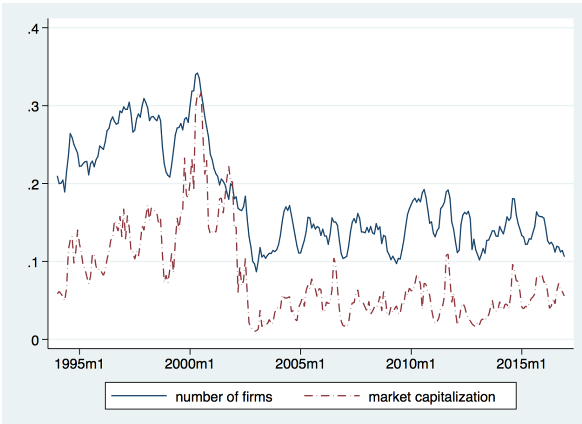


(a) P1, P5, (P1-P5), and market excess return

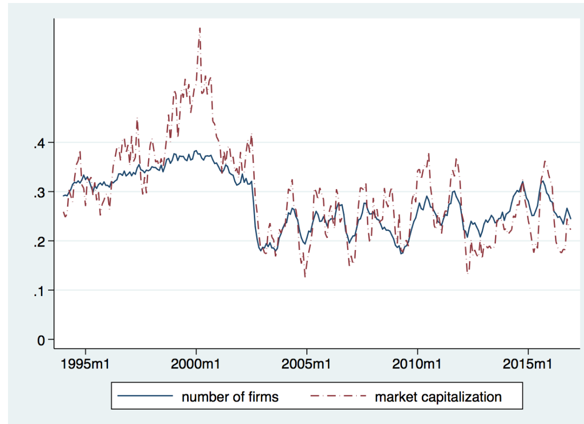


(b) Factor-mimicking portfolios

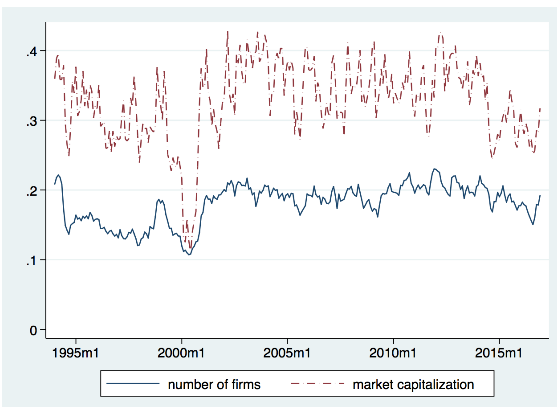
Fig. 3. Cumulative returns, January 1994–December 2016
Panel (a) shows the cumulative returns of P1, P5, (P1−P5), and market excess return. Panel (b) show the cumulative returns of factor-mimicking portfolios.



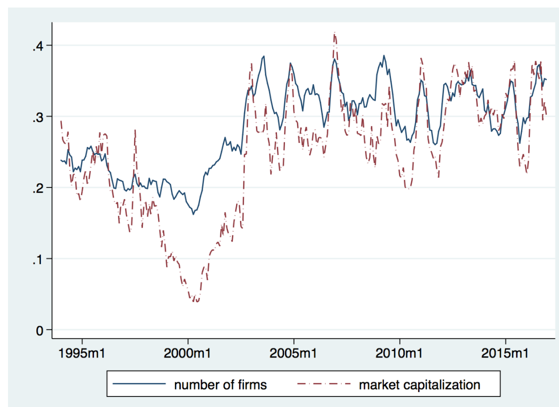
(a) P1 (strong buy)



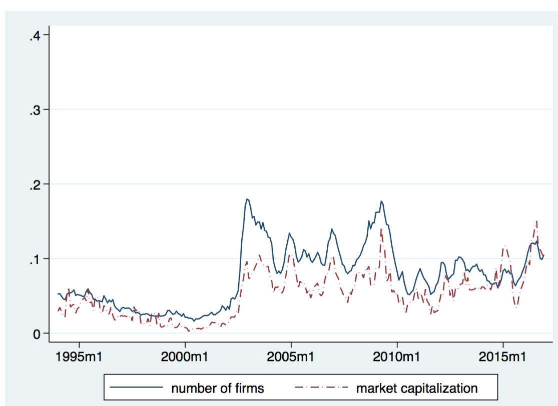
(b) P2



(c) P3



(d) P4



(e) P5 (strong sell)

Fig. 4. Relative shares in terms of number of firms and market capitalization
This figure shows the time series of relative shares in terms of number of firms and market capitalization in each portfolio. The shares in each portfolio are calculated at the end of each month.

