Enhanced Global Asset Pricing Factors

Online Appendix

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Appendix A. Analyses

A. The Benefits of Regional Diversification

The international data in combination with the categorical factors opens up the opportunity to study a further enhancement approach by examining various ways to diversify internationally. This way of obtaining efficiency gains is effectively also a way to reduce risk, as an improvement in Sharpe ratios should be optimally achieved by a reduction in volatility. Table B.3 reports the correlations of the categorical factors between regions. The correlations between the North American and European factors are relatively high in some instances, suggesting that these regions might react similar to shocks that affect factor returns. However, correlations are mostly low for the other regional pairs, ranging between -0.11 and 0.42.[1] The low correlations are signaling possible diversification benefits of international investments. As we want to take an ex-ante perspective, we do not make any assumptions with respect to the weights each regional or categorical factor should be assigned in the resulting global categorical factor portfolio. We thus assign equal weights to each regional or categorical factor and compute the global factors as equal-weighted mean of all regional or categorical factors.[2] First, we show results for internationally diversified categorical factors in Table B.1.

Insert Table B.1 here

For each category and for the overall market, we present summary statistics for four global factor versions: the traditional factor, the cross-sectionally enhanced factor, the

[1]The online appendix also contains correlations with the international Fama and French (2012) factors, as well as a comparison of summary statistics. Correlations are sufficiently high to claim that each categorical factor is capturing the specific concept and sufficiently low to claim that the factors are similar, but distinct from each other.

[2]A regional market value-weighted mean would result in a portfolio dominated by the North American market and thus not deliver the desired diversification benefits.

volatility-scaled factor, and the factor combining both enhancement approaches. Factors resulting from a combination of all enhancement approaches obtain the highest Sharpe ratios for five out of the seven global factors. Only the time-series enhanced momentum factor version and the cross-sectionally enhanced profitability factor version come with the highest Sharpe ratio in the respective category. Further, the average differences in the Sharpe ratio between the regional factors and the global factors are positive. On average, the strongest improvement can be achieved for the investment, profitability, intangibles, and frictions factor, where the increase lies between 35% and 102%. Weakest results are observed for the market factor.

If efficiency gains are due to international diversification benefits, an effect on the Sharpe ratio should follow from a reduction in volatility. We additionally report the average percentage difference between the volatility of the single regional factors and the volatility of the corresponding global factor. Volatility of global categorical factors decreases by at least 24% compared to volatility of regional factors. Again, results for the market factor are slightly weaker, but economically significant. The average increase in the Sharpe ratios is thus reflected in reduced volatility.

Next, we investigate effects of investments in factors across multiple categories. We also combine this cross-factor diversification approach with international diversification to a diversification strategy that invests into multiple regions and categories. Similar as in the preceding analysis, to obtain regional factors that are implementable ex-ante we assign equal share to the six regional categorical factors and the regional market factor. Further, we construct a global factor that assigns equal share to each regional categorical and market factor. Table B.2 reports monthly mean return, the Sharpe ratio, and statistics of the return distribution.

Insert Table B.2 here

The cross-factor diversification approach proves successful in all regions expect for the Asian-Pacific region, when benchmarked to the individual regional factors with the highest

Sharpe ratio. In the Asian-Pacific region, factors from the momentum category perform only slightly worse than the diversified factors. In Emerging Markets the factor that diversifies over traditional factors performs better than all factors that diversify over enhanced factors. However, here the results are dependent on the method employed for annualization of returns. If annualized returns are based on annualization of monthly returns instead of on cumulative returns, the picture reverses. Time variation thus seems to affect results in this case. Generally, the regionally diversified enhanced factors are outperforming their traditional counterpart if this also applies to the categorical level.
To illustrate the joint effect of the examined enhancement approaches, we compare different metrics that constitute suitable estimates for this joint effect. First, we observe the average increase in the Sharpe ratio between the traditional regional factors and the internationally diversified categorical factors combining both enhancement approaches. The increase is 136%, which correspond to a factor of 2.36. Second, we observe which factor yields the highest Sharpe ratio. It is the global factor that combines the cross-sectional and time-series enhancement approach and that diversifies over all regions. The factor yields a Sharpe ratio of 2.96 or 3.34, dependent on the employed annualization method. To quantify the effect, this implies an increases by a factor of 2.19 compared to the average Sharpe ratio of the regionally diversified traditional factors.

B. Time-Effects

Recent evidence suggests that anomaly returns might decline over time. For instance Mclean and Pontiff (2016) show that many anomaly returns decline in the US market after publication and Linnainmaa and Roberts (2018) claim that many accounting based anomalies are insignificant out-of-sample in the US market. However, there is also evidence that international anomaly returns do not decline and remain rather similar in more recent time periods, as suggested by Jacobs and Müller (2020). We therefore want to test whether we can observe time effects for the success of the studied hedging techniques and thus

whether the benefits of factor enhancement also persist in recent time periods. In Table B.4 we report Sharpe ratios of the categorical factors for two different time periods. The first period extends from 1995 to 2006 and the second period from 2007 to 2019, both covering approximately half of our sample. For each composite categorical factor and each region, we report the Sharpe ratio of the unhedged factor and of the cross-sectionally hedged factor, as well as the Sharpe ratio of the volatility-scaled version of both factors. For the sake of brevity, we only report results for the volatility-scaling approach following Moreira and Muir (2017).

Insert Table B.4 here

In case of the value factor, the enhancing effect is clearly weaker in the second half of the sample, although the factors have economically significant Sharpe ratios. This finding is consistent with a declining profitability of the value premium as documented in Lev and Srivastava (2019) or Arnott et al. (2019). There is still an improving effect on the investment, profitability, and intangibles factor in 3 out of the 5 regions, respectively. Results for the momentum factor are very similar in both time periods and the enhancing effect of volatility-scaling persists. The enhancement effect on the market factor clearly improves in the second time period in all regions except for Europe, where the effect is comparable over both periods.

Generally, in the European and Asian-Pacific market the benefits of the hedging techniques do not decline over time, but remain relatively similar. If an enhancement technique works in the first half of our observed time period, it usually also works in the second half. In North America time-series enhancement for the momentum factor and cross-sectional enhancement for the investment, intangibles, and frictions factor keep working in the second half, however, the improvement effects are tendentially weaker. In Japan, especially the effect of cross-sectional enhancement is clearly weaker in the second time period, except for the market factor which profits strongly from this technique. Interestingly, for Emerging Markets the effect of factor enhancement is significantly stronger in the second

half of the sample. The improvement in the Sharpe ratio clearly increases in case of cross-sectional enhancement for all factors except for the composite value factor, for which it works relatively similar in both samples, and for the composite intangibles factor. Volatility-scaling works better on momentum in the second half as well. Overall, it can be said that the examined enhancement techniques work for all regions in the first as well as in the second half of our sample period, except for Japan, consistent with the findings of Jacobs and Müller (2020). There is even an improvement in enhancement outcomes for Emerging Markets.

Table B.1: International Diversification Benefits

This table shows results for internationally diversified categorical factors. For each category an international factor version of the traditional factor, the cross-sectionally enhanced factor, the volatility-scaled factor, and the factor version combining both enhancement approaches by volatility-scaling the cross-sectionally enhanced factor is computed. The international factor is constituted by an equal-weighted average of the 5 regional factors. The table reports the monthly time-series mean return and the corresponding Newey and West (1987) adjusted t-statistics (6 lags), the alpha with respect to a factor model combination of the global market factor and the other 5 global categorical factors (α^{6fac}) and the corresponding Newey-West adjusted t-statistics, the Sharpe ratio from annually compounded returns, the average increase in this Sharpe ratio compared to the Sharpe ratio of the 5 regional factors ($\Delta(\text{SR}^{Comp}\varnothing\ \%)$), the Sharpe ratio from annualized monthly returns, the volatility, the average change in volatility with respect to the volatility of the regional factors ($\Delta(\text{Vola}\ \varnothing\ \%)$), and the skewness.

Category	Enhancement	Mean	T-Stats	α^{6fac}	T-Stats (α^{6fac})	Sharpe	$\Delta(\text{SR}^{Comp}$ $\varnothing\ \%)$	Sharpe Monthly^{Ann}	Vola	Δ(Vola $\varnothing\ \%$)	Skew
Market	Traditional	0.683	2.188	1.465	6.019	0.455	8.38	0.523	4.525	-13.12	-0.751
	Cross-Sectional	0.736	4.042	1.042	5.443	0.770	23.44	0.995	2.563	-29.72	-1.102
	Time-Series	0.993	2.533	1.918	5.336	0.505	6.36	0.620	5.551	-16.06	-0.591
	Combined	1.215	4.240	1.404	4.365	0.775	22.20	1.107	3.802	-29.86	-0.369
Value	Traditional	0.768	2.866	0.621	3.930	0.516	5.09	0.762	3.489	-31.20	-0.544
	Cross-Sectional	0.827	4.282	0.632	4.379	0.767	19.51	1.162	2.467	-36.62	-0.600
	Time-Series	0.864	3.152	0.770	3.414	0.594	27.25	0.783	3.822	-36.72	-0.084
	Combined	1.092	4.748	0.939	4.348	0.843	33.64	1.319	2.867	-41.65	-0.523
Investment	Traditional	0.381	2.825	0.069	0.631	0.519	37.37	0.669	1.974	-36.95	0.574
	Cross-Sectional	0.396	4.029	0.169	1.703	0.731	58.16	0.984	1.395	-44.81	0.517
	Time-Series	0.479	3.273	0.276	1.864	0.633	54.16	0.736	2.253	-41.14	0.298
	Combined	0.499	4.593	0.342	2.653	0.878	66.10	1.031	1.678	-45.96	0.438
Profitability	Traditional	0.716	3.784	-0.203	-1.481	0.744	63.59	0.880	2.818	-40.34	-0.141
	Cross-Sectional	0.666	5.060	-0.065	-0.551	1.012	76.25	1.150	2.005	-40.94	0.022
	Time-Series	1.042	3.932	-0.119	-0.536	0.755	50.88	0.993	3.636	-38.74	-0.043
	Combined	0.828	4.772	-0.138	-0.808	0.950	70.13	1.142	2.510	-40.18	-0.011
Momentum	Traditional	1.129	4.650	1.011	4.856	1.030	30.21	1.036	3.776	-24.50	-0.515
	Cross-Sectional	1.043	4.803	1.060	5.885	1.073	36.76	1.106	3.267	-27.11	-0.432
	Time-Series	1.966	6.758	1.626	5.369	1.336	41.17	1.540	4.423	-31.43	-0.261
	Combined	1.878	6.730	1.707	5.864	1.325	45.76	1.610	4.041	-33.22	-0.252
Intangibles	Traditional	0.536	5.112	0.546	5.669	0.922	78.13	1.273	1.459	-52.96	0.574
	Cross-Sectional	0.537	6.361	0.334	3.642	1.119	67.01	1.561	1.193	-51.54	0.468
	Time-Series	0.659	5.532	0.540	4.268	1.035	101.99	1.225	1.865	-52.69	-0.009
	Combined	0.638	6.698	0.387	3.451	1.270	81.58	1.511	1.462	-50.64	0.048
Frictions	Traditional	0.940	4.814	0.361	2.833	0.845	34.98	1.145	2.843	-41.26	-0.221
	Cross-Sectional	0.910	6.877	0.374	3.299	1.288	71.78	1.494	2.109	-44.26	-0.158
	Time-Series	1.016	4.835	0.360	2.164	0.895	55.81	1.128	3.118	-45.01	-0.227
	Combined	1.135	7.144	0.535	3.361	1.327	87.75	1.584	2.482	-47.95	0.421

