Idiosyncratic Quantile Risk

and the Cross-section of Expected Returns

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Outline

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Outline

- Time-series factor structure of excess stock returns

$$r_{i,t} = \alpha_i + F_t'\beta_i + \epsilon_{i,t} \tag{1}$$

where the exposure to aggregate risk, β_i, is compensated by the risk premium of an asset

$$\mathbb{E}_t[r_{i,t+1}] = \lambda_t'\beta_{i,t}. \tag{2}$$

- But what about the idiosyncratic component $\epsilon_{i,t}$? It should be independent across assets (e.g., APT), and in a well-diversified portfolio, the idiosyncratic component should not matter! Thus, no compensation should be awarded for bearing it.
- Many justifications for the under-diversified portfolio holdings proposed in the literature.

Raw vs. idiosyncratic quantiles

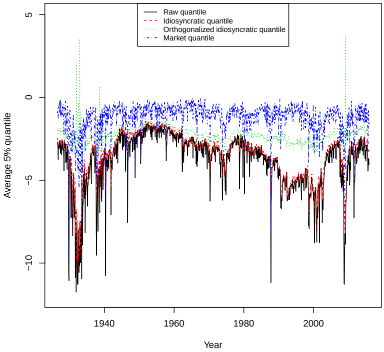

Figure: Average and market quantiles. Panel A shows various versions of average 5% quantile obtained from daily data of returns CRSP stocks during every month. It also includes the market quantile obtained from the daily data for given month.

τ	$\frac{\sigma(q_\tau(e))}{\sigma(q_\tau(r))}$	$\frac{\sigma(q_\tau(e^{ORT}))}{\sigma(q_\tau(e))}$
0.05	0.818	0.400
0.10	0.829	0.406
0.15	0.839	0.414
0.25	0.846	0.425
0.50	0.424	0.772
0.60	0.607	0.623
0.75	0.806	0.476
0.95	0.773	0.383

Table: Ratios between standard deviations of raw, idiosyncratic and orthogonalized quantiles.

τ	EW	VW
0.05	0.557	0.618
0.10	0.571	0.629
0.15	0.544	0.611
0.25	0.496	0.552
0.50	-0.427	-0.482
0.60	-0.036	-0.003
0.75	0.496	0.498
0.95	0.647	0.662

Table: Correlations between market quantiles and equal- and value-weighted idiosyncratic average quantiles.

Total and idiosyncratic correlations

Pairwise correlations between stock returns

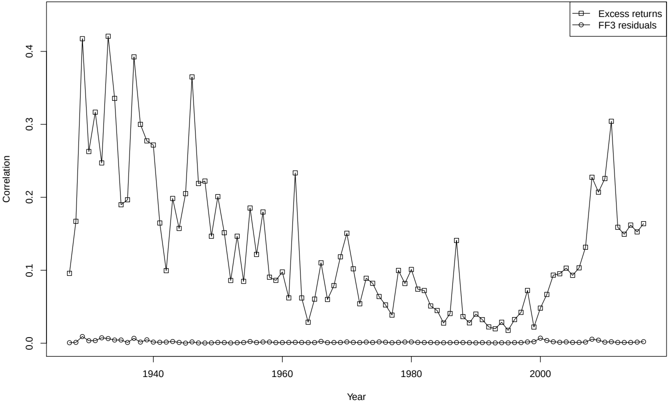

Figure: Average pairwise correlations during years. Figure captures average pairwise time-series correlations between returns of CRSP stocks computed from daily data and averaged for each year. Figure replicates results of Herskovic et al. (2016).

Factor structure of quantiles

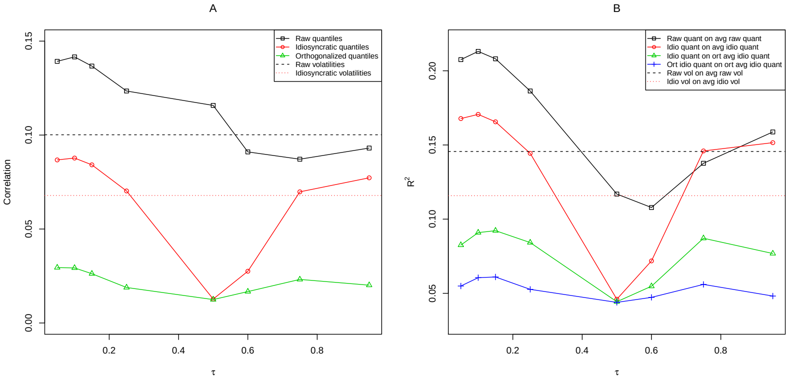

Figure: Average pairwise correlations and average explanatory power. Panel A shows average pairwise time-series correlation between quantiles of CRSP stocks obtained from daily observations throughout months. Panel B depicts average R^2 from time-series regression of stock-level quantiles on averaged value of quantile across stocks.