Table 1: Summary Statistics

This table shows the average monthly returns, standard deviations, and Sharpe ratios for two sample periods. Net returns are used for P1, P5, and (P1-P5),

	P1	P5	(P1-P5)	mktrf	SMB	HML	RMW	CMA	WML
	January 1994–December 2016								
Average returns	0.84	-0.09	0.47	0.63	0.19	0.24	0.34	0.29	0.41
Standard deviations	5.01	4.90	3.32	4.37	3.18	3.11	2.90	2.13	5.09
Sharpe ratios	0.17	-0.02	0.14	0.14	0.06	0.08	0.12	0.13	0.08
	January 2001–December 2016								
Average returns	0.85	0.30	0.38	0.47	0.40	0.24	0.35	0.25	0.07
Standard deviations	4.79	5.14	2.98	4.38	2.61	2.79	2.36	1.90	5.32
Sharpe ratios	0.18	0.06	0.13	0.11	0.15	0.09	0.15	0.13	0.01

Table 2: Estimated alpha from four-factor model

This table shows the results of applying four-factor model (Fama-French three factor with momentum factor) for two kinds of returns (gross and net) and two sample periods (January 1994–December 2016 and January 2001–December 2016). The numbers in parentheses are robust standard errors. *, **, and *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.

	P1 (strong buy)	P2	P3	P4	P5 (strong sell)	(P1-P5)
	(a) gross return, 1994m1-2016m12					
mktrf	1.050***	1.043***	0.955***	0.914***	0.888***	0.161***
	(0.027)	(0.016)	(0.022)	(0.020)	(0.046)	(0.053)
SMB	0.193***	-0.050**	-0.119***	-0.024	0.263***	-0.066
	(0.035)	(0.019)	(0.036)	(0.027)	(0.086)	(0.086)
HML	-0.157***	-0.117***	0.071**	0.222***	0.283***	-0.445***
	(0.042)	(0.024)	(0.033)	(0.030)	(0.072)	(0.075)
WML	0.077***	0.081***	-0.038**	-0.156***	-0.148***	0.221***
	(0.023)	(0.016)	(0.019)	(0.025)	(0.040)	(0.049)
alpha	0.253***	0.021	0.037	0.038	-0.575***	0.626***
	(0.096)	(0.055)	(0.071)	(0.070)	(0.137)	(0.167)
R^2	0.906	0.97	0.935	0.941	0.802	0.365
	(b) net return, 1994m1-2016m12					
mktrf	1.047***	1.040***	0.952***	0.911***	0.885***	0.155***
	(0.027)	(0.016)	(0.022)	(0.020)	(0.047)	(0.052)
SMB	0.198***	-0.046**	-0.113***	-0.019	0.272***	-0.051
	(0.035)	(0.020)	(0.037)	(0.027)	(0.088)	(0.084)
HML	-0.157***	-0.117***	0.070**	0.221***	0.280***	-0.448***
	(0.042)	(0.024)	(0.033)	(0.030)	(0.073)	(0.074)
WML	0.076***	0.080***	-0.040**	-0.158***	-0.149***	0.219***
	(0.023)	(0.016)	(0.019)	(0.025)	(0.041)	(0.048)
alpha	0.150	-0.051	-0.048	-0.058	-0.700***	0.398**
	(0.096)	(0.055)	(0.071)	(0.069)	(0.141)	(0.165)
R^2	0.905	0.969	0.934	0.94	0.794	0.367
	(c) gross return, 2001m1-2016m12					
mktrf	1.048***	1.045***	1.028***	0.959***	0.934***	0.120**
	(0.035)	(0.019)	(0.018)	(0.026)	(0.034)	(0.048)
SMB	0.180***	-0.018	-0.037*	0.053	0.07	0.107
	(0.050)	(0.020)	(0.022)	(0.033)	(0.056)	(0.071)
HML	-0.150***	-0.158***	-0.062**	0.120***	0.395***	-0.548***
	(0.050)	(0.029)	(0.025)	(0.040)	(0.068)	(0.080)
WML	0.089***	0.100***	0.029**	-0.096***	-0.181***	0.271***
	(0.026)	(0.016)	(0.012)	(0.026)	(0.028)	(0.042)
alpha	0.347***	0.004	0.01	0.013	-0.225*	0.457***
	(0.110)	(0.059)	(0.055)	(0.070)	(0.119)	(0.166)
R^2	0.9	0.971	0.976	0.961	0.904	0.441
	(d) net return, 2001m1-2016m12					
mktrf	1.049***	1.045***	1.029***	0.961***	0.936***	0.122**
	(0.034)	(0.019)	(0.018)	(0.025)	(0.034)	(0.048)
SMB	0.180***	-0.019	-0.038*	0.051	0.068	0.105
	(0.050)	(0.020)	(0.022)	(0.033)	(0.056)	(0.071)
HML	-0.150***	-0.159***	-0.062**	0.121***	0.395***	-0.547***
	(0.050)	(0.029)	(0.025)	(0.040)	(0.067)	(0.081)
WML	0.090***	0.101***	0.029**	-0.094***	-0.180***	0.273***
	(0.025)	(0.016)	(0.012)	(0.025)	(0.029)	(0.041)
alpha	0.314***	-0.017	-0.012	-0.011	-0.255**	0.395**
	(0.110)	(0.059)	(0.055)	(0.070)	(0.119)	(0.166)
R^2	0.901	0.971	0.976	0.962	0.905	0.442

