Appendix to
"Volatility-Managed Portfolio: Does It Really Work?"

This appendix provides empirical results and discussions on the performance of volatility-timing strategies applied to the Fama-French size and value factors. Below we briefly describe the contents of the appendix.

- Appendix A: Performance of Volatility-Timing Strategies for Size and Value Factors
- Table A.1: In-Sample Performance of Volatility-Managed Portfolio for Size Factor
- Table A.2: Out-of-Sample Performance of Volatility-Managed Portfolio for Size Factor
- Table A.3: Performance of Volatility Targeting for Size Factor
- Table A.4: Performance of Portfolio Allocation Under Estimation Risk for Size Factor
- Table A.5: Performance of Unconditional Optimal Portfolio with Conditional Information for Size Factor
- Table A.6: In-Sample Performance of Volatility-Managed Portfolio for Value Factor
- Table A.7: Out-of-Sample Performance of Volatility-Managed Portfolio for Value Factor
- Table A.8: Performance of Volatility Targeting for Value Factor
- Table A.9: Performance of Portfolio Allocation Under Estimation Risk for Value Factor
- Table A.10: Performance of Unconditional Optimal Portfolio with Conditional Information for Value Factor

A Performance of Volatility-Timing Strategies for Size and Value Factors

Here we examine the effect of volatility timing on other non-market factors. For brevity, we focus on the size factor of Fama and French (1993).

Table A.1 compares the performance of the size factor portfolio and the corresponding volatility-managed strategy of Moreira and Muir (2017) with L estimated in-sample. The Sharpe ratio (SR) of the volatility-timing strategy over the full sample is 0.1027 under unlimited leverage and 0.1554 under limited leverage, both being lower than the SR of the size factor itself, which is 0.2302. The subsample results show that the SR of the volatility-timing strategy is consistently lower in all subperiods. In particular, from 1961 to 1980 the difference in the SR between the volatility-timing strategy with unlimited leverage and the size portfolio is economically large (0.1403 vs. 0.4316) and significant at the 10% level. In addition, volatility timing also increases the maximum drawdown (MDD), with the largest decline being 0.7154 without leverage constraint and 0.5336 with leverage constraint. Both are substantially larger than the MDD of the size factor itself, which is only 0.3133.

Table A.2 reports performance of the volatility-timing strategy of Moreira and Muir (2017) applied to the size factor with L estimated out-of-sample. Based on both 10-year fixed-window and 10-year rolling-window estimation of L, the SR of the volatility-timing strategy is lower than that of the original size factor for the full sample as well as for most subsamples. This difference is even statistically significant in some cases. Under fixed-window estimation of L, the MDD 0.9993, meaning that the volatility-managed factor portfolio almost goes bankrupt. Under rolling-window estimation, the MDD is 0.3779, still larger than that of the size factor itself.

One silent feature is that the volatility-managed portfolio strategy can no longer improve the performance of the size factor during the last period including the financial crisis, in sharp contrast to the case on the market factor. Upon further examination, this seems expected. What drives the improvement in the market factor case is the extremely high volatility, making it effective to reduce risk exposure. This is exactly the idea of volatility timing that reduces weight when volatility is high. However, the volatility of size factor is fairly stable overtime. The highly stable volatility comes from the fact that it is a long-short portfolio in which large losses of the long position are offset by large gains in the short position.

In summary, the performance of the volatility-timing strategy of Moreira and Muir (2017) on the size factor is worse than its performance on the market factor. The results are similar for value factor. In addition, the other three volatility-timing strategies also do not work. In short, all volatility-timing strategies do not improve the performance of major factor portfolios such as the size and value.

References

[1] Fama, Eugene F., and Kenneth R. French, 1993. Common risk factors in the returns on bonds and stocks. *Journal of Financial Economics* 33, 3–56.

[2] Moreira, Alan, and Tyler Muir, 2017. Volatility-managed portfolios. *Journal of Finance* 72, 1611–1644.

