Preview Document: Daily Country Industry Relative Market Movements Monitoring and Forecast Model

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Contents

1   Introduction

Financial market time series generally exhibit volatility clustering during periods of market stress. There is also the phenomena of volatility co-movements across different financial assets; volatility effects from one asset can have spillover effects on other assets. Such movements and impacts can be used quantified and used as a tool to monitor the joint asset trends and volatility movements of broad markets and industries. Divergences or convergences in the correlation and sensitivities can also serve as early indicators of impending market movements, and imminent relative underperformance or overperformance, of an asset vis-à-vis other assets.

- Model inputs:
    - Time series returns
- Model outputs:
    - Correlation estimates
    - Beta estimates

2   Brief Summary

Dynamic Conditional Correlation (DCC) GARCH models are utilized to dynamically and jointly model the volatility, correlation, and sensitivity dynamics (as measured by beta) across different assets.

Correlation and beta estimates are made on a daily basis, and models are always refitted to incorporate the latest data, before making the next set of estimates. The next set of estimates are look-ahead approximations of correlations and beta. The previous period ex-ante forecast is compared to the current period ex-ante forecast to identify any unusual co-movements or deviations from usual trends.

Time series of broad markets and industry returns extracted from data vendors. The data then undergoes cleaning and pre-processing.

The best models are then selected based on statistical criteria. The models also undergo backtesting to assess their effectiveness.

3   Sample Outputs

This section showcases some examples of analytical outputs for the some GICs stock market sectors, as well as some investment style factors, for USA.

The tables exhibit some examples of daily automated correlation and beta outputs, which are used to analyse any potential imminent divergences or convergences of the industries.

Figures 1 and 2 show the evolution of the out-of-sample dynamic correlations and the cumulative returns of the selected index ("portfolio"), when compared against the cumulative returns of other industries ("benchmark").

Figure 3 shows the evolution of the out-of-sample dynamic beta and cumulative returns of the investment style factors and sectors ("portfolios"), when compared against the S&P 500 index returns ("benchmark").

Figures 4 and 5 shows out-of-sample dynamic beta and cumulative returns of selected sectors ("portfolios"), when compared against the broad market and other investment style factors and sectors.

Table 1: T-1 Ex-ante Forecasted Correlation

Index	S&P 500	S&P 400 MID CAPS	S&P 600 SMALL CAPS	S&P 500 VALUE	S&P 500 GROWTH	S&P COMM SVC	S&P CONS DISC	S&P CONS STAPLES	S&P ENERGY	S&P FINANCIALS	S&P HEALTHCARE	S&P INDUSTRIALS	S&P INFO TECH	S&P MATERIALS	S&P REAL ESTATE	S&P UTILITIES
S&P 500	1.000															
S&P 400 MID CAPS	0.781	1.000														
S&P 600 SMALL CAPS	0.706	0.962	1.000													
S&P 500 VALUE	0.954	0.878	0.803	1.000												
S&P 500 GROWTH	0.966	0.648	0.579	0.848	1.000											
S&P COMM SVC	0.741	0.404	0.350	0.645	0.775	1.000										
S&P CONS DISC	0.834	0.625	0.583	0.767	0.828	0.705	1.000									
S&P CONS STAPLES	0.581	0.389	0.336	0.578	0.540	0.328	0.411	1.000								
S&P ENERGY	0.419	0.650	0.613	0.541	0.294	0.111	0.213	0.218	1.000							
S&P FINANCIALS	0.799	0.862	0.814	0.880	0.679	0.467	0.601	0.441	0.622	1.000						
S&P HEALTHCARE	0.587	0.381	0.349	0.532	0.590	0.346	0.401	0.632	0.216	0.440	1.000					
S&P INDUSTRIALS	0.763	0.902	0.839	0.858	0.632	0.320	0.550	0.486	0.615	0.829	0.482	1.000				
S&P INFO TECH	0.849	0.522	0.452	0.719	0.905	0.713	0.706	0.344	0.108	0.523	0.320	0.482	1.000			
S&P MATERIALS	0.715	0.848	0.801	0.788	0.606	0.294	0.498	0.471	0.607	0.762	0.425	0.816	0.473	1.000		
S&P REAL ESTATE	0.606	0.697	0.661	0.710	0.482	0.327	0.423	0.497	0.414	0.639	0.365	0.679	0.395	0.610	1.000	
S&P UTILITIES	0.409	0.415	0.371	0.502	0.298	0.219	0.217	0.615	0.360	0.413	0.444	0.444	0.123	0.417	0.666	1