Table B.2: Regional and Global Factors

This table presents results for regionally and globally diversified factors. For each region the regionally diversified factor is computed as equal-weighted mean of the six categorical factors and the respective market factor. The combination consists either of the traditional factors, the cross-sectionally enhanced factors, the factors that employ volatility-scaling with time-series information, or the factors that combine both enhancement approaches by volatility-scaling the cross-sectionally enhanced factors. The global factors put equal weights on all market and categorical factors across all regions. The table reports the monthly time-series mean return and the corresponding Newey and West (1987) adjusted t-statistics (6 lags), the Sharpe ratio from annually compounded returns, the Sharpe ratio from annualized monthly returns, the volatility, the kurtosis, and the skewness.

Region	Enhancement	Mean	T-Stats	Sharpe	Sharpe Monthly^{Ann}	Vola	Kurt	Skew
North America	Traditional	0.676	4.742	0.809	1.020	2.296	6.815	0.521
	Cross-Sectional	0.702	6.275	1.091	1.516	1.605	4.596	0.250
	Time-Series	0.677	6.377	1.194	1.274	1.841	3.485	0.207
	Combined	0.711	7.707	1.404	1.693	1.455	3.433	0.245
Europe	Traditional	0.757	7.972	1.653	1.393	1.883	8.599	0.077
	Cross-Sectional	0.761	8.357	1.680	1.579	1.670	10.111	0.677
	Time-Series	0.889	9.113	1.687	1.783	1.727	6.921	0.600
	Combined	0.875	10.349	2.012	2.070	1.464	11.723	1.229
Japan	Traditional	0.531	7.129	1.463	1.421	1.295	4.460	0.078
	Cross-Sectional	0.532	7.988	1.588	1.600	1.151	3.724	0.317
	Time-Series	0.536	5.975	1.331	1.212	1.532	11.650	-0.671
	Combined	0.505	6.639	1.498	1.468	1.191	7.628	-0.051
Asia Pacific	Traditional	1.018	5.259	0.948	1.273	2.771	6.180	-0.159
	Cross-Sectional	0.964	6.483	1.214	1.561	2.139	5.726	0.040
	Time-Series	1.061	6.067	1.138	1.275	2.883	7.581	-0.448
	Combined	1.062	7.046	1.270	1.647	2.234	7.041	0.515
Emerging Markets	Traditional	0.699	9.960	1.892	2.041	1.186	3.650	0.030
	Cross-Sectional	0.695	9.648	1.860	2.089	1.153	4.222	-0.130
	Time-Series	0.906	9.111	1.608	2.083	1.506	5.170	0.378
	Combined	0.880	8.399	1.430	2.309	1.320	5.982	0.867
Global	Traditional	0.736	10.021	1.817	2.220	1.149	4.385	0.209
	Cross-Sectional	0.731	12.928	2.449	2.784	0.909	3.764	0.071
	Time-Series	0.814	12.428	2.426	2.583	1.091	4.213	0.202
	Combined	0.806	15.076	2.960	3.341	0.836	3.852	0.265

Table B.3: Correlations of Traditional Categorical Factors

This table displays Pearson correlations for monthly returns of traditional composite categorical factors. First, firms are sorted into deciles on the country level, on each of 214 firm characteristics. Subsequently, firms are sorted into quintiles on the country level on a composite average decile category score and then aggregated to regional quintile portfolios. The value-weighted quintile portfolio returns are then computed on the regional level, with market capitalization weights based on values transferred to US-Dollars. The respective composite categorical factors go long the regional top quintile portfolio and short the regional bottom quintile portfolio. All portfolios are rebalanced monthly. The table displays the Pearson correlation coefficients between each pair of regional factors for each composite score. The sample period extends from January 1995 to June 2019.

Panel A: Value Score

Region	1	2	3	4	5
1 North America	1.000				
2 Europe	0.530	1.000			
3 Japan	0.356	0.238	1.000		
4 Asia Pacific	0.398	0.347	0.255	1.000	
5 Emerging Markets	0.222	0.173	0.167	0.233	1.000

Panel B: Investment Score

Region	1	2	3	4	5
1 North America	1.000				
2 Europe	0.387	1.000			
3 Japan	0.176	0.168	1.000		
4 Asia Pacific	0.335	0.088	0.204	1.000	
5 Emerging Markets	0.235	0.242	0.093	0.079	1.000

Panel C: Profitability Score

Region	1	2	3	4	5
1 North America	1.000				
2 Europe	0.445	1.000			
3 Japan	0.012	0.203	1.000		
4 Asia Pacific	0.217	0.155	0.067	1.000	
5 Emerging Markets	0.050	0.119	0.098	0.182	1.000

Panel D: Momentum Score

Region	1	2	3	4	5
1 North America	1.000				
2 Europe	0.707	1.000			
3 Japan	0.404	0.396	1.000		
4 Asia Pacific	0.416	0.482	0.312	1.000	
5 Emerging Markets	0.272	0.370	0.278	0.363	1.000

Panel E: Intangibles Score

Region	1	2	3	4	5
1 North America	1.000				
2 Europe	0.170	1.000			
3 Japan	0.068	-0.030	1.000		
4 Asia Pacific	-0.005	-0.107	-0.023	1.000	
5 Emerging Markets	0.138	0.212	0.002	-0.078	1.000

Panel F: Frictions Score

Region	1	2	3	4	5
1 North America	1.000				
2 Europe	0.099	1.000			
3 Japan	0.284	0.002	1.000		
4 Asia Pacific	0.336	0.071	0.069	1.000	
5 Emerging Markets	0.148	0.092	0.077	0.354	1.000

Table B.4: Time Effects

This table explores time effects for different factor enhancement approaches. We compare the annualized Sharpe ratios of categorical factors based on annually compounded returns for two different time periods. The sample is split into two parts, where the first period is extending from 1995 until 2006 and the second period is extending from 2007 until 2019. For each composite categorical factor and each region the Sharpe ratio of the traditional factor, of the cross-sectionally hedged factor, of the volatility-scaled factor, and of the factor that combines both enhancement approaches by volatility-scaling the cross-sectionally hedged factor is shown. Only results for the constant volatility-scaling approach following Moreira and Muir (2017) and Cederburg et al. (2020) are shown.

Region			North America		Europe		Japan		Asia Pacific		Emerging Markets	
Time Period			1995-2006	2007-2019	1995-2006	2007-2019	1995-2006	2007-2019	1995-2006	2007-2019	1995-2006	2007-2019
Factor			Sharpe Ratio									
Market	Unhedged	Unscaled	0.795	0.567	0.761	0.293	0.154	0.282	0.519	0.382	0.270	0.325
		Scaled	0.786	0.762	0.880	0.304	0.063	0.252	0.580	0.462	0.332	0.467
	Hedged	Unscaled	0.815	1.293	1.184	0.505	0.223	0.812	0.510	0.628	0.029	0.554
		Scaled	0.825	1.267	1.258	0.563	0.039	0.751	0.550	0.774	0.081	0.598
Value	Unhedged	Unscaled	0.356	0.252	0.406	0.443	0.677	0.620	0.577	0.623	0.580	0.962
		Scaled	0.416	0.487	0.503	0.260	0.774	0.619	0.581	0.502	0.491	0.837
	Hedged	Unscaled	0.555	0.137	0.454	0.466	1.063	0.656	0.655	0.828	0.949	1.046
		Scaled	0.579	0.243	0.372	0.414	1.292	0.685	0.677	0.616	0.878	0.949
Investment	Unhedged	Unscaled	0.514	0.147	0.467	0.559	-0.019	0.594	0.759	0.079	0.291	0.931
		Scaled	0.467	0.164	0.457	0.556	0.072	0.643	0.703	0.120	0.270	0.965
	Hedged	Unscaled	0.834	0.442	0.582	0.685	0.057	0.427	0.869	0.034	0.232	1.179
		Scaled	0.899	0.403	0.651	0.686	0.105	0.525	0.781	0.253	0.232	1.100
Profitability	Unhedged	Unscaled	0.431	0.431	0.153	0.585	0.208	0.849	0.404	0.674	0.879	0.459
		Scaled	0.563	0.476	0.211	0.614	0.143	1.016	0.399	0.624	0.942	0.571
	Hedged	Unscaled	0.789	0.435	0.032	1.135	0.350	0.668	0.468	0.939	0.667	0.816
		Scaled	0.712	0.437	0.034	0.975	0.212	0.757	0.488	0.748	0.613	0.874
Momentum	Unhedged	Unscaled	0.824	0.395	0.875	0.741	0.573	0.237	1.252	0.982	1.201	0.937
		Scaled	0.953	0.569	1.412	1.093	0.638	0.556	1.337	0.952	1.291	1.137
	Hedged	Unscaled	0.706	0.313	0.869	0.848	0.562	0.285	1.249	1.122	1.098	0.891
		Scaled	0.825	0.467	1.328	1.137	0.625	0.480	1.353	1.017	1.139	1.094
Intangibles	Unhedged	Unscaled	0.725	0.647	0.063	0.776	0.274	0.504	0.719	0.437	0.618	1.243
		Scaled	0.893	0.553	-0.123	0.779	0.263	0.437	0.651	0.395	0.629	1.003
	Hedged	Unscaled	1.291	0.823	0.338	1.035	0.394	0.223	0.638	0.590	0.898	1.066
		Scaled	1.535	0.885	0.290	0.897	0.406	0.306	0.607	0.510	1.039	0.895
Frictions	Unhedged	Unscaled	0.286	0.319	0.839	0.992	0.658	0.415	0.704	0.592	0.690	0.978
		Scaled	0.051	0.406	0.593	0.786	0.950	0.342	0.775	0.642	0.580	0.815
	Hedged	Unscaled	0.682	0.558	0.459	1.094	1.039	0.586	0.757	0.744	0.488	1.514
		Scaled	0.398	0.422	0.579	0.820	1.343	0.508	0.950	0.680	0.519	1.319