Table A.1: In-Sample Performance of Volatility-Managed Portfolio for Size Factor

This table reports summary statistics of the Fama-French size factor (Panel A) and the volatility-managed portfolio of Moreira and Muir (2017) applied to the size factor (Panel B) with the leverage parameter L estimated in-sample. We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). For the volatility-managed portfolio, we consider cases with unlimited leverage (UL) and limited leverage (LL) separately. We also report the risk-adjusted alpha of the volatility-managed portfolio with respect to the size factor and the difference in the Sharpe ratio between the volatility-managed portfolio and the size factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: Size Factor

	Full Sample	Aug1936–Dec1960	Jan1961–Dec1980	Jan1981–Dec2000	Jan2001–Dec2017
#Obs	977	293	240	240	204
Mean	0.0019	0.0019	0.0038	-0.0008	0.0030
Vol	0.0291	0.0260	0.0307	0.0338	0.0252
Min	-0.1728	-0.0776	-0.0991	-0.1728	-0.0611
Max	0.2214	0.2023	0.1101	0.2214	0.0761
MDD	0.3133	0.2843	0.3133	0.2988	0.1690
SR	0.2302	0.2518	0.4316	-0.0821	0.4108

Panel B: Volatility-Managed Portfolio

	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0010	0.0012	0.0021	0.0018	0.0021	0.0033	-0.0014	-0.0015	0.0010	0.0010
Vol	0.0335	0.0266	0.0346	0.0278	0.0517	0.0389	0.0160	0.0158	0.0139	0.0139
Min	-0.2558	-0.1215	-0.1459	-0.0930	-0.2558	-0.1215	-0.0788	-0.0788	-0.0519	-0.0519
Max	0.1911	0.1402	0.1850	0.1390	0.1911	0.1402	0.0645	0.0622	0.0473	0.0473
MDD	0.7154	0.5336	0.5687	0.4589	0.7154	0.5336	0.1013	0.1013	0.0916	0.0916
Alpha	-0.0005	-0.0001	0.0003	0.0003	-0.0029	-0.0010	-0.0012*	-0.0012*	-0.0005	-0.0005
SR	0.1027	0.1554	0.2105	0.2287	0.1403	0.2952	-0.3102	-0.3306	0.2384	0.2384
ΔSR	-0.1275	-0.0748	-0.0413	-0.0230	-0.2914*	-0.1365	-0.2281	-0.2485	-0.1724	-0.1724

Table A.2: Out-of-Sample Performance of Volatility-Managed Portfolio for Size Factor

This table reports summary statistics of the volatility-managed portfolio of Moreira and Muir (2017) applied to the Fama-French size factor with the leverage parameter L estimated out-of-sample using a 10-year fixed training window (Panel A) and 10-year rolling windows (Panel B). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the volatility-managed portfolio with respect to the size factor and the difference in the Sharpe ratio between the volatility-managed portfolio and the size factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: 10-Year Fixed Window										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0031	0.0021	0.0065	0.0024	0.0064	0.0061	-0.0044	-0.0035	0.0029	0.0033
Vol	0.1028	0.0434	0.1064	0.0400	0.1590	0.0567	0.0493	0.0376	0.0427	0.0354
Min	-0.7863	-0.1982	-0.4485	-0.1378	-0.7863	-0.1982	-0.2424	-0.1224	-0.1596	-0.1222
Max	0.5873	0.1802	0.5687	0.1802	0.5873	0.1694	0.1984	0.1226	0.1454	0.1096
MDD	0.9993	0.6406	0.9681	0.5596	0.9993	0.6406	0.9836	0.4293	0.9805	0.2932
Alpha	-0.0015	-0.0005	0.0010	-0.0002	-0.0089	-0.0008	-0.0036*	-0.0028**	-0.0014	-0.0005
SR	0.1027	0.1644	0.2105	0.2085	0.1403	0.3741	-0.3102	-0.3214	0.2384	0.3241
ΔSR	-0.1275	-0.0658	-0.0413	-0.0433	-0.2914*	-0.0576*	-0.2281	-0.2393**	-0.1724	-0.0867
Panel B: 10-Year Rolling Window										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0021	0.0012	0.0058	0.0025	0.0015	0.0018	-0.0020	-0.0023	0.0024	0.0027
Vol	0.0357	0.0280	0.0504	0.0345	0.0250	0.0233	0.0229	0.0215	0.0328	0.0293
Min	-0.1719	-0.1378	-0.1719	-0.1378	-0.1130	-0.0802	-0.1412	-0.1224	-0.1227	-0.1222
Max	0.3736	0.1802	0.3736	0.1802	0.0746	0.0616	0.0997	0.0622	0.1352	0.1084
MDD	0.3779	0.3781	0.3739	0.3781	0.3779	0.3301	0.1902	0.1902	0.2032	0.1575
Alpha	0.0005	-0.0003	0.0030**	0.0003	-0.0010	-0.0006	-0.0016	-0.0019**	-0.0008	-0.0004
SR	0.2076	0.1493	0.3977	0.2558	0.2124	0.2702	-0.2990	-0.3683	0.2588	0.3154
ΔSR	-0.0226	-0.0809	0.1459	0.0041	-0.2193	-0.1614	-0.2169	-0.2862**	-0.1521	-0.0954