Online Appendix

A. *Sample Representativeness*

This table shows the share of firms covered in our sample in terms of number of firms and market capitalization.

Table A.1: Sample Representativeness

Year	Number of firms covered (A)	Number of firms listed in CRSP (B)	(A/B) (%)	Market capitalization (%)
1994	4,339	8,819	49.2	88.1
1995	4,776	9,202	51.9	90.4
1996	5,581	9,787	57.0	92.8
1997	5,916	10,034	59.0	93.8
1998	5,984	9,898	60.5	94.7
1999	5,786	9,592	60.3	97.4
2000	5,443	9,309	58.5	96.8
2001	4,690	8,620	54.4	95.5
2002	4,475	7,940	56.4	95.7
2003	4,508	7,489	60.2	95.6
2004	4,593	7,359	62.4	94.9
2005	4,713	7,385	63.8	93.7
2006	4,772	7,445	64.1	92.3
2007	4,775	7,707	62.0	93.5
2008	4,474	7,421	60.3	92.5
2009	4,063	7,173	56.6	91.1
2010	4,027	7,135	56.4	90.2
2011	4,096	7,151	57.3	90.0
2012	4,058	7,168	56.6	90.5
2013	4,057	7,192	56.4	90.1
2014	4,173	7,442	56.1	87.7
2015	4,196	7,642	54.9	87.0
2016	4,095	7,608	53.8	87.3
average	4,678	8,109	57.7	92.2

B. *Calculating Transactions Cost and Returns*

B.1. *Calculating Transactions Cost*

Daily transactions cost for stock i on date τ This section briefly illustrates how to calculate a measure of transactions cost based on effective tick spreads, developed jointly by

Holden (2009) and Goyenko et al. (2009). Effective tick spread makes use of closing prices with positive trade volume in a given month, and relates them to the spreads. For example, suppose that the tick size is $\$\frac{1}{8}$.[10] Then, there are 4 possible spreads, $s_1 = \$\frac{1}{8}, s_2 = \$\frac{1}{4}, s_3 = \$\frac{1}{2}$, and $s_1 = \$1$. Based on the spread, closing prices are grouped into 4 sets, odd $\$\frac{1}{8}$ prices, odd $\$\frac{1}{4}$ prices, odd $\$\frac{1}{2}$ prices, and \$1 prices. Note that these sets are mutually exclusive. Hence, each observed price is related to one of the 4 spreads (odd prices). Then, the number of closing prices in each set is used to construct the effective tick spread measure.