Appendix B. Additional Tables

Table C.1: Summary Statistics for Traditional Factors - Extended Time Period

This table displays summary statistics for traditional composite categorical factors and the market factor for an extended time period. First, firms are sorted into deciles on the country level, on each of 214 firm characteristics. Subsequently, for each firm a composite category score is computed as the average decile to which a firms has been assigned to within a category. Next, firms are sorted into quintiles on the country level based on the composite category score. The country level quintile assignments are then aggregated to regional quintile portfolios. Regional assignments of countries are based on the MSCI global investable market indexes (GIMI) methodology country classification. Value-weighted quintile portfolio returns are then computed on the regional level, with market capitalization weights based on values transferred to US-Dollars. The respective categorical factors go long the regional top quintile portfolio and short the regional bottom quintile portfolio. The table shows the mean, median, standard deviation, standard error, minimum, maximum, and skewness of monthly factor returns. The sample period extends from July 1992 to June 2019.

Factor	Region	Mean	Median	SD	SE	Minimum	Maximum	Skewness
Market	NA	0.910	1.361	4.262	0.237	-18.867	11.781	-0.784
	EU	0.760	1.066	4.905	0.273	-21.783	14.746	-0.573
	JA	0.427	0.483	5.163	0.287	-15.327	17.092	0.250
	PA	0.895	1.188	5.821	0.323	-25.118	19.855	-0.359
	EM	0.681	0.935	5.857	0.325	-28.171	17.522	-0.704
Value	NA	0.394	-0.055	5.867	0.326	-28.925	31.996	0.444
	EU	0.588	0.602	4.432	0.246	-24.175	17.944	-0.802
	JA	0.955	1.046	4.764	0.265	-17.847	26.416	0.145
	PA	1.129	1.089	5.781	0.321	-41.984	27.752	-0.796
	EM	0.755	0.625	3.619	0.201	-15.267	15.997	0.138
Investment	NA	0.410	0.450	3.047	0.169	-10.328	18.188	0.815
	EU	0.452	0.340	2.437	0.135	-8.134	11.189	0.516
	JA	0.252	0.219	3.403	0.189	-12.110	11.982	-0.104
	PA	0.614	0.495	4.395	0.244	-20.720	22.890	0.168
	EM	0.342	0.238	2.213	0.123	-7.319	13.421	0.392
Profitability	NA	0.715	0.603	5.273	0.293	-22.371	25.472	0.130
	EU	0.486	0.554	4.788	0.266	-26.224	15.482	-0.838
	JA	0.404	0.626	3.771	0.210	-12.260	18.326	0.083
	PA	1.058	0.898	6.126	0.340	-40.121	24.909	-0.840
	EM	0.597	0.403	2.978	0.165	-11.946	11.509	-0.047
Momentum	NA	0.964	0.966	5.321	0.296	-22.572	22.814	-0.285
	EU	1.216	1.220	5.347	0.297	-27.320	21.872	-0.682
	JA	0.648	0.735	5.522	0.307	-23.911	19.267	-0.161
	PA	1.511	1.284	4.945	0.275	-18.579	14.539	-0.236
	EM	1.165	1.366	3.291	0.183	-9.348	12.049	-0.146
Intangibles	NA	0.705	0.523	3.272	0.182	-12.600	16.529	0.199
	EU	0.308	0.150	2.806	0.156	-12.447	12.185	0.211
	JA	0.336	0.240	3.143	0.175	-10.865	9.541	-0.211
	PA	0.635	0.515	3.523	0.196	-10.007	15.168	0.322
	EM	0.561	0.400	2.633	0.146	-8.872	12.285	0.391
Frictions	NA	0.479	0.301	5.848	0.325	-31.263	26.130	-0.066
	EU	1.272	1.034	5.560	0.309	-37.761	51.287	1.514
	JA	0.786	0.922	3.948	0.219	-14.635	16.788	-0.032
	PA	1.210	1.210	4.949	0.275	-17.815	16.770	-0.262
	EM	0.755	0.768	3.294	0.183	-10.744	12.294	-0.031

Table C.2: Cross-Sectionally Enhanced Factor Returns with Dimson Betas and Gammas

This table shows monthly average returns of traditional factors, hedge-portfolios, and factors cross-sectionally enhanced according to Daniel et al. (2020). Pre-formation βs used to obtain the hedge portfolios and γs used for hedging are computed as Dimson (1979) betas. The current portfolio method is employed for beta computation, which employs backward-looking factor and hedge-portfolio returns to compute the beta coefficients in rolling-regressions. Traditional factors f^c are obtained from quintile sorts on the respective category score. Hedge-portfolios are based on 15 portfolios that are obtained from sorting firms within each score quintile into pre-formation β terciles. The hedge factor is long an equal-weighted combination of the low loading portfolios and short an equal-weighted combination of the high loading portfolios. The hedged factor f^{h_c} is obtained by hedging the traditional factor with respect to the hedge factor, as in equation **??**. Enhanced factors are only hedged with respect to their own hedge factor. Newey and West (1987) adjusted t-statistics are in parentheses. The time period extends from July 1992 until June 2019.

Category	Factor	Region				
		North America	Europe	Japan	Asia Pacific	Emerging Markets
Value	F^c Traditional	0.394	0.588**	0.955***	1.129***	0.755***
		(0.991)	(2.061)	(3.155)	(3.096)	(4.223)
	Hedge-Portfolio h	0.156	-0.142	0.148	-0.399*	0.049
		(0.762)	(-0.661)	(0.739)	(-1.668)	(0.197)
	F^{h_c} Enhanced	0.549**	0.462**	1.038***	0.730***	0.793***
		(2.027)	(2.149)	(4.580)	(2.679)	(4.309)
Investment	F^c Traditional	0.410**	0.452***	0.252	0.614**	0.342***
		(2.188)	(2.828)	(1.331)	(2.193)	(2.599)
	Hedge-Portfolio h	0.215	-0.025	-0.242	-0.171	-0.100
		(1.101)	(-0.199)	(-0.980)	(-1.005)	(-0.593)
	F^{h_c} Enhanced	0.543***	0.469***	0.162	0.510**	0.299**
		(3.790)	(3.372)	(1.300)	(2.113)	(2.378)
Profitability	F^c Traditional	0.715**	0.486*	0.404*	1.058***	0.597***
		(2.198)	(1.896)	(1.674)	(2.769)	(3.715)
	Hedge-Portfolio h	-0.157	-0.116	0.113	-0.357	-0.196
		(-0.478)	(-0.523)	(0.436)	(-1.467)	(-0.542)
	F^{h_c} Enhanced	0.610***	0.485***	0.445***	0.588**	0.585***
		(3.056)	(2.636)	(2.736)	(2.190)	(3.989)
Momentum	F^c Traditional	0.964***	1.216***	0.648*	1.511***	1.165***
		(3.360)	(4.020)	(1.904)	(5.240)	(5.507)
	Hedge-Portfolio h	-0.269*	-0.214	-0.051	-0.172	-0.370**
		(-1.797)	(-1.412)	(-0.293)	(-1.051)	(-2.003)
	F^{h_c} Enhanced	0.864***	1.100***	0.624**	1.397***	0.973***
		(3.120)	(4.157)	(2.012)	(5.392)	(4.548)
Intangibles	F^c Traditional	0.705***	0.308	0.336*	0.635***	0.561***
		(3.585)	(1.610)	(1.949)	(3.152)	(3.392)
	Hedge-Portfolio h	0.044	0.337	-0.015	-0.221	-0.278
		(0.162)	(1.436)	(-0.079)	(-0.931)	(-1.272)
	F^{h_c} Enhanced	0.761***	0.484***	0.337**	0.416**	0.452***
		(5.228)	(3.484)	(2.398)	(2.396)	(3.612)
Frictions	F^c Traditional	0.479	1.272***	0.786***	1.210***	0.755***
		(1.487)	(4.779)	(3.013)	(3.855)	(4.008)
	Hedge-Portfolio h	0.125	-0.386*	0.011	-0.250	0.243
		(0.439)	(-1.788)	(0.044)	(-1.029)	(0.684)
	F^{h_c} Enhanced	0.587***	0.807***	0.837***	0.870***	0.934***
		(3.139)	(2.862)	(4.604)	(3.778)	(4.908)

Table C.3: Spanning Tests of the Cross-Sectionally Enhanced Factor Portfolios Based on Dimson Betas

This table presents the results for spanning tests of the cross-sectionally enhanced composite factor portfolios with respect to their traditional factor version (F^c) or to a combination of the traditional factor (F^c), the enhanced market factor, and the other enhanced composite categorical factors ($F^{H_{C\setminus\{c\}}}$) by running monthly time-series regressions of the enhanced factor returns on the reference factor sets. For computation of betas in the cross-sectional enhancement approach Dimson (1979) betas are employed. Regressions are conducted for each region separately. The table shows regression alphas for two versions of enhanced factors. Panel A shows results when the traditional factor is enhanced with respect to its own hedge factor only. Panel B shows results when the traditional factor is enhanced with respect to the hedge factors of all categorical factors and the market hedge factor. Newey and West (1987) adjusted t-statistics are in parentheses. The time period comprises July 1992 until July 2019.