Table A.3: Performance of Volatility Targeting for Size Factor

This table reports summary statistics of the volatility-targeting strategy of Barroso and Santa-Clara (2015) applied to the Fama-French size factor with annualized target volatility of 12% (Panel A), 16% (Panel B), and 20% (Panel C). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the volatility-targeting strategy with respect to the size factor and the difference in the Sharpe ratio between the volatility-targeting strategy and the size factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
Panel A: Annualized Target Volatility 12%										
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0029	0.0026	0.0039	0.0029	0.0069	0.0065	-0.0031	-0.0028	0.0039	0.0040
Vol	0.0577	0.0456	0.0568	0.0420	0.0793	0.0571	0.0447	0.0425	0.0392	0.0380
Min	-0.2288	-0.1982	-0.1610	-0.1378	-0.2288	-0.1982	-0.1569	-0.1396	-0.1273	-0.1222
Max	0.2496	0.2214	0.2496	0.2214	0.2462	0.1694	0.1421	0.1421	0.1087	0.1084
MDD	0.8531	0.6353	0.7578	0.5550	0.8531	0.6353	0.4755	0.4643	0.2745	0.2590
Alpha	-0.0005	-0.0003	0.0003	-0.0000	-0.0023	-0.0005	-0.0021*	-0.0019**	-0.0006	-0.0003
SR	0.1759	0.1968	0.2389	0.2363	0.3018	0.3939	-0.2376	-0.2323	0.3422	0.3652
ΔSR	-0.0543	-0.0334	-0.0128	-0.0155	-0.1298	-0.0378	-0.1555*	-0.1502*	-0.0686	-0.0456
Panel B: Annualized Target Volatility 16%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0039	0.0032	0.0052	0.0031	0.0092	0.0074	-0.0041	-0.0028	0.0052	0.0053
Vol	0.0769	0.0509	0.0758	0.0458	0.1057	0.0603	0.0596	0.0511	0.0523	0.0449
Min	-0.3051	-0.1982	-0.2146	-0.1378	-0.3051	-0.1982	-0.2092	-0.1861	-0.1697	-0.1222
Max	0.3328	0.2952	0.3328	0.2952	0.3283	0.1954	0.1895	0.1895	0.1450	0.1276
MDD	0.9379	0.6303	0.8664	0.5637	0.9379	0.6303	0.6938	0.5499	0.5599	0.3413
Alpha	-0.0006	-0.0001	0.0003	-0.0001	-0.0031	-0.0001	-0.0028*	-0.0016*	-0.0008	0.0000
SR	0.1759	0.2157	0.2389	0.2370	0.3018	0.4230	-0.2376	-0.1873	0.3422	0.4059
ΔSR	-0.0543	-0.0145	-0.0128	-0.0148	-0.1298	-0.0087	-0.1555*	-0.1052	-0.0686	-0.0049
Panel C: Annualized Target Volatility 20%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0049	0.0036	0.0065	0.0035	0.0115	0.0076	-0.0051	-0.0021	0.0065	0.0058
Vol	0.0961	0.0539	0.0947	0.0488	0.1321	0.0612	0.0744	0.0566	0.0654	0.0480
Min	-0.3813	-0.2327	-0.2683	-0.1378	-0.3813	-0.1982	-0.2616	-0.2327	-0.2121	-0.1222
Max	0.4160	0.3690	0.4160	0.3690	0.4104	0.2187	0.2369	0.2369	0.1812	0.1522
MDD	0.9757	0.6338	0.9294	0.5635	0.9757	0.6338	0.8354	0.5793	0.7578	0.3300
Alpha	-0.0008	0.0001	0.0004	0.0000	-0.0039	-0.0000	-0.0035*	-0.0008	-0.0010	0.0001
SR	0.1759	0.2321	0.2389	0.2512	0.3018	0.4313	-0.2376	-0.1304	0.3422	0.4158
ΔSR	-0.0543	0.0019	-0.0128	-0.0005	-0.1298	-0.0003	-0.1555*	-0.0483	-0.0686	0.0050