Table 2: T+1 Ex-ante Correlation

Index	S&P 500	S&P 400 MID CAPS	S&P 600 SMALL CAPS	S&P 500 VALUE	S&P 500 GROWTH	S&P COMM SVC	S&P CONS DISC	S&P CONS STAPLES	S&P ENERGY	S&P FINANCIALS	S&P HEALTHCARE	S&P INDUSTRIALS	S&P INFO TECH	S&P MATERIALS	S&P REAL ESTATE	S&P UTILITIES
S&P 500	1.000															
S&P 400 MID CAPS	0.783	1.000														
S&P 600 SMALL CAPS	0.708	0.962	1.000													
S&P 500 VALUE	0.952	0.876	0.801	1.000												
S&P 500 GROWTH	0.966	0.652	0.583	0.842	1.000											
S&P COMM SVC	0.730	0.394	0.341	0.642	0.757	1.000										
S&P CONS DISC	0.833	0.626	0.583	0.767	0.826	0.700	1.000									
S&P CONS STAPLES	0.572	0.380	0.328	0.576	0.525	0.332	0.407	1.000								
S&P ENERGY	0.417	0.646	0.610	0.541	0.290	0.112	0.212	0.218	1.000							
S&P FINANCIALS	0.798	0.861	0.813	0.868	0.685	0.444	0.598	0.421	0.609	1.000						
S&P HEALTHCARE	0.576	0.370	0.339	0.528	0.572	0.350	0.397	0.634	0.217	0.416	1.000					
S&P INDUSTRIALS	0.764	0.902	0.840	0.857	0.635	0.312	0.551	0.478	0.612	0.826	0.473	1.000				
S&P INFO TECH	0.847	0.528	0.459	0.709	0.906	0.685	0.701	0.326	0.105	0.539	0.298	0.487	1.000			
S&P MATERIALS	0.713	0.845	0.799	0.788	0.602	0.292	0.498	0.470	0.607	0.750	0.422	0.814	0.467	1.000		
S&P REAL ESTATE	0.584	0.673	0.637	0.700	0.453	0.334	0.412	0.500	0.411	0.594	0.372	0.657	0.357	0.602	1.000	
S&P UTILITIES	0.386	0.391	0.348	0.492	0.269	0.229	0.207	0.616	0.357	0.368	0.451	0.422	0.088	0.409	0.675	1

Table 3: Daily Forecasted Correlation Change

Index	S&P 500	S&P 400 MID CAPS	S&P 600 SMALL CAPS	S&P 500 VALUE	S&P 500 GROWTH	S&P COMM SVC	S&P CONS DISC	S&P CONS STA-PLES	S&P EN-ERGY	S&P FINAN-CIALS	S&P HEALTH-CARE	S&P INDUS-TRIALS	S&P INFO TECH	S&P MATE-RIALS	S&P REAL ESTATE	S&P UTILI-TIES
S&P 500	0.000															
S&P 400 MID CAPS	0.002	0.000														
S&P 600 SMALL CAPS	0.002	0.000	0.000													
S&P 500 VALUE	-0.002	-0.002	-0.002	0.000												
S&P 500 GROWTH	-0.001	0.004	0.004	-0.005	0.000											
S&P COMM SVC	-0.011	-0.010	-0.009	-0.003	-0.019	0.000										
S&P CONS DISC	0.000	0.001	0.001	0.000	-0.002	-0.006	0.000									
S&P CONS STA-PLES	-0.009	-0.009	-0.008	-0.002	-0.014	0.004	-0.004	0.000								
S&P EN-ERGY	-0.002	-0.004	-0.003	0.000	-0.004	0.001	0.000	0.001	0.000							
S&P FINAN-CIALS	-0.001	-0.001	-0.001	-0.012	0.006	-0.023	-0.003	-0.021	-0.012	0.000						
S&P HEALTH-CARE	-0.011	-0.011	-0.010	-0.003	-0.018	0.004	-0.005	0.002	0.000	-0.024	0.000					
S&P INDUS-TRIALS	0.002	0.001	0.001	-0.002	0.003	-0.008	0.001	-0.008	-0.003	-0.002	-0.010	0.000				
S&P INFO TECH	-0.002	0.006	0.007	-0.009	0.001	-0.028	-0.005	-0.019	-0.004	0.016	-0.022	0.005	0.000			
S&P MATE-RIALS	-0.002	-0.003	-0.003	0.000	-0.004	-0.001	0.000	-0.002	0.000	-0.011	-0.002	-0.002	-0.006	0.000		
S&P REAL ESTATE	-0.022	-0.025	-0.024	-0.011	-0.029	0.007	-0.011	0.004	-0.003	-0.046	0.007	-0.022	-0.039	-0.009	0.000	
S&P UTILI-TIES	-0.022	-0.024	-0.023	-0.011	-0.030	0.010	-0.010	0.001	-0.003	-0.045	0.006	-0.022	-0.036	-0.008	0.009	0