Panel A: Dependent Variable = Return to factor portfolio cross-sectionally enhanced with respect to the factor's hedge factor only

	Factor	Value		Investment		Profitability		Momentum		Intangibles		Frictions	
Region	Factor Set	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$
North	$\widehat{\alpha}$	0.357***	0.346**	0.334***	0.092	0.366**	0.191	0.162	0.284**	0.433***	0.207**	0.392***	0.332**
America	t($\widehat{\alpha}$)	(2.850)	(2.385)	(3.999)	(1.168)	(2.545)	(1.350)	(1.470)	(2.431)	(4.360)	(2.138)	(3.094)	(2.352)
Europe	$\widehat{\alpha}$	0.124	0.464***	0.159***	0.086	0.212*	0.112	0.189**	0.275***	0.331***	0.251**	-0.041	-0.250
	t($\widehat{\alpha}$)	(0.994)	(3.680)	(2.605)	(1.339)	(1.915)	(1.020)	(2.096)	(2.972)	(3.378)	(2.405)	(-0.199)	(-1.252)
Japan	$\widehat{\alpha}$	0.507***	0.427***	0.035	-0.041	0.248**	0.196*	0.145	0.342***	0.128	0.130	0.349***	0.336**
	t($\widehat{\alpha}$)	(4.147)	(3.234)	(0.372)	(-0.400)	(2.541)	(1.792)	(1.176)	(2.790)	(1.375)	(1.214)	(2.805)	(2.457)
Asia	$\widehat{\alpha}$	0.033	0.155	0.072	0.037	-0.022	-0.191	0.135	0.228**	0.046	-0.038	0.224	0.095
Pacific	t($\widehat{\alpha}$)	(0.220)	(1.039)	(0.744)	(0.366)	(-0.129)	(-1.162)	(1.216)	(2.131)	(0.347)	(-0.268)	(1.468)	(0.645)
Emerging	$\widehat{\alpha}$	0.372***	0.482***	0.033	-0.075	0.290**	-0.159	-0.078	-0.125	0.091	0.116	0.493***	0.081
Markets	t($\widehat{\alpha}$)	(2.888)	(3.759)	(0.514)	(-1.124)	(2.306)	(-1.354)	(-0.943)	(-1.510)	(1.100)	(1.211)	(3.207)	(0.574)

Panel B: Dependent Variable = Return to factor portfolio cross-sectionally enhanced with respect to the hedge factors of all composite factors

	Factor	Value		Investment		Profitability		Momentum		Intangibles		Frictions	
Region	Factor Set	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$	F^c	MKT+F^c +$F^{H_{C\setminus\{c\}}}$
North	$\widehat{\alpha}$	1.278**	0.404	1.461***	0.082	1.759***	0.115	1.203**	0.440	1.894***	0.814***	1.550**	0.170
America	t($\widehat{\alpha}$)	(2.229)	(1.226)	(3.707)	(0.314)	(2.821)	(0.305)	(2.459)	(0.985)	(4.005)	(2.682)	(2.516)	(0.497)
Europe	$\widehat{\alpha}$	-0.496	-0.575*	0.483*	0.608***	0.706	0.122	1.247**	0.633	1.637***	1.165***	-0.381	-0.222
	t($\widehat{\alpha}$)	(-0.893)	(-1.946)	(1.850)	(3.015)	(1.329)	(0.430)	(2.400)	(1.628)	(3.645)	(3.649)	(-0.649)	(-0.434)
Japan	$\widehat{\alpha}$	1.640***	1.296***	0.045	0.311	0.963**	0.779***	0.646	0.429	0.414	0.098	0.739	-0.130
	t($\widehat{\alpha}$)	(2.789)	(2.579)	(0.107)	(0.800)	(2.290)	(2.591)	(1.135)	(0.931)	(1.173)	(0.323)	(1.383)	(-0.324)
Asia	$\widehat{\alpha}$	-0.157	0.020	-0.220	-0.393	-0.460	-1.026***	-0.071	-0.048	-0.078	0.043	0.486	0.146
Pacific	t($\widehat{\alpha}$)	(-0.230)	(0.055)	(-0.515)	(-1.548)	(-0.674)	(-3.138)	(-0.191)	(-0.140)	(-0.172)	(0.146)	(0.793)	(0.441)
Emerging	$\widehat{\alpha}$	0.835***	0.619***	0.118	-0.241	1.094**	-0.638***	0.647**	0.090	-0.095	0.043	1.180**	-0.193
Markets	t($\widehat{\alpha}$)	(2.843)	(2.693)	(0.649)	(-1.387)	(2.478)	(-2.759)	(2.175)	(0.345)	(-0.415)	(0.218)	(2.058)	(-0.637)

Table C.4: Sharpe Ratio Improvement - Different Scaling Approaches

This table compares Sharpe ratios of traditional factors with Sharpe ratios of different versions of enhanced factors. For each region and each composite categorical factor, as well as the market factors, the compounded annualized returns and the corresponding Sharpe ratio is shown. Six different factor versions are compared: The unhedged traditional factors, the cross-sectionally hedged factors, the unhedged volatility-managed factors, where we apply both the constant scaling approach of Barroso and Santa-Clara (2015) and the dynamic in-sample approach of Daniel and Moskowitz (2016) based on a volatility estimate from a GJR-GARCH, and the cross-sectionally hedged volatility-managed factors, where we apply the same constant and dynamic scaling approach as for the unhedged factors.

Category		Market				Value				Investment			
Region	Factor	Unhedged		Hedged		Unhedged		Hedged		Unhedged		Hedged	
		Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio
North America	Unscaled	11.715	0.676	11.648	1.014	7.746	0.194	8.312	0.323	5.170	0.358	6.955	0.608
	Scaled 12%	11.294	0.721	18.801	0.924	0.717	0.047	7.100	0.346	4.019	0.305	8.886	0.639
	Scaled Dyn GJR	12.779	0.631	12.482	0.968	-0.789	-0.041	7.584	0.371	3.318	0.323	4.861	0.633
Europe	Unscaled	10.006	0.491	11.977	0.772	7.920	0.379	7.084	0.457	5.395	0.492	5.865	0.596
	Scaled 12%	10.014	0.576	18.876	0.838	5.496	0.337	5.317	0.319	6.089	0.446	8.525	0.582
	Scaled Dyn GJR	12.268	0.527	14.767	0.885	4.308	0.285	5.634	0.413	3.707	0.441	4.030	0.553
Japan	Unscaled	4.241	0.188	5.926	0.443	12.630	0.628	12.916	0.839	2.104	0.167	1.451	0.192
	Scaled 12%	2.061	0.147	5.356	0.414	8.821	0.563	14.748	0.811	2.400	0.158	2.128	0.177
	Scaled Dyn GJR	6.438	0.355	6.833	0.608	8.334	0.545	10.278	0.768	1.431	0.134	0.388	0.054
Asia Pacific	Unscaled	10.935	0.445	10.635	0.571	15.945	0.531	14.952	0.662	7.263	0.360	6.847	0.412
	Scaled 12%	9.718	0.535	16.517	0.621	9.178	0.504	12.177	0.634	5.764	0.353	6.796	0.430
	Scaled Dyn GJR	11.024	0.468	12.820	0.607	12.715	0.512	16.550	0.688	5.897	0.312	6.242	0.386
Emerging Markets	Unscaled	8.437	0.299	7.108	0.319	8.940	0.723	12.411	0.928	4.674	0.512	4.027	0.503
	Scaled 12%	7.512	0.314	9.721	0.335	11.935	0.729	17.888	0.924	11.069	0.586	10.497	0.612
	Scaled Dyn GJR	14.552	0.413	8.003	0.319	11.117	0.709	12.815	0.918	7.158	0.621	5.930	0.667