Table A.4: Performance of Portfolio Allocation Under Estimation Risk for Size Factor

This table reports summary statistics of the mean-variance portfolio allocation strategy under estimation risk of Kan and Zhou (2007) applied to the Fama-French size factor with risk aversion levels of $A = 3$ (Panel A) and $A = 5$ (Panel B). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the portfolio allocation strategy with respect to the size factor and the difference in the Sharpe ratio between the portfolio allocation strategy and the size factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: Risk Aversion $A = 3$										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0038	0.0016	0.0275	0.0029	-0.0119	0.0027	-0.0056	-0.0007	-0.0006	0.0013
Vol	0.1583	0.0384	0.2229	0.0452	0.1837	0.0477	0.0742	0.0277	0.0404	0.0237
Min	-1.1581	-0.1548	-0.4114	-0.1378	-1.1581	-0.1548	-0.4139	-0.0858	-0.2910	-0.0844
Max	1.5618	0.3574	1.5618	0.3574	0.6194	0.1694	0.4460	0.1226	0.1882	0.1084
MDD	Broke	0.6482	0.9881	0.4497	Broke	0.6482	Broke	0.2440	Broke	0.1771
Alpha	-0.0009	0.0001	0.0177*	0.0003	-0.0245*	-0.0020	-0.0052	-0.0006	-0.0032	-0.0006
SR	0.0835	0.1484	0.4273	0.2196	-0.2247	0.1997	-0.2625	-0.0833	-0.0495	0.1920
ΔSR	-0.1467	-0.0818	0.1756	-0.0321	-0.6563***	-0.2320	-0.1805	-0.0012	-0.4603**	-0.2188
Panel B: Risk Aversion $A = 5$										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0023	0.0009	0.0165	0.0027	-0.0071	0.0010	-0.0034	-0.0012	-0.0003	0.0005
Vol	0.0950	0.0333	0.1337	0.0403	0.1102	0.0411	0.0445	0.0235	0.0243	0.0184
Min	-0.6948	-0.1378	-0.2468	-0.1378	-0.6948	-0.1226	-0.2483	-0.0858	-0.1746	-0.0844
Max	0.9371	0.2144	0.9371	0.2144	0.3717	0.1472	0.2676	0.1226	0.1129	0.0769
MDD	0.9976	0.6367	0.8976	0.4519	0.9976	0.6367	0.9935	0.2296	0.9888	0.1598
Alpha	-0.0005	-0.0004	0.0106*	0.0005	-0.0147*	-0.0029	-0.0031	-0.0011	-0.0019	-0.0009
SR	0.0835	0.0899	0.4273	0.2311	-0.2247	0.0860	-0.2625	-0.1731	-0.0495	0.0867
ΔSR	-0.1467	-0.1403	0.1756	-0.0207	-0.6563***	-0.3457**	-0.1805	-0.0910	-0.4603**	-0.3241*

Table A.5: Performance of Unconditional Optimal Portfolio with Conditional Information for Size Factor