Formally, let s_j, $j = 1, \ldots, J$, be the jth spread, and N_j, $j = 1, \ldots, J$, be the number of closing prices with positive trade volume related to odd-jth spread. The fraction of each spread F_j is given by

$$F_j = \frac{N_j}{\sum_{j=1}^{J} N_j}, \quad j = 1, \ldots, J. \tag{B.1}$$

The unconditional probability related to jth spread, denoted by U_j, is computed as below:

$$U_j = \begin{cases} 2F_j, & j = 1, \\ 2F_j - F_{j-1}, & j = 2, \ldots, J-1, \\ F_j - F_{j-1}, & j = J. \end{cases} \tag{B.2}$$

The unconditional probability above sometimes happens to be negative, since Eq. (B.2) implicitly assumes that prices associated with narrower spreads are observed more frequently. Holden (2009) and Goyenko et al. (2009) address this problem by deriving constrained probability, denoted by $\hat{\gamma}_j$, as follows:

$$\hat{\gamma}_j = \begin{cases} \min\left[\max\{U_j, 0\}, 1\right], & j = 1, \\ \min\left[\max\{U_j, 0\}, 1 - \sum_{k=1}^{j-1} \hat{\gamma}_k\right], & j = 2, \ldots, J. \end{cases} \tag{B.3}$$

Then, the effective tick spread is obtained as follows:

$$\mathit{EffectiveTick} = \frac{\sum_{j=1}^{J} \hat{\gamma}_j s_j}{\overline{prc}}, \tag{B.4}$$

where $\overline{prc}$ is the average closing price in a given month. In what follows, monthly transactions cost for stock i for month t, which is the effective tick spread in Eq. (B.4), is denoted by TC_{it}. It is assumed that daily transactions cost is constant over the month, and daily transactions cost for stock i on date τ, denoted by $TC_{i\tau}$ is replaced by monthly transactions cost.

[10] Tick size has changed from $\$\frac{1}{8}$ to $\$\frac{1}{16}$ during 1997, and from $\$\frac{1}{16}$ to decimals in April 2001.

Daily transactions cost for portfolio p on date τ Now, let's assume that there are N stocks in portfolio p either on date τ, $\tau+1$, or both. The weight for stock i in portfolio p on date τ, denoted by $\omega_{i\tau}$, is given based on the market capitalization on date $\tau-1$. That is,

$$\omega_{i\tau} = \begin{cases} \dfrac{prc_{i\tau-1} \cdot shr_{i\tau-1}}{\sum_{j=1}^{N} prc_{j\tau-1} \cdot shr_{j\tau-1}} & \text{if } i \in p, \\ 0 & \text{if } i \notin p, \end{cases} \tag{B.5}$$

where $prc_{i\tau-1}$ is the price of stock i on date $\tau-1$, and $shr_{i\tau-1}$ is the number of outstanding shares of stock i on date $\tau-1$. Note that $\omega_{i\tau}=0$ indicates stock i doesn't belong to portfolio p on date τ.

Then, the proportion of stock i in portfolio p at the close of the market on date τ, right before rebalancing is

$$G_{i\tau} = \frac{\omega_{i\tau}(1+R_{i\tau})}{\sum_{j=1}^{N} \omega_{j\tau}(1+R_{j\tau})}. \tag{B.6}$$