Table 4: T-1 Ex-ante Forecasted Beta

Index	S&P 500	S&P 400 MID CAPS	S&P 600 SMALL CAPS	S&P 500 VALUE	S&P 500 GROWTH	S&P COMM SVC	S&P CONS DISC	S&P CONS STAPLES	S&P ENERGY	S&P FINANCIALS	S&P HEALTHCARE	S&P INDUSTRIALS	S&P INFO TECH	S&P MATERIALS	S&P REAL ESTATE	S&P UTILITIES
S&P 500	1.000	0.504	0.361	0.876	0.897	0.390	0.530	0.505	0.148	0.585	0.427	0.610	0.572	0.378	0.412	0.251
S&P 400 MID CAPS	1.212	1.000	0.764	1.250	0.934	0.330	0.616	0.525	0.357	0.980	0.429	1.120	0.546	0.695	0.736	0.395
S&P 600 SMALL CAPS	1.379	1.212	1.000	1.440	1.051	0.360	0.723	0.571	0.424	1.165	0.495	1.313	0.595	0.828	0.878	0.445
S&P 500 VALUE	1.040	0.617	0.448	1.000	0.858	0.370	0.531	0.548	0.209	0.703	0.421	0.748	0.528	0.454	0.526	0.336
S&P 500 GROWTH	1.041	0.450	0.319	0.838	1.000	0.439	0.567	0.505	0.112	0.536	0.462	0.544	0.656	0.345	0.353	0.197
S&P COMM SVC	1.408	0.494	0.340	1.125	1.368	1.000	0.852	0.542	0.075	0.650	0.478	0.487	0.912	0.295	0.422	0.255
S&P CONS DISC	1.312	0.634	0.469	1.108	1.211	0.584	1.000	0.563	0.119	0.693	0.459	0.693	0.749	0.414	0.453	0.209
S&P CONS STAPLES	0.668	0.289	0.198	0.610	0.576	0.199	0.300	1.000	0.089	0.372	0.529	0.447	0.267	0.287	0.388	0.433
S&P ENERGY	1.182	1.182	0.885	1.401	0.770	0.164	0.381	0.534	1.000	1.286	0.444	1.388	0.206	0.906	0.795	0.623
S&P FINANCIALS	1.090	0.758	0.568	1.102	0.860	0.335	0.521	0.524	0.301	1.000	0.436	0.905	0.481	0.549	0.593	0.346
S&P HEALTHCARE	0.808	0.338	0.245	0.671	0.753	0.250	0.351	0.756	0.105	0.443	1.000	0.531	0.297	0.309	0.341	0.375
S&P INDUSTRIALS	0.953	0.726	0.537	0.984	0.733	0.210	0.437	0.528	0.272	0.759	0.438	1.000	0.406	0.539	0.577	0.340
S&P INFO TECH	1.260	0.500	0.343	0.979	1.247	0.557	0.666	0.445	0.057	0.569	0.345	0.573	1.000	0.371	0.399	0.112
S&P MATERIALS	1.354	1.035	0.776	1.368	1.065	0.292	0.599	0.776	0.407	1.056	0.584	1.236	0.603	1.000	0.785	0.484
S&P REAL ESTATE	0.891	0.661	0.497	0.959	0.658	0.253	0.396	0.635	0.216	0.689	0.390	0.800	0.392	0.474	1.000	0.601
S&P UTILITIES	0.667	0.437	0.310	0.752	0.452	0.188	0.225	0.872	0.208	0.494	0.527	0.580	0.136	0.360	0.739	1.000

Note:

Columns indicate the benchmark whose forecasted variance are used in the forecasted beta calculation.