- Common factors do not explain the time variation of the realized quantiles.
- There is a factor structure in the quantiles.
- This structure is not fully captured by the common volatility.

Question: Is the exposure to the common quantile risk (CIQ) priced in the cross section of expected returns?

Outline

Construction of the factors

Construction procedure

Each month and for every quantile τ, I repeat the following procedure:

1. I take all stocks with all daily observations during that month and for each of them estimate model of Fama and French (1993)

$$r_{i,t} = \beta_i^{MKT} MKT_t + \beta_i^{SMB} SMB_t + \beta_i^{SBM} SMB_t + e_{i,t} \tag{3}$$

where t is from month T and there are N_T such stocks during that month.

2. For each stock, I calculate τ-quantiles of the estimated residuals.

$$IQ_{i,T}(\tau) = q_\tau(e_{i,t}) \tag{4}$$

3. Factor value is computed as an winsorized average of the cross-section of the stock-level quantiles

$$CIQ_T(\tau) = \frac{1}{N_T} \sum_{i}^{N_T} IQ_{i,T}(\tau) \tag{5}$$

This creates time-series of average quantiles.

CIV vs. CIQ

- Herskovic et al. (2016) proposed to compute average common variance as

$$CIV_t = \frac{1}{N_t} \sum_{i=1}^{N_t} \mathbb{V}ar(e_{i,t}) \tag{6}$$

and they use differences as their pricing factor

$$\Delta CIV_t = CIV_t - CIV_{t-1} \tag{7}$$

where they estimate it using daily data and aggregate the resulting factor into monthly values.

- I follow the same estimation specification (window size, time period etc.) to show that the CIQ risk does not simply mirror the CIV risk.
- To control for the CIV risk, I perform various robustness checks.

Empirical specification

Data

- I work with CRSP database sampled between 196301 and 201512.
- For the construction of the CIQ factors, I use daily-sampled observations.
- Asset pricing tests are performed using monthly data.

Beta estimation

- Betas, for both CIQ and competing models, are estimated using univariate regression of single-stock returns on factors.
- Betas are estimated using 60-month rolling window.
- Betas computed up to time t are used to predict returns at time $t + 1$ or further - no overlap between estimation and prediction periods.

Outline

Univariate portfolio sorts

Annualized returns and four-factor alphas of CIQ(τ) portfolios

τ	Low	2	3	4	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.708	8.151	9.479	11.042	12.738	6.029	2.376	8.143	2.970
0.1	6.538	8.282	9.246	10.906	13.151	6.614	2.594	8.847	3.243
0.15	6.677	7.930	9.341	10.726	13.449	6.773	2.592	9.112	3.308
0.25	6.654	7.894	9.484	10.909	13.176	6.522	2.324	9.203	3.289
0.5	7.380	9.804	10.287	10.062	10.572	3.192	0.937	5.554	2.462
0.6	9.927	10.408	10.218	9.229	8.318	-1.609	-0.486	-2.038	-0.762
0.75	12.480	10.520	9.629	8.375	7.107	-5.373	-2.169	-7.730	-2.874
0.95	13.466	10.773	9.515	7.921	6.441	-7.025	-2.523	-9.484	-3.402

Table: Equal-weighted portfolios.

τ	Low	2	3	4	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	5.791	4.673	6.039	8.209	9.904	4.113	1.537	6.983	2.333
0.1	5.173	5.229	5.589	7.880	10.053	4.879	1.766	7.795	2.523
0.15	5.078	4.735	5.680	7.686	10.798	5.719	1.950	8.367	2.533
0.25	4.432	4.356	5.324	7.516	10.009	5.578	1.858	8.713	2.733
0.5	4.772	4.860	6.090	6.335	6.910	2.138	0.596	5.100	2.390
0.6	5.048	7.468	6.148	5.893	5.518	0.470	0.140	1.041	0.504
0.75	10.165	7.970	5.770	5.289	6.200	-3.965	-1.493	-6.795	-2.334
0.95	10.246	7.382	5.547	4.498	4.230	-6.016	-2.011	-8.957	-2.826

Table: Value-weighted portfolios.