This table reports summary statistics of the unconditional optimal portfolio with conditional information of Ferson and Siegel (2001) applied to the Fama-French size factor with annualized target expected returns of 6% (Panel A) and 10% (Panel B). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the unconditional optimal portfolio with respect to the size factor and the difference in the Sharpe ratio between the unconditional optimal portfolio and the size factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
Panel A: Annualized Target Expected Return 6%										
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0005	0.0006	0.0027	0.0024	-0.0005	0.0003	-0.0010	-0.0009	0.0000	0.0000
Vol	0.0230	0.0214	0.0279	0.0270	0.0295	0.0256	0.0143	0.0141	0.0123	0.0122
Min	-0.1592	-0.1078	-0.1048	-0.1048	-0.1592	-0.1078	-0.0606	-0.0606	-0.0721	-0.0721
Max	0.1635	0.1635	0.1635	0.1635	0.0930	0.0924	0.0812	0.0812	0.0512	0.0512
MDD	0.6014	0.4906	0.2549	0.2547	0.6014	0.4906	0.0857	0.0857	0.1088	0.1095
Alpha	-0.0004	-0.0002	0.0012	0.0009	-0.0029	-0.0020	-0.0009	-0.0009	-0.0009	-0.0009
SR	0.0721	0.0946	0.3404	0.3105	-0.0573	0.0393	-0.2312	-0.2212	0.0140	0.0129
ΔSR	-0.1581	-0.1356	0.0887	0.0587	-0.4889**	-0.3924**	-0.1491	-0.1391	-0.3968**	-0.3979**
Panel B: Annualized Target Expected Return 10%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0008	0.0010	0.0046	0.0027	-0.0008	0.0016	-0.0016	-0.0012	0.0001	0.0004
Vol	0.0384	0.0301	0.0466	0.0378	0.0492	0.0349	0.0238	0.0212	0.0204	0.0184
Min	-0.2653	-0.1378	-0.1746	-0.1378	-0.2653	-0.1222	-0.1010	-0.0857	-0.1201	-0.0844
Max	0.2725	0.2725	0.2725	0.2725	0.1550	0.1286	0.1354	0.1226	0.0854	0.0710
MDD	0.8304	0.5639	0.3965	0.3592	0.8304	0.5639	0.4415	0.1567	0.1806	0.1628
Alpha	-0.0006	-0.0002	0.0020	0.0004	-0.0048	-0.0017	-0.0015	-0.0011	-0.0016	-0.0012
SR	0.0721	0.1127	0.3404	0.2432	-0.0573	0.1600	-0.2312	-0.1942	0.0140	0.0729
ΔSR	-0.1581	-0.1175	0.0887	-0.0086	-0.4889**	-0.2716	-0.1491	-0.1121	-0.3968**	-0.3379**

Table A.6: In-Sample Performance of Volatility-Managed Portfolio for Value Factor

This table reports summary statistics of the Fama-French value factor (Panel A) and the volatility-managed portfolio of Moreira and Muir (2017) applied to the value factor (Panel B) with the leverage parameter L estimated in-sample. We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). For the volatility-managed portfolio, we consider cases with unlimited leverage (UL) and limited leverage (LL) separately. We also report the risk-adjusted alpha of the volatility-managed portfolio with respect to the value factor and the difference in the Sharpe ratio between the volatility-managed portfolio and the value factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: Value Factor					
	Full Sample	Aug1936–Dec1960	Jan1961–Dec1980	Jan1981–Dec2000	Jan2001–Dec2017
#Obs	977	293	240	240	204
Mean	0.0038	0.0040	0.0042	0.0048	0.0017
Vol	0.0283	0.0293	0.0249	0.0306	0.0276
Min	-0.1110	-0.0829	-0.0999	-0.1057	-0.1110
Max	0.2222	0.2222	0.0857	0.1130	0.1290
MDD	0.3730	0.3630	0.1971	0.3730	0.2502
SR	0.4621	0.4672	0.5904	0.5435	0.2168

Panel B: Volatility-Managed Portfolio										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0042	0.0039	0.0021	0.0029	0.0092	0.0066	0.0035	0.0038	0.0023	0.0021
Vol	0.0365	0.0285	0.0323	0.0277	0.0466	0.0334	0.0333	0.0286	0.0317	0.0228
Min	-0.2061	-0.1274	-0.1424	-0.0752	-0.1898	-0.1274	-0.1155	-0.0784	-0.2061	-0.0668
Max	0.2350	0.1750	0.1750	0.1750	0.2350	0.1517	0.1237	0.1174	0.1283	0.0897
MDD	0.4369	0.2488	0.2615	0.2158	0.3474	0.2471	0.3138	0.2382	0.4369	0.2488
Alpha	0.0009	0.0009	-0.0012	-0.0002	0.0031	0.0017	-0.0001	0.0005	0.0012	0.0011
SR	0.4021	0.4710	0.2285	0.3651	0.6810	0.6879	0.3660	0.4643	0.2527	0.3148
ΔSR	-0.0600	0.0089	-0.2387*	-0.1021	0.0907	0.0976	-0.1776	-0.0792	0.0360	0.0980

Table A.7: Out-of-Sample Performance of Volatility-Managed Portfolio for Value Factor