The proportion of stock i in portfolio p on date $\tau+1$ (or equivalently, right after rebalaning at the close of the market on date τ) is simply given by

$$F_{i\tau} = \omega_{i\tau+1}. \tag{B.7}$$

Note that if the composition of the portfolio and the of outstanding shares of each stock in the portfolio don't change, then $G_{i\tau}=F_{i\tau}$ by definition. The turnover for stock i in portfolio p on date τ, denoted by $U_{i\tau}$ is the absolute value of the difference between $G_{i\tau}$ and $F_{i\tau}$:

$$U_{i\tau} = \left| G_{i\tau} - F_{i\tau} \right|. \tag{B.8}$$

Then, the daily transactions cost for stock i in portfolio p on date τ is expressed as $\frac{1}{2}TC_{i\tau}U_{i\tau}$. Note that $\frac{1}{2}$ is multiplied because $TC_{i\tau}$ is the round-trip transactions cost. Finally, daily transactions cost for portfolio p on date τ, denoted by $TC_{p\tau}$ is given by

$$TC_{p\tau} = \sum_{i=1}^{N} \frac{1}{2} TC_{i\tau}U_{i\tau}. \tag{B.9}$$

Monthly transactions cost for portfolio p on date t Suppose that there are M trading days in month t. Then, the monthly transactions cost for portfolio p in month t, TC_{pt}, is calculated as the sum of the daily transactions costs for portfolio p in month t. That is,

$$TC_{pt} = \sum_{\tau=1}^{M} TC_{p\tau}. \tag{B.10}$$

B.2. Calculating Returns

The daily gross return on portfolio p on date τ, denoted by $R_{p\tau}$, is the value-weighted return of the stocks in portfolio p:

$$R_{p\tau} = \sum_{i=1}^{N} \omega_{i\tau} R_{i\tau}, \tag{B.11}$$

where $R_{i\tau}$ is the rate of return on stock i on date τ. Then, the monthly gross return on portfolio p in month t, denoted by R_{pt}, is given by

$$R_{pt} = \prod_{\tau=1}^{M} (1 + R_{p\tau}) - 1. \tag{B.12}$$

C. Estimation Results

This section reports the results of four kinds of factor pricing models (CAPM, FF3 model, four-factor model, and FF5 model) for two return type (gross and net) and two sample periods (January 1994–December 2016 and January 2001–December 2016). The numbers in parentheses are robust standard errors. *, **, and *** denote p-value<0.10, p-value<0.05, and p-value<0.01, respectively.

Table C.1: Gross return, January 1994–December 2016

	P1	P2	P3	P4	P5	(P1-P6)
			CAPM			
mktrf	1.070***	1.021***	0.942***	0.938***	0.945***	0.126*
	(0.034)	(0.020)	(0.021)	(0.030)	(0.054)	(0.070)
alpha	0.271**	0.03	0.024	0.007	-0.554***	0.620***
	(0.110)	(0.061)	(0.078)	(0.097)	(0.157)	(0.200)
R^2	0.869	0.953	0.92	0.871	0.718	0.027
			FF 3-factor			
mktrf	1.021***	1.012***	0.970***	0.973***	0.945***	0.076
	(0.029)	(0.017)	(0.021)	(0.021)	(0.048)	(0.059)
SMB	0.202***	-0.040*	-0.124***	-0.043	0.244***	-0.038
	(0.035)	(0.021)	(0.039)	(0.039)	(0.086)	(0.086)
SMB	-0.188***	-0.149***	0.086**	0.285***	0.343***	-0.534***
	(0.043)	(0.023)	(0.037)	(0.039)	(0.071)	(0.077)
alpha	0.309***	0.08	0.009	-0.076	-0.683***	0.787***
	(0.095)	(0.054)	(0.072)	(0.081)	(0.139)	(0.171)
R^2	0.901	0.963	0.933	0.913	0.782	0.268
			FF 3-factor + momentum			
mktrf	1.050***	1.043***	0.955***	0.914***	0.888***	0.161***
	(0.027)	(0.016)	(0.022)	(0.020)	(0.046)	(0.053)
SMB	0.193***	-0.050**	-0.119***	-0.024	0.263***	-0.066
	(0.035)	(0.019)	(0.036)	(0.027)	(0.086)	(0.086)
HML	-0.157***	-0.117***	0.071**	0.222***	0.283***	-0.445***
	(0.042)	(0.024)	(0.033)	(0.030)	(0.072)	(0.075)
WML	0.077***	0.081***	-0.038**	-0.156***	-0.148***	0.221***
	(0.023)	(0.016)	(0.019)	(0.025)	(0.040)	(0.049)
alpha	0.253***	0.021	0.037	0.038	-0.575***	0.626***
	(0.096)	(0.055)	(0.071)	(0.070)	(0.137)	(0.167)
R^2	0.906	0.97	0.935	0.941	0.802	0.365
			FF 5-factor			
mktrf	0.999***	1.006***	1.006***	0.999***	0.927***	0.072
	(0.031)	(0.018)	(0.024)	(0.026)	(0.052)	(0.066)
SMB	0.194***	-0.016	-0.088***	-0.031	0.195***	0.002
	(0.047)	(0.023)	(0.030)	(0.036)	(0.072)	(0.085)
HML	-0.139**	-0.114***	0.024	0.229***	0.346***	-0.487***
	(0.061)	(0.032)	(0.039)	(0.045)	(0.078)	(0.103)
RMW	-0.044	0.043	0.117**	0.055	-0.125	0.081
	(0.060)	(0.032)	(0.048)	(0.051)	(0.085)	(0.101)
CMA	-0.084	-0.120***	0.059	0.09	0.091	-0.177
	(0.084)	(0.044)	(0.057)	(0.087)	(0.108)	(0.144)
alpha	0.352***	0.09	-0.062	-0.125	-0.646***	0.794***
	(0.099)	(0.056)	(0.075)	(0.098)	(0.133)	(0.169)
R^2	0.902	0.965	0.936	0.914	0.786	0.278
N	276	276	276	276	276	276