Univariate portfolio sorts

Annualized returns and four-factor alphas of CIQ(τ) portfolios

τ	Low	2	3	4	5	6	7	8	9	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.184	7.233	7.878	8.427	8.891	10.068	11.042	11.039	11.863	13.635	7.451	2.426	10.016	2.956
0.1	6.131	6.941	8.318	8.249	8.654	9.838	10.877	10.933	11.828	14.499	8.368	2.670	11.170	3.268
0.15	5.806	7.536	7.929	7.932	8.910	9.772	10.345	11.107	12.023	14.903	9.097	2.855	12.038	3.511
0.25	6.152	7.147	7.737	8.050	9.289	9.677	10.815	11.003	11.355	15.014	8.862	2.603	12.221	3.523
0.5	6.084	8.679	9.691	9.920	9.797	10.776	10.156	9.966	10.546	10.612	4.529	1.108	7.229	2.491
0.6	10.593	9.270	10.339	10.478	10.396	10.038	9.453	9.010	8.699	7.937	-2.656	-0.660	-3.754	-1.053
0.75	13.181	11.801	10.731	10.312	10.137	9.120	9.040	7.710	7.732	6.487	-6.694	-2.209	-9.783	-2.916
0.95	15.143	11.803	10.652	10.891	9.801	9.232	7.834	8.009	6.955	5.915	-9.228	-2.728	-12.198	-3.536

Table: Equal-weighted portfolios.

τ	Low	2	3	4	5	6	7	8	9	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.711	5.306	4.436	5.259	6.188	5.819	7.240	9.703	9.441	11.063	4.352	1.251	8.466	2.316
0.1	6.632	4.379	5.411	5.424	5.150	6.098	8.034	7.914	8.945	12.698	6.067	1.702	10.269	2.849
0.15	5.282	4.802	4.376	5.309	5.343	5.900	7.710	7.727	9.405	13.483	8.201	2.179	12.265	3.175
0.25	5.995	3.704	3.904	5.113	5.508	5.353	7.558	7.557	8.805	12.483	6.488	1.682	10.609	2.636
0.5	3.909	5.247	5.173	4.516	5.214	6.774	5.741	7.042	7.411	6.087	2.178	0.495	4.779	1.735
0.6	3.673	5.689	8.739	6.844	6.081	6.364	6.843	5.407	5.078	6.857	3.185	0.800	3.357	1.226
0.75	9.744	10.428	8.548	7.664	5.739	6.084	5.607	5.050	5.600	7.734	-2.010	-0.583	-6.977	-2.093
0.95	11.845	9.410	7.761	7.402	5.466	5.894	4.693	4.540	3.317	5.863	-5.983	-1.546	-9.660	-2.356

Table: Value-weighted portfolios.

Dependent bivariate portfolio sorts

Control for CIV betas

τ	Low	2	3	4	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	7.530	8.367	9.786	10.556	11.920	4.390	1.943	6.220	2.548
0.1	7.429	8.211	9.649	10.604	12.259	4.830	2.118	6.728	2.727
0.15	7.356	8.186	9.553	10.536	12.518	5.161	2.246	7.038	2.849
0.25	7.209	8.275	9.858	10.145	12.661	5.452	2.183	7.518	2.953
0.5	7.400	9.713	9.932	10.067	11.028	3.628	1.214	5.085	2.312
0.6	9.424	10.592	9.874	9.697	8.561	-0.864	-0.302	-1.942	-0.814
0.75	11.329	10.445	9.827	8.664	7.888	-3.441	-1.558	-5.638	-2.361
0.95	12.836	10.231	9.913	7.858	7.297	-5.539	-2.209	-7.404	-2.882

Table: Equal-weighted portfolios.

τ	Low	2	3	4	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.376	6.534	6.739	8.483	9.111	2.735	1.256	5.069	2.165
0.1	6.722	5.614	6.987	8.142	9.799	3.076	1.392	5.610	2.302
0.15	6.430	5.287	6.676	8.310	9.666	3.236	1.390	5.666	2.276
0.25	5.600	5.384	6.167	8.348	9.460	3.860	1.549	6.027	2.376
0.5	5.613	5.797	6.040	7.418	8.011	2.398	0.768	3.820	1.825
0.6	6.231	7.326	6.966	6.660	6.527	0.297	0.109	-0.217	-0.107
0.75	8.563	8.571	6.806	6.672	6.721	-1.842	-0.864	-4.658	-2.020
0.95	9.988	7.952	6.356	5.426	5.423	-4.565	-1.841	-6.415	-2.508

Table: Value-weighted portfolios.