This table reports summary statistics of the volatility-managed portfolio of Moreira and Muir (2017) applied to the Fama-French value factor with the leverage parameter L estimated out-of-sample using a 10-year fixed training window (Panel A) and 10-year rolling windows (Panel B). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the volatility-managed portfolio with respect to the value factor and the difference in the Sharpe ratio between the volatility-managed portfolio and the value factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: 10-Year Fixed Window

	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0164	0.0066	0.0082	0.0065	0.0354	0.0086	0.0136	0.0071	0.0089	0.0037
Vol	0.1410	0.0474	0.1248	0.0525	0.1801	0.0476	0.1288	0.0474	0.1223	0.0392
Min	-0.7966	-0.1761	-0.5505	-0.1201	-0.7335	-0.1761	-0.4463	-0.1196	-0.7966	-0.1194
Max	0.9082	0.4444	0.6764	0.4444	0.9082	0.1714	0.4781	0.1520	0.4960	0.1654
MDD	0.9679	0.5018	0.9325	0.5018	0.9313	0.3881	0.9205	0.4613	0.9679	0.3201
Alpha	0.0033	0.0007	-0.0046	-0.0003	0.0118	0.0006	-0.0004	0.0004	0.0045	0.0017
SR	0.4021	0.4798	0.2285	0.4285	0.6810	0.6274	0.3660	0.5171	0.2527	0.3253
ΔSR	-0.0600	0.0177	-0.2387*	-0.0386	0.0907	0.0371	-0.1776	-0.0264	0.0360	0.1085

Panel B: 10-Year Rolling Window

	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0043	0.0032	0.0057	0.0037	0.0050	0.0042	0.0022	0.0022	0.0042	0.0026
Vol	0.0451	0.0297	0.0695	0.0431	0.0252	0.0224	0.0214	0.0201	0.0394	0.0226
Min	-0.2563	-0.1271	-0.2086	-0.1271	-0.0975	-0.0975	-0.0719	-0.0719	-0.2563	-0.0668
Max	0.7880	0.4444	0.7880	0.4444	0.1444	0.0982	0.0859	0.0811	0.1913	0.0868
MDD	0.5981	0.5239	0.5981	0.5239	0.1398	0.1398	0.1762	0.1444	0.4642	0.2177
Alpha	0.0005	0.0002	-0.0016	-0.0015*	0.0017	0.0011	-0.0002	-0.0001	0.0029	0.0017
SR	0.3323	0.3777	0.2825	0.2955	0.6827	0.6571	0.3529	0.3818	0.3680	0.4055
ΔSR	-0.1298	-0.0844	-0.1847*	-0.1717**	0.0924	0.0667	-0.1907	-0.1618	0.1513	0.1887