Table C.2: Net return, January 1994–December 2016

	P1	P2	P3	P4	P5	(P1-P5)
			CAPM			
mktrf	1.068***	1.020***	0.941***	0.936***	0.944***	0.123*
	(0.034)	(0.020)	(0.021)	(0.030)	(0.054)	(0.070)
alpha	0.168	-0.042	-0.062	-0.09	-0.680***	0.391*
	(0.111)	(0.061)	(0.077)	(0.097)	(0.160)	(0.200)
R^2	0.867	0.952	0.92	0.87	0.71	0.026
			FF 3-factor			
mktrf	1.018***	1.010***	0.968***	0.971***	0.942***	0.071
	(0.029)	(0.017)	(0.021)	(0.021)	(0.049)	(0.059)
SMB	0.208***	-0.036*	-0.118***	-0.039	0.253***	-0.024
	(0.035)	(0.021)	(0.040)	(0.040)	(0.089)	(0.084)
SMB	-0.188***	-0.149***	0.086**	0.284***	0.341***	-0.536***
	(0.043)	(0.023)	(0.037)	(0.039)	(0.072)	(0.075)
alpha	0.205**	0.007	-0.077	-0.173**	-0.809***	0.557***
	(0.095)	(0.055)	(0.072)	(0.081)	(0.142)	(0.170)
R^2	0.9	0.962	0.932	0.911	0.774	0.271
			FF 3-factor + momentum			
mktrf	1.047***	1.040***	0.952***	0.911***	0.885***	0.155***
	(0.027)	(0.016)	(0.022)	(0.020)	(0.047)	(0.052)
SMB	0.198***	-0.046**	-0.113***	-0.019	0.272***	-0.051
	(0.035)	(0.020)	(0.037)	(0.027)	(0.088)	(0.084)
HML	-0.157***	-0.117***	0.070**	0.221***	0.280***	-0.448***
	(0.042)	(0.024)	(0.033)	(0.030)	(0.073)	(0.074)
WML	0.076***	0.080***	-0.040**	-0.158***	-0.149***	0.219***
	(0.023)	(0.016)	(0.019)	(0.025)	(0.041)	(0.048)
alpha	0.15	-0.051	-0.048	-0.058	-0.700***	0.398**
	(0.096)	(0.055)	(0.071)	(0.069)	(0.141)	(0.165)
R^2	0.905	0.969	0.934	0.94	0.794	0.367
			FF 5-factor			
mktrf	0.996***	1.004***	1.003***	0.996***	0.924***	0.066
	(0.031)	(0.019)	(0.023)	(0.026)	(0.053)	(0.065)
SMB	0.200***	-0.012	-0.083***	-0.027	0.204***	0.017
	(0.047)	(0.023)	(0.031)	(0.037)	(0.074)	(0.084)
HML	-0.138**	-0.113***	0.025	0.231***	0.344***	-0.487***
	(0.060)	(0.032)	(0.039)	(0.045)	(0.080)	(0.101)
RMW	-0.043	0.043	0.117**	0.055	-0.126	0.082
	(0.060)	(0.032)	(0.048)	(0.052)	(0.087)	(0.100)
CMA	-0.085	-0.122***	0.055	0.086	0.089	-0.18
	(0.084)	(0.044)	(0.056)	(0.087)	(0.111)	(0.142)
alpha	0.248**	0.018	-0.147*	-0.222**	-0.771***	0.565***
	(0.099)	(0.056)	(0.075)	(0.098)	(0.136)	(0.169)
R^2	0.901	0.965	0.935	0.913	0.778	0.281
N	276	276	276	276	276	276