Dependent bivariate portfolio sorts

Control for CIV betas

τ	Low	2	3	4	5	6	7	8	9	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.994	8.164	8.378	8.569	9.724	9.767	10.826	10.604	11.155	12.144	5.150	1.874	7.254	2.420
0.1	6.906	8.005	7.983	8.592	9.625	9.911	10.628	10.562	11.415	12.677	5.771	2.082	7.983	2.660
0.15	6.495	8.435	7.776	8.526	9.672	9.828	10.189	10.725	11.599	13.053	6.558	2.372	8.767	2.941
0.25	6.279	7.985	8.062	8.675	9.611	10.202	10.031	10.535	11.220	13.687	7.408	2.540	9.753	3.227
0.5	6.102	8.978	9.071	10.236	9.626	10.138	10.114	9.950	10.411	11.666	5.564	1.583	7.146	2.439
0.6	9.538	9.410	10.580	10.007	10.418	9.827	9.847	9.820	8.345	8.447	-1.092	-0.322	-2.724	-0.913
0.75	11.890	10.693	10.466	10.351	9.920	9.814	9.074	8.303	8.522	7.275	-4.615	-1.715	-7.285	-2.519
0.95	13.410	11.679	10.497	10.397	10.102	9.506	8.694	7.620	8.267	6.103	-7.308	-2.476	-9.537	-3.145

Table: Equal-weighted portfolios.

τ	Low	2	3	4	5	6	7	8	9	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	5.849	6.726	6.934	6.736	6.672	6.828	8.538	8.247	9.206	9.424	3.575	1.204	6.384	2.078
0.1	5.839	6.387	7.022	6.012	7.047	7.535	7.932	7.805	9.403	10.104	4.266	1.436	6.888	2.202
0.15	4.768	6.750	6.518	6.082	6.708	6.853	8.492	8.216	9.615	10.143	5.374	1.801	7.953	2.509
0.25	4.041	5.505	6.866	5.661	6.873	6.574	7.921	8.693	8.999	10.395	6.354	2.062	9.274	2.899
0.5	4.702	5.589	6.350	6.454	6.650	7.701	8.474	7.304	7.538	7.564	2.862	0.778	4.866	1.814
0.6	5.659	7.340	7.293	7.860	7.024	7.590	7.285	6.807	6.439	7.619	1.961	0.558	0.267	0.101
0.75	8.826	8.973	8.470	8.003	6.966	7.133	6.814	6.546	7.934	5.460	-3.367	-1.161	-6.236	-2.105
0.95	10.761	9.587	7.580	8.108	6.950	7.357	5.996	5.842	5.744	4.085	-6.677	-2.095	-9.349	-2.787

Table: Value-weighted portfolios.

Outline

Fama-MacBeth regressions

Control for other common risk measures

		0.05	0.1	0.15	0.25	0.5	0.6	0.75	0.95
	β^{CIQ}	1.030	0.792	0.620	0.369	0.020	-0.084	-0.365	-0.951
		2.597	2.548	2.457	2.234	0.827	-1.338	-2.356	-2.307
Herskovic et al. (2016)	β^{CIQ}	0.885	0.696	0.557	0.340	0.026	-0.078	-0.309	-0.886
		2.245	2.258	2.228	2.070	1.078	-1.245	-2.006	-2.163
	β^{CIV}	-4.847	-4.774	-4.730	-4.890	-6.648	-3.255	-5.075	-4.733
		-2.306	-2.230	-2.180	-2.197	-3.234	-2.270	-2.542	-2.117
Fama and French (1993)	β^{CIQ}	7.471	5.822	4.727	3.200	0.498	-0.797	-2.658	-8.345
		2.820	2.808	2.819	2.925	1.815	-1.897	-2.575	-3.046
	β^{MKT}	-0.001	-0.001	-0.000	0.000	0.002	-0.001	-0.001	0.000
		-0.789	-0.603	-0.405	0.075	1.175	-1.177	-0.883	0.063
	β^{SMB}	-0.000	0.000	0.000	0.001	0.002	-0.000	-0.000	0.001
		-0.015	0.118	0.269	0.640	1.557	-0.169	-0.051	0.619
	β^{HML}	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001
		2.115	2.072	1.984	1.691	1.061	2.013	2.241	1.732
Pástor and Stambaugh (2003)	β^{CIQ}	1.016	0.772	0.607	0.373	0.027	-0.078	-0.364	-0.960
		2.569	2.493	2.413	2.270	1.092	-1.211	-2.352	-2.348
	β^{LIQ}	-1.686	-1.228	-0.763	0.043	1.873	0.357	-1.682	-0.048
		-0.975	-0.708	-0.443	0.026	1.244	0.278	-0.947	-0.029