Table A.8: Performance of Volatility Targeting for Value Factor

This table reports summary statistics of the volatility-targeting strategy of Barroso and Santa-Clara (2015) applied to the Fama-French value factor with annualized target volatility of 12% (Panel A), 16% (Panel B), and 20% (Panel C). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the volatility-targeting strategy with respect to the value factor and the difference in the Sharpe ratio between the volatility-targeting strategy and the value factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: Annualized Target Volatility 12%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0077	0.0065	0.0062	0.0064	0.0123	0.0086	0.0079	0.0074	0.0041	0.0034
Vol	0.0549	0.0445	0.0552	0.0479	0.0614	0.0447	0.0547	0.0457	0.0461	0.0372
Min	-0.2258	-0.1386	-0.1503	-0.0991	-0.2258	-0.1386	-0.1382	-0.1097	-0.1704	-0.1026
Max	0.4050	0.4050	0.4050	0.4050	0.2342	0.1714	0.1918	0.1520	0.1572	0.1572
MDD	0.5062	0.4580	0.4580	0.4580	0.5062	0.3567	0.4553	0.4298	0.5017	0.3174
Alpha	0.0012	0.0009*	-0.0007	0.0001	0.0025	0.0011*	0.0004	0.0007	0.0018	0.0013
SR	0.4841	0.5087	0.3886	0.4594	0.6909	0.6650	0.5026	0.5571	0.3102	0.3178
ΔSR	0.0220	0.0466	-0.0786	-0.0078	0.1005	0.0746*	-0.0409	0.0136	0.0934	0.1010
Panel B: Annualized Target Volatility 16%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0102	0.0069	0.0083	0.0070	0.0163	0.0085	0.0106	0.0079	0.0055	0.0037
Vol	0.0733	0.0495	0.0736	0.0542	0.0819	0.0484	0.0729	0.0509	0.0615	0.0420
Min	-0.3011	-0.1848	-0.2004	-0.1322	-0.3011	-0.1848	-0.1842	-0.1394	-0.2272	-0.1368
Max	0.5400	0.4444	0.5400	0.4444	0.3122	0.1714	0.2557	0.1520	0.2096	0.1654
MDD	0.6380	0.5411	0.5719	0.5411	0.6380	0.4007	0.5898	0.5374	0.6302	0.3466
Alpha	0.0016	0.0005	-0.0010	-0.0002	0.0034	0.0003	0.0005	0.0002	0.0023	0.0013
SR	0.4841	0.4831	0.3886	0.4479	0.6909	0.6122	0.5026	0.5368	0.3102	0.3051
ΔSR	0.0220	0.0210	-0.0786	-0.0193	0.1005	0.0219	-0.0409	-0.0068	0.0934	0.0883
Panel C: Annualized Target Volatility 20%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0128	0.0071	0.0103	0.0074	0.0204	0.0084	0.0132	0.0084	0.0069	0.0038
Vol	0.0916	0.0520	0.0921	0.0564	0.1024	0.0496	0.0911	0.0545	0.0769	0.0446
Min	-0.3764	-0.1998	-0.2505	-0.1652	-0.3764	-0.1998	-0.2303	-0.1743	-0.2840	-0.1616
Max	0.6750	0.4444	0.6750	0.4444	0.3903	0.1714	0.3197	0.1520	0.2620	0.1654
MDD	0.7396	0.6014	0.6693	0.5927	0.7396	0.4190	0.6938	0.6014	0.7326	0.3636
Alpha	0.0019	0.0004	-0.0012	-0.0001	0.0042	-0.0000	0.0006	0.0001	0.0029	0.0012
SR	0.4841	0.4766	0.3886	0.4548	0.6909	0.5867	0.5026	0.5360	0.3102	0.2941
ΔSR	0.0220	0.0145	-0.0786	-0.0124	0.1005	-0.0036	-0.0409	-0.0075	0.0934	0.0773

Table A.9: Performance of Portfolio Allocation Under Estimation Risk for Value Factor

This table reports summary statistics of the mean-variance portfolio allocation strategy under estimation risk of Kan and Zhou (2007) applied to the Fama-French value factor with risk aversion levels of $A = 3$ (Panel A) and $A = 5$ (Panel B). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the portfolio allocation strategy with respect to the value factor and the difference in the Sharpe ratio between the portfolio allocation strategy and the value factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

Panel A: Risk Aversion $A = 3$										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0185	0.0065	0.0105	0.0067	0.0354	0.0081	0.0158	0.0077	0.0131	0.0028
Vol	0.1940	0.0452	0.1754	0.0528	0.2561	0.0469	0.1705	0.0436	0.1571	0.0314
Min	-1.2116	-0.1998	-0.7663	-0.1188	-1.0916	-0.1998	-0.7397	-0.1196	-1.2116	-0.1616
Max	1.8175	0.4444	0.8616	0.4444	1.8175	0.1714	0.7787	0.1520	0.7130	0.1162
MDD	Broke	0.5112	0.9969	0.5112	Broke	0.3758	Broke	0.3425	Broke	0.3195
Alpha	0.0034	0.0014	-0.0061	-0.0001	0.0071	0.0002	0.0002	0.0025	0.0093	0.0017
SR	0.3302	0.4968	0.2081	0.4423	0.4792	0.5969	0.3219	0.6132	0.2889	0.3090
ΔSR	-0.1319	0.0347	-0.2591*	-0.0249	-0.1112	0.0066	-0.2216	0.0697	0.0721	0.0922
Panel B: Risk Aversion $A = 5$										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0111	0.0060	0.0063	0.0059	0.0213	0.0081	0.0095	0.0067	0.0079	0.0029
Vol	0.1164	0.0399	0.1052	0.0453	0.1536	0.0423	0.1023	0.0394	0.0943	0.0272
Min	-0.7269	-0.1279	-0.4598	-0.1188	-0.6550	-0.1279	-0.4438	-0.1196	-0.7269	-0.1119
Max	1.0905	0.2968	0.5170	0.2968	1.0905	0.1714	0.4672	0.1520	0.4278	0.1162
MDD	0.9163	0.4027	0.9057	0.4027	0.9163	0.3131	0.9105	0.3151	08977	0.2680
Alpha	0.0020	0.0017**	-0.0036	0.0002	0.0043	0.0012	0.0001	0.0022	0.0056	0.0019
SR	0.3302	0.5219	0.2081	0.4484	0.4792	0.6661	0.3219	0.5921	0.2889	0.3632
ΔSR	-0.1319	0.0598	-0.2591*	-0.0187	-0.1112	0.0757	-0.2216	0.0486	0.0721	0.1464