Table C.3: Gross return, January 2001–December 2016

	P1	P2	P3	P4	P5	(P1-P5)
			CAPM			
mktrf	1.025***	0.978***	1.002***	1.029***	1.066***	-0.037
	(0.038)	(0.025)	(0.016)	(0.027)	(0.056)	(0.078)
alpha	0.399***	-0.003	-0.006	0.023	-0.176	0.460**
	(0.119)	(0.073)	(0.058)	(0.083)	(0.161)	(0.217)
R^2	0.88	0.949	0.972	0.945	0.827	0.003
			FF 3-factor			
mktrf	0.998***	0.987***	1.012***	1.014***	1.037***	-0.035
	(0.038)	(0.019)	(0.017)	(0.023)	(0.041)	(0.061)
SMB	0.180***	-0.019	-0.038*	0.054	0.072	0.104
	(0.054)	(0.028)	(0.021)	(0.042)	(0.064)	(0.089)
SMB	-0.151***	-0.160***	-0.063**	0.121***	0.397***	-0.551***
	(0.053)	(0.027)	(0.026)	(0.042)	(0.064)	(0.080)
alpha	0.378***	0.038	0.02	-0.02	-0.288**	0.551***
	(0.111)	(0.064)	(0.055)	(0.073)	(0.134)	(0.184)
R^2	0.893	0.959	0.975	0.952	0.877	0.259
			FF 3-factor + momentum			
mktrf	1.048***	1.045***	1.028***	0.959***	0.934***	0.120**
	(0.035)	(0.019)	(0.018)	(0.026)	(0.034)	(0.048)
SMB	0.180***	-0.018	-0.037*	0.053	0.07	0.107
	(0.050)	(0.020)	(0.022)	(0.033)	(0.056)	(0.071)
HML	-0.150***	-0.158***	-0.062**	0.120***	0.395***	-0.548***
	(0.050)	(0.029)	(0.025)	(0.040)	(0.068)	(0.080)
WML	0.089***	0.100***	0.029**	-0.096***	-0.181***	0.271***
	(0.026)	(0.016)	(0.012)	(0.026)	(0.028)	(0.042)
alpha	0.347***	0.004	0.01	0.013	-0.225*	0.457***
	(0.110)	(0.059)	(0.055)	(0.070)	(0.119)	(0.166)
R^2	0.900	0.971	0.976	0.961	0.904	0.441
			FF 5-factor			
mktrf	1.008***	0.990***	1.028***	0.994***	1.042***	-0.029
	(0.042)	(0.024)	(0.019)	(0.029)	(0.044)	(0.070)
SMB	0.191***	-0.011	-0.023	0.041	0.067	0.121
	(0.058)	(0.030)	(0.022)	(0.041)	(0.067)	(0.096)
HML	-0.131*	-0.132***	-0.05	0.125***	0.358***	-0.495***
	(0.074)	(0.037)	(0.032)	(0.040)	(0.059)	(0.103)
RMW	0.058	0.033	0.076***	-0.075	-0.013	0.07
	(0.065)	(0.053)	(0.029)	(0.053)	(0.093)	(0.128)
CMA	-0.083	-0.089	-0.072**	0.028	0.108	-0.185
	(0.095)	(0.057)	(0.035)	(0.085)	(0.105)	(0.158)
alpha	0.363***	0.038	-0.006	0.013	-0.301**	0.549***
	(0.111)	(0.070)	(0.056)	(0.089)	(0.137)	(0.186)
R^2	0.894	0.96	0.976	0.953	0.878	0.270
N	192	192	192	192	192	192