Table: Fama-MacBeth cross-sectional predictive regressions. Table reports annualized risk premia and their Newey-West robust t-statistics using 6 lags. Estimated values are based on monthly data from CRSP database between 1963 and 2015.

Fama-MacBeth Regressions

Control for other asymmetry risk measures

		0.05	0.1	0.15	0.25	0.5	0.6	0.75	0.95
Co-skewness	β^{CIQ}	0.898	0.681	0.528	0.311	0.019	-0.071	-0.316	-0.797
		2.156	2.090	1.991	1.804	0.766	-1.071	-1.917	-1.852
	β^{CSK}	-2.862	-2.611	-2.842	-3.753	-6.298	-6.245	-3.613	-3.613
		-1.367	-1.178	-1.240	-1.609	-3.397	-3.038	-1.724	-1.559
Co-kurtosis	β^{CIQ}	0.923	0.710	0.555	0.327	0.018	-0.079	-0.333	-0.835
		2.356	2.314	2.225	2.001	0.753	-1.232	-2.162	-2.047
	β^{CKT}	-0.234	-0.268	-0.284	-0.268	-0.055	-0.128	-0.294	-0.320
		-0.278	-0.315	-0.333	-0.315	-0.067	-0.161	-0.347	-0.377
Both	β^{CIQ}	0.942	0.711	0.546	0.318	0.017	-0.072	-0.332	-0.813
		2.181	2.094	1.975	1.755	0.703	-1.084	-1.962	-1.799
	β^{CSK}	-1.511	-1.767	-2.413	-3.832	-8.805	-5.911	-2.508	-3.723
		-0.494	-0.569	-0.766	-1.202	-3.401	-2.087	-0.852	-1.167
	β^{CKT}	-0.237	-0.272	-0.274	-0.247	-0.926	-0.305	-0.195	-0.370
		-0.213	-0.246	-0.248	-0.224	-0.866	-0.309	-0.179	-0.333
Kelly and Jinag (2014)	β^{CIQ}	1.009	0.759	0.590	0.364	0.027	-0.072	-0.365	-0.912
		2.637	2.520	2.411	2.237	1.174	-1.194	-2.433	-2.246
	β^{TR}	-0.789	-0.833	-0.902	-1.104	-0.868	-0.344	-0.783	-0.963
		-0.645	-0.698	-0.780	-0.991	-0.927	-0.361	-0.644	-0.868

Table: Fama-MacBeth cross-sectional predictive regressions. Table reports annualized risk premia and their Newey-West robust *t*-statistics using 6 lags. Estimated values are based on monthly data from CRSP database between 1963 and 2015.

Outline

Longer holding periods of sorted portfolios

1-year post-formation holding period

τ	Low	2	3	4	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.588	9.240	10.288	10.790	9.345	2.600	1.995	4.998	2.087
0.1	6.215	9.195	10.294	10.574	9.984	3.566	2.643	6.161	2.537
0.15	6.059	8.945	10.172	10.603	10.490	4.198	2.890	6.959	2.820
0.25	5.740	8.757	10.136	10.695	10.957	4.958	2.910	8.129	3.250
0.5	4.716	9.754	11.121	10.658	10.070	5.133	2.106	7.519	4.525
0.6	5.761	10.273	10.712	10.333	9.195	3.263	1.473	1.973	0.941
0.75	8.871	10.394	10.394	9.360	7.212	-1.535	-1.227	-3.689	-1.665
0.95	11.134	10.713	10.020	8.822	5.598	-5.025	-3.111	-7.951	-3.450

Table: Equal-weighted portfolios.