Table C.4 continued

Category		Profitability				Momentum				Intangibles				Frictions			
Reg	Fac	Unhedged		Hedged		Unhedged		Hedged		Unhedged		Hedged		Unhedged		Hedged	
		Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio	Ann. Return	Sharpe Ratio
NA	Unsc.	11.171	0.426	9.864	0.582	11.326	0.588	10.228	0.505	9.301	0.607	10.006	0.968	6.731	0.273	7.278	0.570
	$Sc^{12\%}$	9.960	0.533	10.928	0.620	13.653	0.766	12.662	0.634	12.127	0.795	15.815	1.190	3.858	0.287	8.257	0.488
	SSc^{GJR}	11.884	0.495	8.348	0.614	17.842	0.819	15.192	0.685	11.039	0.887	9.849	1.292	5.839	0.301	6.818	0.464
EU	Unsc.	6.238	0.381	5.657	0.484	15.526	0.806	14.738	0.859	4.138	0.318	5.855	0.576	16.458	0.864	15.287	0.756
	$Sc^{12\%}$	10.394	0.542	9.009	0.541	21.660	1.000	23.616	0.964	5.928	0.326	9.588	0.570	13.453	0.986	15.617	0.853
	Sc^{GJR}	12.139	0.602	8.155	0.590	26.740	0.990	24.863	0.923	4.247	0.310	5.588	0.584	17.761	0.897	15.958	0.758
JA	Unsc.	5.927	0.350	5.552	0.455	9.094	0.416	8.556	0.430	4.212	0.365	2.947	0.308	10.703	0.523	10.373	0.790
	$Sc^{12\%}$	7.514	0.382	6.864	0.452	10.047	0.531	10.862	0.536	5.647	0.331	4.204	0.312	8.680	0.544	12.576	0.813
	Sc^{GJR}	6.155	0.352	5.102	0.407	15.651	0.597	13.426	0.572	4.110	0.299	2.489	0.283	8.758	0.469	9.236	0.669
PA	Unsc.	14.819	0.497	14.022	0.610	20.643	1.106	20.739	1.183	8.605	0.573	7.264	0.585	15.203	0.641	12.975	0.749
	$Sc^{12\%}$	11.488	0.507	13.288	0.640	22.048	1.314	23.391	1.310	7.172	0.499	6.973	0.553	11.844	0.671	12.436	0.736
	Sc^{GJR}	15.791	0.565	15.279	0.618	28.948	1.337	29.122	1.314	7.244	0.527	6.554	0.547	15.961	0.770	12.488	0.749
EM	Unsc.	7.063	0.620	6.668	0.740	15.257	1.039	12.819	0.946	8.388	0.725	8.508	0.913	10.476	0.829	11.041	0.884
	$Sc^{12\%}$	11.038	0.655	11.395	0.702	25.440	1.105	24.966	1.028	12.033	0.803	14.048	1.057	11.636	0.820	18.083	0.957
	Sc^{GJR}	9.373	0.669	7.876	0.708	21.582	1.172	20.636	1.170	9.473	0.775	9.699	1.094	10.717	0.790	14.963	1.046

Table C.5: Autocorrelation Adjusted Time-Series Efficient Factors

This table show results for the application of the autocorrelation adjustment to obtain time-series efficient factors proposed by Ehsani and Linnainmaa (2021). The method is employed on the traditional factor model version and on the different enhanced factor model versions, respectively. Efficient factors are constructed using a five-year rolling window to obtain factor means, volatilities, and first-order autocorrelations. The same parameters for all factors are used by pooling all parameters over all factors of a specific factor model version. For each factor we report the standard Sharpe ratio and the Sharpe ratio of the adjusted factor. Due to constraints by the rolling parameters the time period starts in January 2000 and ends in July 2019.

	Factor	Market		Value		Investment		Profitability		Momentum		Intangibles		Frictions	
Reg	Enh	Standard	Adjusted	Standard	Adjusted	Standard	Adjusted	Standard	Adjusted	Standard	Adjusted	Standard	Adjusted	Standard	Adjusted
NA	Trad	0.568	0.293	0.225	0.242	0.507	0.525	0.513	0.549	0.526	0.413	0.644	0.480	0.263	0.257
	CS	0.977	0.746	0.380	0.392	0.849	0.914	0.796	0.761	0.548	0.586	1.136	1.086	0.475	0.347
	TS	0.712	0.589	0.010	0.097	0.362	0.452	0.603	0.717	0.715	0.574	0.661	0.538	0.145	0.158
	Comb	1.074	1.032	0.331	0.354	0.661	0.713	0.645	0.633	0.673	0.580	1.077	1.037	0.296	0.220
EU	Trad	0.443	0.629	0.458	0.716	0.691	0.674	0.334	0.340	0.692	0.802	0.357	0.673	0.799	0.638
	CS	0.868	1.056	0.529	0.693	0.896	0.986	0.425	0.333	0.780	1.013	0.696	0.759	0.797	0.681
	TS	0.554	0.651	0.428	0.523	0.668	0.610	0.419	0.659	1.190	1.157	0.323	0.720	0.657	0.543
	Comb	0.965	1.050	0.446	0.589	0.877	0.817	0.380	0.557	1.295	1.366	0.541	0.737	0.773	0.590
JA	Trad	0.255	0.338	0.645	0.530	0.330	0.116	0.354	0.378	0.446	0.320	0.251	0.083	0.686	0.649
	CS	0.520	0.469	0.906	0.849	0.273	0.148	0.547	0.553	0.483	0.349	0.212	0.155	0.836	0.760
	TS	0.192	0.531	0.715	0.694	0.494	0.309	0.333	0.399	0.713	0.685	0.211	0.113	0.665	0.546
	Comb	0.453	0.469	1.111	1.042	0.411	0.278	0.477	0.532	0.691	0.649	0.303	0.251	0.852	0.787
PA	Trad	0.431	0.486	0.748	0.732	0.421	0.361	0.692	0.549	1.049	1.039	0.759	0.553	0.772	0.720
	CS	0.773	0.812	0.870	0.852	0.481	0.509	0.835	0.605	1.080	1.217	0.761	0.613	0.905	0.980
	TS	0.537	0.544	0.721	0.814	0.415	0.495	0.726	0.652	1.183	1.219	0.634	0.537	0.859	0.930
	Comb	0.992	0.964	0.905	1.056	0.533	0.620	0.895	0.729	1.273	1.374	0.626	0.589	0.904	1.054
EM	Trad	0.357	0.638	0.569	0.335	0.582	0.539	0.688	0.713	1.176	1.283	0.835	0.653	0.868	0.855
	CS	0.398	0.781	0.973	0.989	0.588	0.563	0.803	0.810	1.010	1.123	1.005	0.818	0.987	1.114
	TS	0.494	0.772	0.614	0.548	0.739	0.801	0.830	0.819	1.467	1.450	0.756	0.684	0.711	0.790
	Comb	0.571	0.892	0.945	0.918	0.759	0.768	0.890	0.849	1.404	1.412	0.980	0.822	1.159	1.367

Table C.6: Annualized Sharpe Ratios from Compounded and Multiplied Returns

This table compares different computational approach for the annualized Sharpe ratio. For each regional factor and for a global factor obtained as equal-weighted average of all regional factors, the Sharpe ratio obtained from compounded annualized returns is compared to the Sharpe ratio obtained from returns annualized by multiplying the monthly returns by 12. Compounded returns are computed by rolling over each 12 months window and computing the corresponding return the respective factor would have yielded during these 12 months. For each composite categorical factor the table shows the Sharpe ratios for the traditional factor, the cross-sectionally hedged factor, the volatility-scaled factor following the approach of Moreira and Muir (2017) and Cederburg et al. (2020), and the factor that combines both enhancement approaches by volatility-scaling the cross-sectionally hedged factor.

Annualization		Com-pounded	Monthly Annual	Com-pounded	Monthly Annual	Com-pounded	Monthly Annual	Com-pounded	Monthly Annual	Com-pounded	Monthly Annual	Com-pounded	Monthly Annual	Com-pounded	Monthly Annual
Reg	Score	Market		Value		Investment		Profitability		Momentum		Intangibles		Frictions	
NA	Trad	0.676	0.728	0.194	0.241	0.358	0.438	0.426	0.516	0.588	0.577	0.607	0.717	0.273	0.320
EU		0.491	0.539	0.379	0.448	0.492	0.621	0.381	0.383	0.806	0.792	0.318	0.367	0.864	0.823
JA		0.188	0.199	0.628	0.669	0.167	0.150	0.350	0.422	0.416	0.432	0.365	0.372	0.523	0.697
PA		0.445	0.508	0.531	0.676	0.360	0.416	0.497	0.637	1.106	1.098	0.573	0.659	0.641	0.780
EM		0.299	0.338	0.723	0.651	0.512	0.594	0.620	0.675	1.039	1.239	0.725	0.918	0.829	0.865
GL		0.455	0.523	0.516	0.762	0.519	0.669	0.744	0.880	1.030	1.036	0.922	1.273	0.845	1.145
NA	Hedged	1.014	1.117	0.323	0.473	0.608	0.803	0.582	0.792	0.505	0.573	0.968	1.186	0.570	0.630
EU		0.772	0.996	0.457	0.504	0.596	0.826	0.484	0.487	0.859	0.883	0.576	0.715	0.756	0.784
JA		0.443	0.447	0.839	0.950	0.192	0.164	0.455	0.574	0.430	0.468	0.308	0.310	0.790	0.876
PA		0.571	0.755	0.662	0.775	0.412	0.462	0.610	0.743	1.183	1.108	0.585	0.660	0.749	0.888
EM		0.319	0.387	0.928	1.056	0.503	0.581	0.740	0.781	0.946	1.081	0.913	1.021	0.884	1.032
GL		0.770	0.995	0.767	1.162	0.731	0.984	1.012	1.150	1.073	1.106	1.119	1.561	1.288	1.494
NA	Scaled	0.774	0.908	0.068	0.045	0.316	0.332	0.506	0.604	0.712	0.766	0.709	0.724	0.203	0.219
EU		0.569	0.726	0.389	0.417	0.508	0.598	0.428	0.511	1.231	1.341	0.291	0.329	0.664	0.682
JA		0.124	0.089	0.694	0.752	0.273	0.251	0.381	0.438	0.572	0.650	0.326	0.365	0.623	0.701
PA		0.520	0.630	0.526	0.653	0.363	0.401	0.517	0.673	1.098	1.231	0.521	0.539	0.684	0.830
EM		0.387	0.446	0.657	0.710	0.593	0.728	0.670	0.810	1.119	1.508	0.715	0.872	0.698	0.746
GL		0.505	0.620	0.594	0.783	0.633	0.736	0.755	0.993	1.336	1.540	1.035	1.225	0.895	1.128
NA	Comb	0.974	1.224	0.304	0.424	0.627	0.639	0.548	0.637	0.614	0.694	1.092	1.145	0.383	0.457
EU		0.855	1.128	0.390	0.419	0.670	0.812	0.427	0.481	1.227	1.421	0.547	0.593	0.699	0.757
JA		0.294	0.312	0.938	1.159	0.285	0.256	0.456	0.491	0.546	0.643	0.350	0.387	0.837	0.910
PA		0.662	0.964	0.627	0.826	0.471	0.507	0.618	0.815	1.136	1.289	0.558	0.561	0.750	0.868
EM		0.386	0.552	0.895	1.052	0.590	0.735	0.743	0.838	1.022	1.453	0.950	1.013	0.865	1.211
GL		0.775	1.107	0.843	1.319	0.878	1.031	0.950	1.142	1.325	1.610	1.270	1.511	1.327	1.584

Table C.7: Tests of Equality of Squared Sharpe Ratios with Dimson Beta Enhancement

This table shows pairwise test of equality of squared Sharpe ratios of traditional and enhanced factors following Barillas et al. (2020) where cross-sectional enhancement is based on Dimson (1979) betas. The left column for each region reports the difference $\hat{\theta}_i^2 - \hat{\theta}_j^2$ between the sample squared Sharpe ratio of the enhanced factor version i (applied enhancement method as indicated in each row) and the traditional factor version j. The right column for each region reports the associated t-statistics for the test of H_0: $\hat{\theta}_i^2 = \hat{\theta}_j^2$. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. The time period comprises July 1992 until June 2019.