Table 5: T+1 Ex-ante Beta

Index	S&P 500	S&P 400 MID CAPS	S&P 600 SMALL CAPS	S&P 500 VALUE	S&P 500 GROWTH	S&P COMM SVC	S&P CONS DISC	S&P CONS STAPLES	S&P ENERGY	S&P FINANCIALS	S&P HEALTHCARE	S&P INDUSTRIALS	S&P INFO TECH	S&P MATERIALS	S&P REAL ESTATE	S&P UTILITIES
S&P 500	1.000	0.507	0.363	0.876	0.898	0.376	0.535	0.490	0.148	0.573	0.408	0.607	0.560	0.378	0.371	0.217
S&P 400 MID CAPS	1.209	1.000	0.761	1.245	0.936	0.314	0.620	0.504	0.355	0.955	0.404	1.107	0.539	0.691	0.659	0.338
S&P 600 SMALL CAPS	1.381	1.216	1.000	1.438	1.059	0.343	0.731	0.549	0.423	1.140	0.468	1.302	0.592	0.825	0.789	0.381
S&P 500 VALUE	1.035	0.616	0.446	1.000	0.851	0.360	0.535	0.537	0.209	0.678	0.406	0.739	0.510	0.453	0.483	0.299
S&P 500 GROWTH	1.039	0.454	0.321	0.834	1.000	0.419	0.570	0.485	0.111	0.529	0.435	0.542	0.644	0.343	0.309	0.162
S&P COMM SVC	1.416	0.495	0.339	1.146	1.365	1.000	0.871	0.552	0.077	0.618	0.480	0.481	0.879	0.300	0.411	0.249
S&P CONS DISC	1.299	0.631	0.466	1.100	1.197	0.562	1.000	0.544	0.118	0.669	0.437	0.682	0.722	0.411	0.408	0.180
S&P CONS STAPLES	0.667	0.287	0.196	0.618	0.570	0.200	0.305	1.000	0.091	0.352	0.523	0.443	0.251	0.290	0.370	0.402
S&P ENERGY	1.172	1.176	0.878	1.400	0.758	0.162	0.383	0.526	1.000	1.231	0.431	1.366	0.195	0.903	0.734	0.562
S&P FINANCIALS	1.111	0.776	0.580	1.113	0.887	0.318	0.534	0.502	0.302	1.000	0.409	0.913	0.496	0.553	0.525	0.287
S&P HEALTHCARE	0.815	0.339	0.245	0.687	0.752	0.255	0.360	0.769	0.109	0.422	1.000	0.530	0.279	0.316	0.334	0.357
S&P INDUSTRIALS	0.962	0.736	0.542	0.993	0.743	0.203	0.445	0.516	0.274	0.748	0.421	1.000	0.406	0.542	0.526	0.298
S&P INFO TECH	1.280	0.517	0.355	0.987	1.273	0.534	0.680	0.422	0.056	0.585	0.319	0.584	1.000	0.373	0.342	0.074
S&P MATERIALS	1.348	1.035	0.773	1.370	1.059	0.285	0.604	0.761	0.408	1.019	0.565	1.221	0.583	1.000	0.722	0.434
S&P REAL ESTATE	0.920	0.686	0.514	1.014	0.663	0.271	0.417	0.676	0.230	0.672	0.415	0.822	0.372	0.502	1.000	0.596
S&P UTILITIES	0.690	0.452	0.318	0.808	0.446	0.210	0.237	0.942	0.227	0.471	0.569	0.598	0.103	0.387	0.765	1.000

Note:
Columns indicate the benchmark whose forecasted variance are used in the forecasted beta calculation.