τ	Low	2	3	4	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	6.853	6.254	6.940	7.946	10.189	3.140	1.989	5.226	2.195
0.1	6.547	6.286	6.992	7.630	10.729	3.946	2.448	5.847	2.416
0.15	6.452	5.960	6.916	7.859	10.679	3.992	2.426	5.883	2.433
0.25	6.356	5.625	6.594	7.702	10.418	3.839	2.098	5.896	2.335
0.5	5.928	6.031	7.160	6.976	7.459	1.453	0.599	3.727	1.907
0.6	5.243	7.614	6.505	6.302	6.907	1.587	0.739	0.931	0.440
0.75	9.393	8.124	6.845	6.518	7.092	-2.119	-1.413	-3.886	-1.785
0.95	10.554	7.623	6.588	5.840	6.202	-3.970	-2.280	-5.546	-2.320

Table: Value-weighted portfolios.

Longer holding periods of sorted portfolios

1-year post-formation holding period

τ	Low	2	3	4	5	6	7	8	9	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	5.318	7.869	8.980	9.499	9.943	10.634	10.994	10.584	10.631	8.078	2.632	1.601	5.188	1.729
0.1	4.932	7.510	9.142	9.249	10.046	10.541	10.699	10.448	11.056	8.926	3.822	2.309	6.492	2.160
0.15	4.685	7.448	8.794	9.097	10.101	10.242	10.539	10.667	11.068	9.920	5.020	2.859	8.150	2.710
0.25	4.416	7.077	8.418	9.095	9.911	10.362	10.528	10.861	11.307	10.613	5.957	2.915	9.613	3.072
0.5	1.890	7.613	9.296	10.217	10.899	11.343	10.862	10.454	10.546	9.598	7.577	2.655	11.050	5.399
0.6	3.717	7.844	9.470	11.081	10.892	10.533	10.335	10.331	10.099	8.297	4.429	1.664	2.542	0.915
0.75	7.637	10.122	10.306	10.484	10.570	10.219	9.668	9.053	8.356	6.079	-1.456	-0.895	-3.754	-1.294
0.95	10.896	11.379	10.650	10.776	10.345	9.697	9.257	8.390	7.114	4.100	-6.179	-3.246	-9.449	-3.336

Table: Equal-weighted portfolios.

τ	Low	2	3	4	5	6	7	8	9	High	H-L	t(H - L)	α	$t(\alpha)$
0.05	7.797	6.399	6.302	6.462	6.921	7.079	7.812	8.189	10.081	10.610	2.626	1.310	4.536	1.328
0.1	7.385	6.168	6.589	6.240	6.980	7.152	7.698	7.677	10.311	12.068	4.387	2.159	6.026	1.783
0.15	7.217	6.033	6.343	6.004	7.082	6.812	7.787	8.035	9.884	13.054	5.477	2.615	6.768	2.101
0.25	7.850	5.662	5.623	5.956	6.816	6.553	7.485	8.115	9.518	12.730	4.554	1.995	6.638	2.106
0.5	3.761	7.021	6.321	6.090	6.799	7.502	6.730	7.429	7.383	7.510	3.624	1.297	5.299	2.309
0.6	4.018	5.599	7.821	7.770	6.966	6.292	6.816	6.166	6.721	7.593	3.448	1.397	3.139	1.119
0.75	9.680	9.174	8.535	7.772	6.500	7.269	6.768	6.563	6.661	8.178	-1.380	-0.706	-3.305	-1.014
0.95	12.566	9.768	8.211	7.448	6.689	6.655	6.330	5.607	5.567	7.537	-4.511	-2.078	-6.039	-1.993

Table: Value-weighted portfolios.

Additional robustness checks

- *Sub-periods*: Results hold separately for periods 1963-1989 and 1990-2015; although, the performance in the second one is slightly weakened.
- *Control for CIV betas*: CIQ betas estimated from multiple time-series regression jointly with CIV betas perform qualitatively the same as being estimated from the univariate regressions.
- *No penny stocks*: Excluding stocks with price $< 1\$$ does not significantly alter the results.
- *Value-weighted factor*: Results still hold using value-weighted definition of the CIQ factors.

Outline

Further work

- Profitable investment strategy?
- Use traded versions of the factors?
- Aggregation of CIQ betas into one risk measure?
- Theoretical justification of the empirical results?

Conclusion

Main results

- There is an average quantile risk priced in the cross-section of stock returns.
- It is not captured by previously proposed risk factors.
- The pricing information is the strongest outside the median.

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The End