		North America		Europe		Japan		Asia-Pacific		Emerging Markets	
		$\hat{\theta}_i^2 - \hat{\theta}_j^2$	t	$\hat{\theta}_i^2 - \hat{\theta}_j^2$	t	$\hat{\theta}_i^2 - \hat{\theta}_j^2$	t	$\hat{\theta}_i^2 - \hat{\theta}_j^2$	t	$\hat{\theta}_i^2 - \hat{\theta}_j^2$	t
Market	Hedged	0.249***	3.957	0.118**	2.543	0.051***	2.679	0.097*	1.965	-0.061***	-2.589
	Scaled	0.174***	3.748	0.089***	3.269	-0.032***	-3.052	0.067***	2.916	0.070***	4.289
	Combined	0.309***	4.168	0.221***	4.014	0.016	1.007	0.218***	4.306	-0.024	-1.072
Value	Hedged	0.084***	5.755	0.043	1.437	0.412***	5.453	-0.045	-1.520	-0.043	-0.762
	Scaled	-0.034***	-3.974	0.009	0.460	0.137***	3.608	-0.008	-0.397	-0.091**	-2.455
	Combined	0.087***	4.937	0.044	1.371	0.409***	6.171	-0.082**	-2.366	-0.074	-1.225
Investment	Hedged	0.281***	7.735	0.111***	3.596	0.001	0.066	0.015	0.912	-0.033	-1.190
	Scaled	-0.002	-0.109	0.031	1.519	0.044***	2.794	-0.001	-0.050	0.086***	4.179
	Combined	0.576***	6.476	0.292***	4.404	0.009	0.430	0.053*	1.815	0.151***	3.509
Profitability	Hedged	0.128***	4.672	0.108***	2.780	0.138***	4.394	-0.086***	-3.172	0.127	1.491
	Scaled	0.060***	2.728	0.043**	2.420	0.029**	1.976	0.016	0.776	0.053**	2.534
	Combined	0.093**	2.332	0.084**	2.481	0.133***	3.142	-0.080***	-2.695	0.243***	2.696
Momentum	Hedged	-0.061**	-2.424	0.034	1.278	0.011	0.635	0.118	1.324	-0.368***	-6.064
	Scaled	0.177***	4.552	0.799***	8.184	0.107***	4.284	0.015	0.149	0.117	1.643
	Combined	0.097**	2.375	0.783***	8.859	0.062**	2.491	-0.083	-0.726	-0.240**	-2.490
Intangibles	Hedged	0.372***	5.625	0.274***	5.895	0.106**	2.569	-0.079**	-2.059	0.119**	2.176
	Scaled	0.114***	2.645	-0.015	-1.066	-0.015	-0.904	-0.039***	-2.820	-0.026	-1.049
	Combined	0.459***	4.984	0.301***	4.405	0.073*	1.667	-0.094**	-2.339	0.031	0.517
Frictions	Hedged	0.234***	5.575	-0.424***	-5.237	0.400***	5.410	-0.003	-0.048	0.254***	2.973
	Scaled	-0.026**	-2.056	-0.264***	-5.738	0.102***	2.995	0.042	1.108	-0.196***	-5.657
	Combined	0.146***	3.359	-0.346***	-4.713	0.309***	3.713	0.042	0.694	0.246***	3.118

Table C.8: Further Statistics for Comparative Performance of Traditional and Enhanced Factor Models

This table reports comparative performance in the explanatory power for anomalies across regions for the categorical factor model based on different versions of enhanced factors. As comparative statistics the number of alphas significant at the 1% level and the average absolute alphas is used. The table shows the aggregate performance for all anomalies and for each category of anomalies separately. The values for all anomalies includes 24 anomalies based on dummy variables that have not been employed previously. The table shows results for the CAPM based on the regional market factor and for four versions of the categorical factor model that consists of the market factor and the six categorical factors. A factor model version is included with the unhedged traditional factors, the cross-sectionally hedged factors, the unhedged volatility-scaled factors and the factors that combine both enhancement approaches, respectively.

Category		All	Value	Inv	Prof	Mom	Int	Fric	All	Value	Inv	Prof	Mom	Int	Fric
Region	Enhancement	$\#_{p_\alpha<1\%}$							$\overline{\lvert\alpha\rvert}$						
North America	Market	59	9	12	10	9	3	10	0.60	0.69	0.61	0.68	0.76	0.39	0.62
	Traditional	19	2	4	2	2	5	2	0.30	0.29	0.23	0.21	0.33	0.33	0.38
	Cross-Sectional	31	5	3	4	3	8	6	0.48	0.48	0.31	0.44	0.46	0.59	0.66
	Time-Series	9	2	3	0	1	2	1	0.36	0.48	0.36	0.30	0.31	0.29	0.45
	Combined	8	1	1	0	1	3	2	0.32	0.28	0.26	0.29	0.37	0.35	0.36
Europe	Market	59	6	7	15	11	5	7	0.42	0.36	0.35	0.61	0.68	0.26	0.45
	Traditional	13	1	0	0	3	4	3	0.23	0.14	0.18	0.27	0.30	0.27	0.25
	Cross-Sectional	13	0	0	1	3	4	3	0.30	0.22	0.23	0.31	0.36	0.34	0.37
	Time-Series	10	0	0	1	2	2	3	0.24	0.21	0.19	0.30	0.29	0.22	0.28
	Combined	11	1	0	0	2	4	3	0.26	0.22	0.19	0.32	0.35	0.27	0.29
Japan	Market	9	1	0	1	0	1	5	0.29	0.33	0.20	0.25	0.43	0.24	0.37
	Traditional	12	1	0	2	0	5	3	0.26	0.28	0.21	0.26	0.32	0.23	0.28
	Cross-Sectional	11	1	0	0	0	4	5	0.32	0.32	0.24	0.28	0.39	0.29	0.42
	Time-Series	16	4	2	2	0	2	5	0.27	0.31	0.25	0.28	0.30	0.23	0.32
	Combined	5	0	1	0	0	1	2	0.24	0.24	0.19	0.23	0.31	0.24	0.28
Asia Pacific	Market	48	4	6	11	12	5	9	0.62	0.60	0.63	0.72	1.01	0.39	0.66
	Traditional	19	1	1	0	3	7	7	0.40	0.26	0.26	0.27	0.54	0.53	0.57
	Cross-Sectional	16	1	1	0	3	3	8	0.42	0.30	0.26	0.28	0.56	0.50	0.63
	Time-Series	16	1	2	1	7	1	4	0.43	0.30	0.44	0.37	0.69	0.41	0.50
	Combined	13	0	1	0	8	1	3	0.42	0.29	0.39	0.36	0.75	0.38	0.52
Emerging Markets	Market	32	11	4	2	3	3	7	0.36	0.48	0.23	0.35	0.45	0.25	0.45
	Traditional	11	2	0	1	2	1	3	0.28	0.25	0.16	0.33	0.36	0.23	0.36
	Cross-Sectional	8	0	0	1	1	2	4	0.27	0.20	0.18	0.21	0.30	0.23	0.42
	Time-Series	9	3	0	2	1	0	3	0.28	0.30	0.17	0.28	0.35	0.23	0.38
	Combined	7	1	0	2	0	1	3	0.27	0.21	0.16	0.21	0.30	0.29	0.42

Table C.9: Summary Statistics of and Correlations with Standard Factors

This table displays summary statistics and Pearson correlations for monthly returns of traditional composite categorical factors and the standard Fama and French (1993, 2015) factors and the Carhart (1997) momentum factor. The table shows the means and standard errors of the factors and Pearson correlation coefficients between the regional categorical factors and the standard factor corresponding to the category. Standard factors are obtained from the Kenneth French data library and are based on Fama and French (2012). The sample period extends from July 1992 to June 2019.