Table C.4: Net return, January 2001–December 2016

	P1	P2	P3	P4	P5	(P1-P5)
			CAPM			
mktrf	1.025***	0.978***	1.003***	1.030***	1.067***	-0.036
	(0.037)	(0.025)	(0.016)	(0.027)	(0.056)	(0.078)
alpha	0.367***	-0.024	-0.028	-0.001	-0.206	0.397*
	(0.119)	(0.073)	(0.058)	(0.082)	(0.161)	(0.217)
R^2	0.88	0.948	0.972	0.946	0.828	0.003
			FF 3-factor			
mktrf	0.998***	0.988***	1.012***	1.015***	1.039***	-0.034
	(0.038)	(0.019)	(0.017)	(0.023)	(0.041)	(0.061)
SMB	0.179***	-0.02	-0.038*	0.052	0.07	0.102
	(0.053)	(0.028)	(0.021)	(0.041)	(0.063)	(0.089)
SMB	-0.151***	-0.160***	-0.063**	0.122***	0.397***	-0.550***
	(0.052)	(0.028)	(0.026)	(0.042)	(0.063)	(0.081)
alpha	0.345***	0.018	-0.002	-0.044	-0.317**	0.489***
	(0.110)	(0.064)	(0.055)	(0.073)	(0.133)	(0.184)
R^2	0.893	0.959	0.975	0.953	0.878	0.257
			FF 3-factor + momentum			
mktrf	1.049***	1.045***	1.029***	0.961***	0.936***	0.122**
	(0.034)	(0.019)	(0.018)	(0.025)	(0.034)	(0.048)
SMB	0.180***	-0.019	-0.038*	0.051	0.068	0.105
	(0.050)	(0.020)	(0.022)	(0.033)	(0.056)	(0.071)
HML	-0.150***	-0.159***	-0.062**	0.121***	0.395***	-0.547***
	(0.050)	(0.029)	(0.025)	(0.040)	(0.067)	(0.081)
WML	0.090***	0.101***	0.029**	-0.094***	-0.180***	0.273***
	(0.025)	(0.016)	(0.012)	(0.025)	(0.029)	(0.041)
alpha	0.314***	-0.017	-0.012	-0.011	-0.255**	0.395**
	(0.110)	(0.059)	(0.055)	(0.070)	(0.119)	(0.166)
R^2	0.901	0.971	0.976	0.962	0.905	0.442
			FF 5-factor			
mktrf	1.008***	0.990***	1.029***	0.996***	1.043***	-0.028
	(0.042)	(0.024)	(0.019)	(0.028)	(0.044)	(0.070)
SMB	0.191***	-0.012	-0.024	0.038	0.065	0.118
	(0.058)	(0.030)	(0.022)	(0.040)	(0.067)	(0.097)
HML	-0.131*	-0.133***	-0.05	0.125***	0.358***	-0.494***
	(0.074)	(0.037)	(0.032)	(0.040)	(0.059)	(0.103)
RMW	0.059	0.033	0.075***	-0.075	-0.013	0.07
	(0.064)	(0.053)	(0.029)	(0.052)	(0.093)	(0.129)
CMA	-0.083	-0.089	-0.072**	0.03	0.109	-0.184
	(0.095)	(0.057)	(0.035)	(0.083)	(0.104)	(0.160)
alpha	0.330***	0.018	-0.027	-0.011	-0.330**	0.487***
	(0.111)	(0.070)	(0.056)	(0.088)	(0.136)	(0.187)
R^2	0.894	0.96	0.976	0.954	0.879	0.268
N	192	192	192	192	192	192