Table A.10: Performance of Unconditional Optimal Portfolio with Conditional Information for Value Factor

This table reports summary statistics of the unconditional optimal portfolio with conditional information of Ferson and Siegel (2001) applied to the Fama-French value factor with annualized target expected returns of 6% (Panel A) and 10% (Panel B). We report results for the full sample from August 1936 to December 2017 as well as for four different subsample periods. We consider cases with unlimited leverage (UL) and limited leverage (LL) separately. The summary statistics include the number of observations, mean, volatility, minimum, maximum, maximum drawdown (MDD), and the Sharpe ratio (SR). We also report the risk-adjusted alpha of the unconditional optimal portfolio with respect to the value factor and the difference in the Sharpe ratio between the unconditional optimal portfolio and the value factor. Asterisks denote statistical significance based on Newey-West standard errors (for alpha) or HAC standard errors (for the Sharpe ratio test) at the 1% (***), 5% (**) and 10% (*) levels.

	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
Panel A: Annualized Target Expected Return 6%										
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0037	0.0031	0.0049	0.0033	0.0050	0.0044	0.0024	0.0025	0.0018	0.0019
Vol	0.0310	0.0265	0.0434	0.0353	0.0296	0.0264	0.0207	0.0203	0.0187	0.0164
Min	-0.1211	-0.1211	-0.1199	-0.1188	-0.1211	-0.1211	-0.0794	-0.0784	-0.1155	-0.0668
Max	0.3736	0.3081	0.3736	0.3081	0.1372	0.1156	0.0944	0.0944	0.0759	0.0744
MDD	0.3474	0.3474	0.3474	0.3474	0.2140	0.2080	0.1818	0.1756	0.2320	0.1706
Alpha	0.0008	0.0004	0.0001	-0.0010	0.0011	0.0006	0.0003	0.0003	0.0013	0.0014
SR	0.4116	0.4019	0.3889	0.3267	0.5895	0.5740	0.4034	0.4183	0.3415	0.4009
ΔSR	-0.0505	-0.0602	-0.0782	-0.1404*	-0.0008	-0.0163	-0.1401	-0.1253	0.1248	0.1841
Panel B: Annualized Target Expected Return 10%										
	Full Sample		Aug1936–Dec1960		Jan1961–Dec1980		Jan1981–Dec2000		Jan2001–Dec2017	
	UL	LL	UL	LL	UL	LL	UL	LL	UL	LL
#Obs	977	977	293	293	240	240	240	240	204	204
Mean	0.0061	0.0045	0.0081	0.0048	0.0084	0.0063	0.0040	0.0043	0.0031	0.0023
Vol	0.0516	0.0359	0.0724	0.0477	0.0494	0.0342	0.0346	0.0300	0.0312	0.0214
Min	-0.2018	-0.1274	-0.1998	-0.1188	-0.2018	-0.1274	-0.1324	-0.0784	-0.1924	-0.0668
Max	0.6227	0.4444	0.6227	0.4444	0.2287	0.1714	0.1574	0.1520	0.1266	0.0822
MDD	0.5309	0.4899	0.5309	0.4899	0.3994	0.2471	0.3679	0.2462	0.3916	0.2072
Alpha	0.0014	0.0007	0.0002	-0.0014**	0.0018	0.0011	0.0005	0.0010	0.0022	0.0017
SR	0.4116	0.4359	0.3889	0.3451	0.5895	0.6375	0.4034	0.4927	0.3415	0.3801
ΔSR	-0.0505	-0.0262	-0.0782	-0.1221**	-0.0008	0.0472	-0.1401	-0.0509	0.1248	0.1633