Panel A: Summary Statistics

	North America		Europe		Japan		Asia-Pacific		Emerging Markets	
	Value	HML	Value	HML	Value	HML	Value	HML	Value	HML
Mean	0.394	0.159	0.588	0.325	0.955	0.287	1.129	0.600	0.755	0.653
SE	0.326	0.184	0.246	0.136	0.265	0.162	0.321	0.168	0.201	0.124
	Inv	CMA	Inv	CMA	Inv	CMA	Inv	CMA	Inv	CMA
Mean	0.410	0.269	0.452	0.171	0.252	0.032	0.614	0.348	0.342	0.282
SE	0.169	0.147	0.135	0.102	0.189	0.135	0.244	0.136	0.123	0.106
	Prof	RMW	Prof	RMW	Prof	RMW	Prof	RMW	Prof	RMW
Mean	0.715	0.328	0.486	0.335	0.404	0.103	1.058	0.285	0.597	0.190
SE	0.293	0.137	0.266	0.089	0.210	0.118	0.340	0.151	0.165	0.090
	Mom	WML	Mom	WML	Mom	WML	Mom	WML	Mom	WML
Mean	0.964	0.570	1.216	0.883	0.648	0.099	1.511	0.788	1.165	0.780
SE	0.296	0.268	0.297	0.221	0.307	0.243	0.275	0.246	0.183	0.164

Panel B: Value Score

	Val^{NA}	Val^{EU}	Val^{JA}	Val^{PA}	Val^{EM}
HML^{NA}	0.834	0.449	0.344	0.364	0.216
HML^{EU}	0.530	0.350	0.318	0.317	0.129
HML^{JA}	0.431	0.304	0.614	0.343	0.266
HML^{PA}	0.198	0.177	-0.025	0.002	0.079
HML^{EM}	0.288	0.229	0.122	0.156	0.091

Panel C: Investment Score

	Inv^{NA}	Inv^{EU}	Inv^{JA}	Inv^{PA}	Inv^{EM}
CMA^{NA}	0.837	0.414	0.193	0.356	0.254
CMA^{EU}	0.480	0.687	0.235	0.186	0.263
CMA^{JA}	0.171	0.261	0.633	0.217	0.053
CMA^{PA}	0.315	0.234	0.197	0.416	0.177
CMA^{EM}	0.078	0.019	-0.003	0.068	0.101

Panel D: Profitability Score

	Prf^{NA}	Prf^{EU}	Prf^{JA}	Prf^{PA}	Prf^{EM}
RMW^{NA}	0.832	0.348	-0.046	0.223	0.026
RMW^{EU}	0.270	0.619	0.247	0.076	0.054
RMW^{JA}	-0.045	0.076	0.587	0.053	0.076
RMW^{PA}	0.149	0.122	0.081	0.521	0.139
RMW^{EM}	-0.029	0.035	0.018	0.042	-0.011

Panel E: Momentum Score

	Mo^{NA}	Mo^{EU}	Mo^{JA}	Mo^{PA}	Mo^{EM}
WML^{NA}	0.819	0.698	0.444	0.414	0.435
WML^{EU}	0.671	0.845	0.412	0.486	0.405
WML^{JA}	0.397	0.382	0.884	0.342	0.311
WML^{PA}	0.377	0.433	0.320	0.536	0.457
WML^{EM}	0.371	0.494	0.387	0.428	0.559

Panel F: Intangibles Score

	Int^{NA}	Int^{EU}	Int^{JA}	Int^{PA}	Int^{EM}
HML	-0.494	-0.636	0.058	-0.220	-0.201
CMA	-0.407	-0.210	-0.078	0.142	-0.102
RMW	-0.428	0.433	0.258	0.480	-0.057
WML	0.267	0.333	-0.071	0.025	0.080
SMB	0.352	-0.000	-0.281	-0.390	0.018

Panel G: Frictions Score

	Fr^{NA}	Fr^{EU}	Fr^{JA}	Fr^{PA}	Fr^{EM}
HML	0.577	0.089	0.334	-0.121	0.038
CMA	0.592	0.041	0.148	0.374	-0.006
RMW	0.696	0.006	-0.063	0.449	0.017
WML	-0.071	-0.073	-0.197	0.127	-0.030
SMB	-0.510	-0.360	0.123	-0.367	-0.161

Table C.10: Category Assignments

This table provides an overview of the assignment of firm characteristics and trading signals to categories on which the categorical factors are based. The table lists the description and reference papers. The variables are sorted alphabetically by their underlying acronyms. To construct the variables Thomson Reuters Datastream, Worldscope, and I/B/E/S are used.

#	Firm Characteristic	Source
	Value	
1	Abnormal operating cash flows	Li (2012)
2	Analyst value	Frankel and Lee (1998)
3	Industry-adjusted book-to-market	Asness et al. (2000)
4	Book-to-market ratio	Rosenberg et al. (1985)
5	Cash flow-to-debt ratio	Ou and Penman (1989)
6	Cash flow over market value of equity	Lakonishok et al. (1994)
7	Industry-adjusted cash flow-to-price ratio	Asness et al. (2000)
8	Cash flow-to-price ratio	Desai et al. (2004)
9	Current ratio	Ou and Penman (1989)
10	Earnings distributed to equity holders	Papanastasopoulos et al. (2010)
11	Equity duration	Dechow et al. (2004)
12	Dividends-to-price ratio	Litzenberger and Ramaswamy (1982)
13	Dividend yield estimate from Datastream	Litzenberger and Ramaswamy (1982)
14	Enterprise component of book/price	Penman et al. (2007)
15	Analysts' 1-year earnings forecast-to-price	Elgers et al. (2001)
16	Enterprise Multiple	Loughran and Wellman (2011)
17	Value-weighted industry long-term return (5 years)	De Bondt and Thaler (1985)
18	Financial constraints index	Lamont et al. (2001)
19	Leverage component of book/price	Penman et al. (2007)
20	Forecasted growth in 5-year EPS	La Porta (1996)
21	Long-term reversal	De Bondt and Thaler (1985)
22	Market leverage	Bhandari (1988)
23	Consensus recommendations	Barber et al. (2001)
24	Earnings-to-price ratio	Basu (1977)
25	Net cash distributed to equity holders	Boudoukh et al. (2007)
26	Payout yield	Asness et al. (2019)
27	Percentage change in current ratio	Ou and Penman (1989)
28	Percentage change in quick ratio	Ou and Penman (1989)
29	Quick ratio	Ou and Penman (1989)
30	Sales growth	Lakonishok et al. (1994)
31	Sales-to-price	Lewellen (2015)
32	Short-term debt over current assets	Yan and Zheng (2017)
	Investment	
33	Absolute accruals	Bandyopadhyay et al. (2010)
34	Accruals as defined in Richardson et al. (2005)	Richardson et al. (2005)
35	Accruals as defined in Sloan (1996)	Sloan (1996)
36	Abnormal corporate investment	Titman et al. (2004)
37	Asset growth	Cooper et al. (2008)
38	Capital expenditures over net property, plant, and equipment	Polk and Sapienza (2009)
39	Capital expenditures	Anderson and Garcia-Feijóo (2006)
40	Annual growth in cost	Huang et al. (2017)

Table C.10 continued

#	Firm Characteristic	Source
	Investment	
41	Composite equity issuance	Daniel and Titman (2006)
42	Net external financing based on balance sheet	Bradshaw et al. (2006)
43	Net external financing based on cash flow statement	Richardson and Sloan (2003)
44	Change in total equity capital from outside	Richardson and Sloan (2003)
45	Change in interest expense divided by total assets	Yan and Zheng (2017)
46	Change in total liabilities divided by lagged total assets	Yan and Zheng (2017)
47	Change in cash holdings	Sodjahin (2013)
48	Deferred revenues	Prakash and Sinha (2013)
49	Change in common shareholder equity	Richardson et al. (2005)
50	Growth in net operating assets	Fairfield et al. (2003)
51	Investments over total assets	Titman et al. (2004)
52	Investment growth	Xing (2008)
53	Inventory changes	Thomas and Zhang (2002)
54	Growth in Inventory	Belo and Lin (2012)
55	Change in long-term debt	Richardson et al. (2005)
56	Percentage change in gross margin - percentage change in sales	Abarbanell and Bushee (1998)
57	Earnings management likelihood score	Beneish et al. (2013)
58	Noncurrent operating assets changes	Soliman (2008)
59	Level of net operating assets	Hirshleifer et al. (2004)
60	Share issuance (1 year)	Pontiff and Woodgate (2008)
61	Net working capital change	Soliman (2008)
62	Percentage change in CAPEX - percentage change in industry CAPEX	Abarbanell and Bushee (1998)
63	Percentage change in depreciation-to-gross-PPE	Holthausen and Larcker (1992)
64	Percentage change in sales-to-inventory	Ou and Penman (1989)
65	Percent operating accrual	Hafzalla et al. (2011)
66	Percent total accruals	Hafzalla et al. (2011)
67	Growth in SGA expenses	Abarbanell and Bushee (1998)
68	Sustainable growth	Lockwood and Prombutr (2010)
	Profitability	
69	Asset turnover	Soliman (2008)
70	Cash productivity	Chandrashekar and Rao (2006)
71	Industry-adjusted change in asset turnover	Soliman (2008)
72	Change in asset turnover	Soliman (2008)
73	Change in profit margin	Soliman (2008)
74	Industry-adjusted change in profit margin	Soliman (2008)
75	Failure predictor from Campbell et al. (2008)	Campbell et al. (2008)
76	F-Score	Piotroski (2001)
77	Gross profitability (Gross profits-to-assets)	Novy-Marx (2013)
78	G-Score	Mohanram (2005)
79	Long-term profit	Fuller et al. (2014)
80	Gross profit margin	Abarbanell and Bushee (1998)
81	Sales-to-inventories	Ou and Penman (1989)
82	Operating profitability	Fama and French (2006)
83	Distress risk from Ohlson (1981)	Dichev (1998)
84	Productivity of cash	Chandrashekar and Rao (2006)