Table 6: Daily Forecasted Beta Change

Index	S&P 500	S&P 400 MID CAPS	S&P 600 SMALL CAPS	S&P 500 VALUE	S&P 500 GROWTH	S&P COMM SVC	S&P CONS DISC	S&P CONS STA- PLES	S&P EN- ERGY	S&P FINAN- CIALS	S&P HEALTH- CARE	S&P INDUS- TRIALS	S&P INFO TECH	S&P MATE- RIALS	S&P REAL ESTATE	S&P UTILI- TIES
S&P 500	0.000	0.003	0.001	0.000	0.001	-0.014	0.005	-0.015	0.000	-0.012	-0.019	-0.004	-0.012	0.000	-0.041	-0.034
S&P 400 MID CAPS	-0.003	0.000	-0.002	-0.006	0.002	-0.016	0.004	-0.021	-0.002	-0.025	-0.025	-0.013	-0.006	-0.005	-0.076	-0.057
S&P 600 SMALL CAPS	0.003	0.004	0.000	-0.001	0.008	-0.017	0.008	-0.022	-0.001	-0.025	-0.028	-0.010	-0.002	-0.003	-0.089	-0.064
S&P 500 VALUE	-0.005	-0.001	-0.002	0.000	-0.006	-0.010	0.004	-0.011	0.000	-0.025	-0.015	-0.009	-0.018	-0.001	-0.044	-0.036
S&P 500 GROWTH	-0.002	0.004	0.002	-0.004	0.000	-0.020	0.003	-0.021	-0.001	-0.006	-0.026	-0.003	-0.012	-0.002	-0.044	-0.035
S&P COMM SVC	0.008	0.000	-0.002	0.021	-0.003	0.000	0.019	0.010	0.002	-0.032	0.003	-0.006	-0.034	0.005	-0.011	-0.006
S&P CONS DISC	-0.013	-0.003	-0.004	-0.008	-0.014	-0.022	0.000	-0.018	-0.001	-0.024	-0.022	-0.011	-0.026	-0.004	-0.045	-0.029
S&P CONS STA- PLES	-0.001	-0.001	-0.002	0.008	-0.007	0.001	0.004	0.000	0.002	-0.020	-0.005	-0.005	-0.016	0.003	-0.018	-0.031
S&P EN- ERGY	-0.011	-0.006	-0.007	-0.002	-0.012	-0.003	0.002	-0.008	0.000	-0.056	-0.013	-0.022	-0.011	-0.002	-0.061	-0.061
S&P FINAN- CIALS	0.021	0.018	0.012	0.010	0.027	-0.017	0.013	-0.021	0.001	0.000	-0.027	0.009	0.015	0.004	-0.068	-0.059
S&P HEALTH- CARE	0.007	0.001	0.000	0.016	-0.001	0.005	0.009	0.013	0.004	-0.021	0.000	0.000	-0.017	0.007	-0.007	-0.018
S&P INDUS- TRIALS	0.010	0.009	0.006	0.009	0.010	-0.008	0.009	-0.012	0.002	-0.011	-0.017	0.000	0.000	0.004	-0.052	-0.042
S&P INFO TECH	0.020	0.017	0.012	0.007	0.026	-0.023	0.014	-0.023	-0.001	0.016	-0.026	0.012	0.000	0.002	-0.057	-0.038
S&P MATE- RIALS	-0.005	0.000	-0.003	0.002	-0.007	-0.008	0.005	-0.014	0.001	-0.038	-0.019	-0.014	-0.020	0.000	-0.063	-0.051
S&P REAL ESTATE	0.029	0.025	0.017	0.055	0.005	0.018	0.021	0.041	0.015	-0.017	0.025	0.023	-0.020	0.027	0.000	-0.005
S&P UTILI- TIES	0.023	0.015	0.008	0.055	-0.006	0.022	0.012	0.070	0.018	-0.023	0.042	0.018	-0.032	0.027	0.026	0.000

Note:

Columns indicate the benchmark whose forecasted variance are used in the forecasted beta calculation.
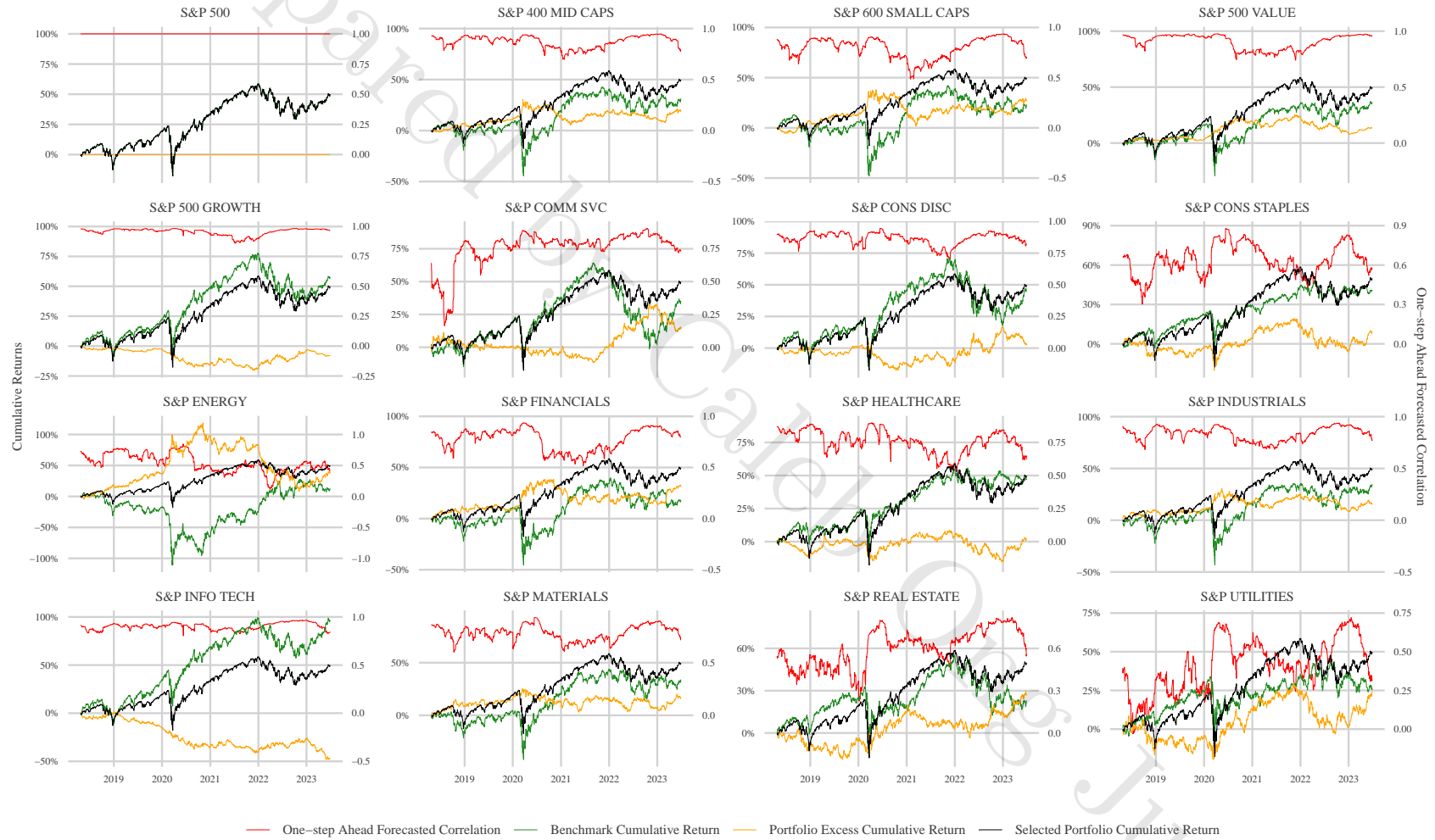
Figure 1: Comparison of forecasted pairwise correlations of S&P500, with cumulative returns. Correlation spikes can serve as imminent indicators of systematic shocks to broad markets.