Table C.10 continued

#	Firm Characteristic	Source
	Profitability	
85	Capital turnover	Haugen and Baker (1996)
86	Predicted earnings increase score	Wahlen and Wieland (2011)
87	Net profit margin	Soliman (2008)
88	Quality minus junk composite score	Asness et al. (2019)
89	Return on net operating assets	Soliman (2008)
90	Quarterly return on assets	Balakrishnan et al. (2010)
91	Return on equity	Haugen and Baker (1996)
92	Quarterly return on equity	Hou et al. (2015)
93	Return on invested capital	Brown and Rowe (2007)
94	Sales-to-cash	Ou and Penman (1989)
95	Sales-to-receivables	Ou and Penman (1989)
96	Distress risk measure from Shumway (2001)	Shumway (2001)
97	Taxable income to book income if book income is positive	Lev and Nissim (2004)
98	Taxable income to book income if book income is negative	Lev and Nissim (2004)
99	Z-Score (financial distress)	Dichev (1998)
	Momentum	
100	Capital gains overhang over 5 years	Grinblatt and Han (2005)
101	Change in forecasted annual EPS	Hawkins et al. (1984)
102	Change in recommendation	Jegadeesh et al. (2004)
103	Change in 6-month momentum	Gettleman and Marks (2006)
104	Analyst forecast optimism	La Porta (1996)
105	Tax expense surprise	Thomas and Zhang (2011)
106	Earnings consistency	Alwathainani (2013)
107	Earnings announcement return	Chan et al. (1996)
108	Analyst forecast revision ratio	Achour et al. (1998)
109	6-months value-weighted industry momentum	Moskowitz and Grinblatt (1999)
110	Lagged value-weighted industry momentum	Novy-Marx (2012)/Moskowitz and Grinblatt (1999)
111	6-month momentum	Jegadeesh and Titman (1993)
112	11-month momentum	Jegadeesh and Titman (1993)
113	Lagged Momentum	Novy-Marx (2012)
114	Number of consecutive quarters with earnings increases	Barth et al. (1999)
115	52-Week High	George and Hwang (2004)
116	Profitability trend in quarterly earnings	Akbas et al. (2017)
117	Revisions in analysts earnings forecasts (1-month)	Chan et al. (1996)
118	6-months rolling revisions in analysts' earnings forecasts	Chan et al. (1996)
119	Annual seasonality momentum	Heston and Sadka (2008)
120	Quarterly seasonality momentum	Sias (2007)
121	Revenue surprise scaled by market value	Kama (2009)
122	Revenue surprise scaled by standard deviation	Jegadeesh and Livnat (2006)
123	Composite style-based earnings surprise	Müller (2019)
124	Seasonality in style returns	Müller (2019)
125	Earnings surprise scaled by standard deviation	Foster et al. (1984)
126	Earnings surprise scaled by market value	Livnat and Mendenhall (2006)
127	Trendfactor from moving averages	Han et al. (2016)
128	Volume trend	Haugen and Baker (1996)

Table C.10 continued

#	Firm Characteristic	Source
	Intangibles	
129	Accumulated depreciation	Yan and Zheng (2017)
130	Accrual quality	Francis et al. (2005)
131	Advertising expenses over market value of equity	Chan et al. (2001)
132	Firm age	Barry and Brown (1984)
133	Abnormal production costs	Li (2012)
134	Cash holdings	Palazzo (2012)
135	Cash flow volatility	Haugen and Baker (1996)
136	Industry-adjusted change in employees	Asness et al. (2000)
137	Change in number of analysts	Sadka and Scherbina (2007)
138	Capital intensity	Gorodnichenko and Weber (2016)
139	Depreciation-to-gross-PPE	Holthausen and Larcker (1992)
140	Earnings conservatism	Francis et al. (2004)
141	Earnings persistence	Francis et al. (2004)
142	Earnings predictability	Francis et al. (2004)
143	Earnings relevance	Francis et al. (2004)
144	Earnings smoothness	Francis et al. (2004)
145	Earnings timeliness	Francis et al. (2004)
146	Dispersion in forecasted EPS	Diether et al. (2002)
147	Herfindahl index (industry market competition)	Hou and Robinson (2006)
148	Employee growth rate	Belo et al. (2014)
149	Firm's ability to innovate	Cohen et al. (2013)
150	Value-weighted industry return same calendar month	Keloharju et al. (2016)
151	Industry-adjusted labor productivity	Liu et al. (2017)
152	Dispersion in expected long-term growth	Anderson et al. (2005)
153	Number of analysts covering stock	Ali et al. (2003)
154	Operating leverage	Novy-Marx (2011)
155	Organizational capital	Eisfeldt and Papanikolaou (2013)
156	Percentage change in sales - percentage change in accounts receivable	Abarbanell and Bushee (1998)
157	Percentage change in sales - percentage change in SG&A	Abarbanell and Bushee (1998)
158	R&D-to-sales	Chan et al. (2001)
159	R&D capital-to-assets	Li (2011)
160	R&D-to-market capitalization	Chan et al. (2001)
161	Industry adjusted real estate holdings	Tuzel (2010)
162	Residual analyst coverage	Lee and So (2017)
163	Earnings volality	Francis et al. (2004)
164	Percentage change in sales - percentage change in inventory	Abarbanell and Bushee (1998)
165	SGA expenses divided by total assets	Yan and Zheng (2017)
166	Standard deviation in recommendation change	Womack (1996)/Jegadeesh et al. (2004)
167	Short-term debt per employee	Yan and Zheng (2017)
168	Accrual volatility	Bandyopadhyay et al. (2010)
169	Standard deviation of analyst recommendations	Jegadeesh et al. (2004)
170	Debt capacity-to-firm tangibility	Hahn and Lee (2009)
171	Debt capacity	Almeida and Campello (2007)

Table C.10 continued

#	Firm Characteristic	Source
	Frictions	
172	Amihud (2002) illiquidity measure	Amihud (2002)
173	Abnormal turnover ratio	Pan et al. (2016)
174	Average trading volume previous 60 months	Lee and Swaminathan (2000)
175	Average monthly turnover previous 12 months	Lewellen (2015)
176	Abnormal trading volume over 3-day earnings announcement window	Choi et al. (2010)
177	CAPM beta using daily returns from the previous month	Ang et al. (2006)
178	CAPM beta using monthly returns from the previous 60 months	Baker et al. (2011)
179	CAPM residual volatility using daily returns from the previous month	Ang et al. (2006)
180	CAPM residual volatility using monthly returns from the previous 60 months	Baker et al. (2011)
181	Economic uncertainty beta	Bali et al. (2017)
182	Corwin and Schultz (2012) bid-ask-spread estimator	Amihud and Mendelson (1986)
183	Coskewness	Harvey and Siddique (2000)
184	Dollar trading volume	Brennan et al. (1998)
185	Efficiency score	Nguyen and Swanson (2009)
186	Expected idiosyncratic skewness	Boyer et al. (2010)
187	Microstructure frictions	Hou et al. (2016)
188	Industry-adjusted size	Asness et al. (2000)
189	Idiosyncratic skewness from Kumar (2009)	Kumar (2009)
190	Information uncertainty	Jiang et al. (2005)
191	Idiosyncratic volatility from Kumar (2009)	Kumar (2009)
192	Recent minus distant idiosyncratic volatility	Rachwalski and Wen (2016)
193	Jackpot probability	Conrad et al. (2014)
194	Kurtosis of residual daily returns from CAPM, 1 month	Amaya et al. (2015)
195	Kurtosis of residual returns from CAPM, 60 months	Amaya et al. (2015)
196	Maximum daily return in prior month	Bali et al. (2011)
197	Minimum daily return during previous month	Bali et al. (2011)
198	Price delay	Hou and Moskowitz (2005)
199	Price	Blume and Husic (1973)
200	R-squared from CAPM, 60 months	Hou and Loh (2016)
201	Related industry returns	Menzly and Ozbas (2010)
202	Short-term reversal	Jegadeesh (1990)
203	Information revelation	Gokcen (2009)
204	Volatility of liquidity	Akbas et al. (2012)
205	Average trading volume previous 3 months	Datar et al. (1998)
206	Shock in bid/ask spread	Bali et al. (2014)
207	Equity market value	Banz (1981)
208	Skewness of residual daily returns from CAPM, 1 month	Amaya et al. (2015)
209	Skewness of residual returns from CAPM, 60 months	Amaya et al. (2015)
210	Volume variance	Chordia et al. (2001)
211	Turnover volatility	Chordia et al. (2001)
212	Extreme downside risk	Kelly and Jiang (2014)
213	Trading volume over market value	Haugen and Baker (1996)
214	Fraction of zero trading days	Liu (2006)

Table C.11: Anomaly Variables

This table provides an overview of firm characteristics where the trading signal is an (0/1) indicator variable or based on intermediate past-returns and where the firm characteristic is used to construct anomalies to test factor model performance. The table lists the description and reference papers. The variables are sorted alphabetically by their underlying acronyms. To construct the variables Thomson Reuters Datastream, Worldscope, and I/B/E/S are used.

#	Variable	Reference Paper
	Dummy Variables	
1	Dividend initiation	Michaely et al. (1995)
2	Dividend omission	Michaely et al. (1995)
3	Convertible debt indicator	Valta (2016)
4	Change in forecast and accrual	Barth and Hutton (2004)
5	Loser in recent month	Kumar et al. (2019)
6	Merger in previous 12 months	Langetieg (1978)
7	Reverse stock split in recent 6 months	Desai and Jain (1997)
8	Public seasoned equity offering in recent 3 years	Loughran and Ritter (1995)
9	Negative price shock	Lu et al. (2014)
10	Positive price shock	Lu et al. (2014)
11	Stock split in recent 6 months	Desai and Jain (1997)
12	Winner in recent month	Kumar et al. (2019)
13	Debt Issuance	Spiess and Affleck-Graves (1999)
14	Analyst down forecast	Barber et al. (2001)
15	Pension funding status	Franzoni and Marín (2006)
16	Earnings announcement premium	Lamont and Frazzini (2007)
17	Expected dividend month	Hartzmark and Solomon (2013)
18	New equity share issue	Loughran and Ritter (1995)
19	Recent IPO and no R&D expenses	Guo et al. (2006)
20	Lottery stock dummy	Kumar (2009)
21	Unexpected R&D increases	Eberhart et al. (2004)
22	Share repurchases	Ikenberry et al. (1995)
23	Firm operates in sin industry	Hong and Kacperczyk (2009)
24	Analyst up forecast	Barber et al. (2001)
	Intermediate Past-Returns	
25	Cumulative returns month (t-180) to (t-121)	Yan and Zheng (2017)
26	Cumulative returns month (t-120) to (t-61)	Yan and Zheng (2017)
27	Stock-reversal month (t-13) to (t-18)	Jegadeesh and Titman (1993)

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