Out–of–Sample One–step Ahead Correlation Forecasts and Relative Returns

Forecasts are based on rolling windows
Selected portfolio for pairwise correlation comparison: S&P FINANCIALS
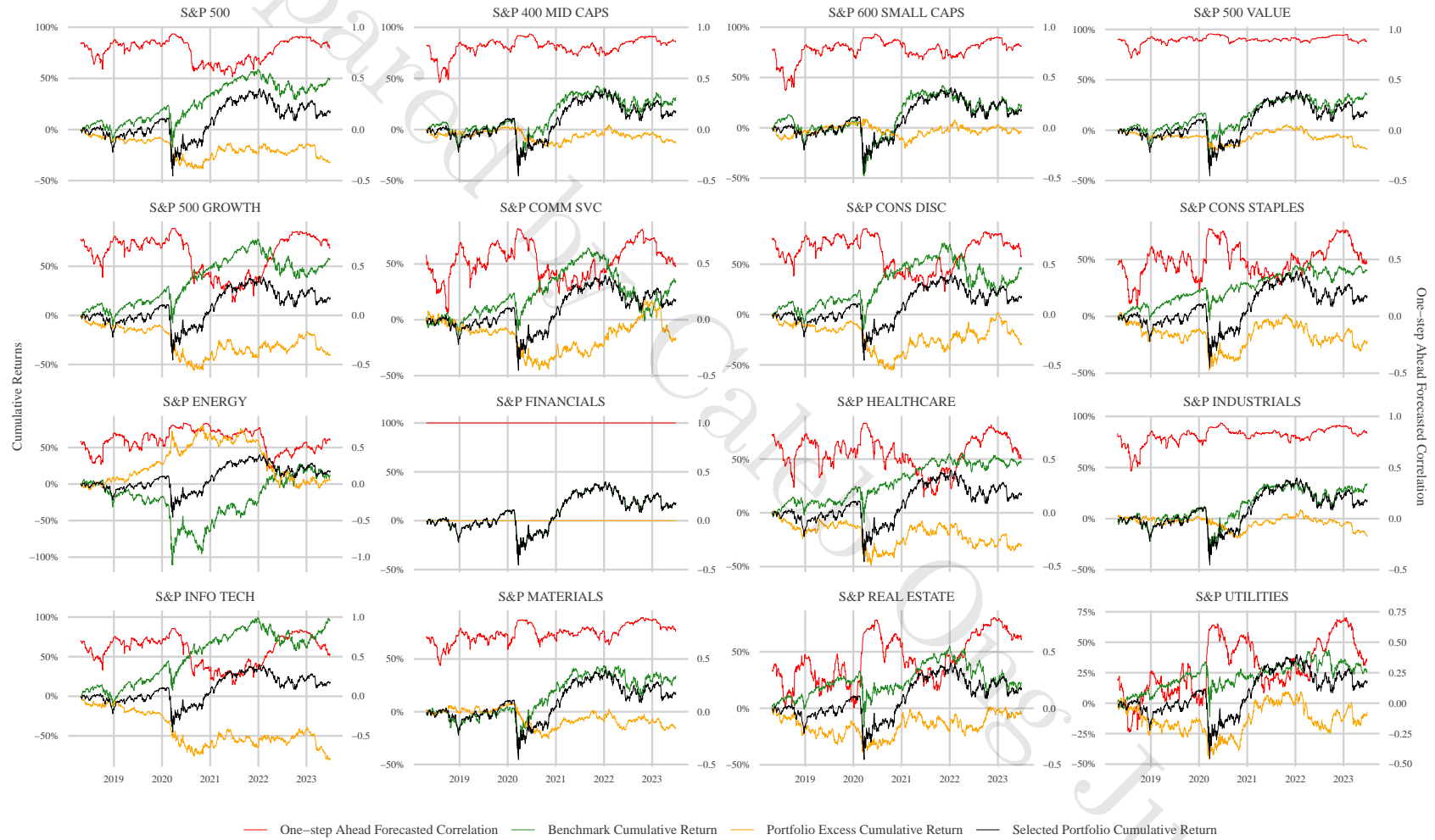
Legend: One–step Ahead Forecasted Correlation — Benchmark Cumulative Return — Portfolio Excess Cumulative Return — Selected Portfolio Cumulative Return

Figure 2: Comparison of forecasted pairwise correlations of S&P Financials, with cumulative returns. Correlation divergences and convergences can serve as indicators of relative overperformance or underperformance (asset co-movements and co-volatility), between asset pairs, for further analysis.

Figure 3: Comparison of forecasted beta of investment style factors and sectors against S&P500, with cumulative returns. Time-varying beta trends and changes can serve to identify any unusual deviations in the return sensitivities magnitude against the broad market, for further analysis.
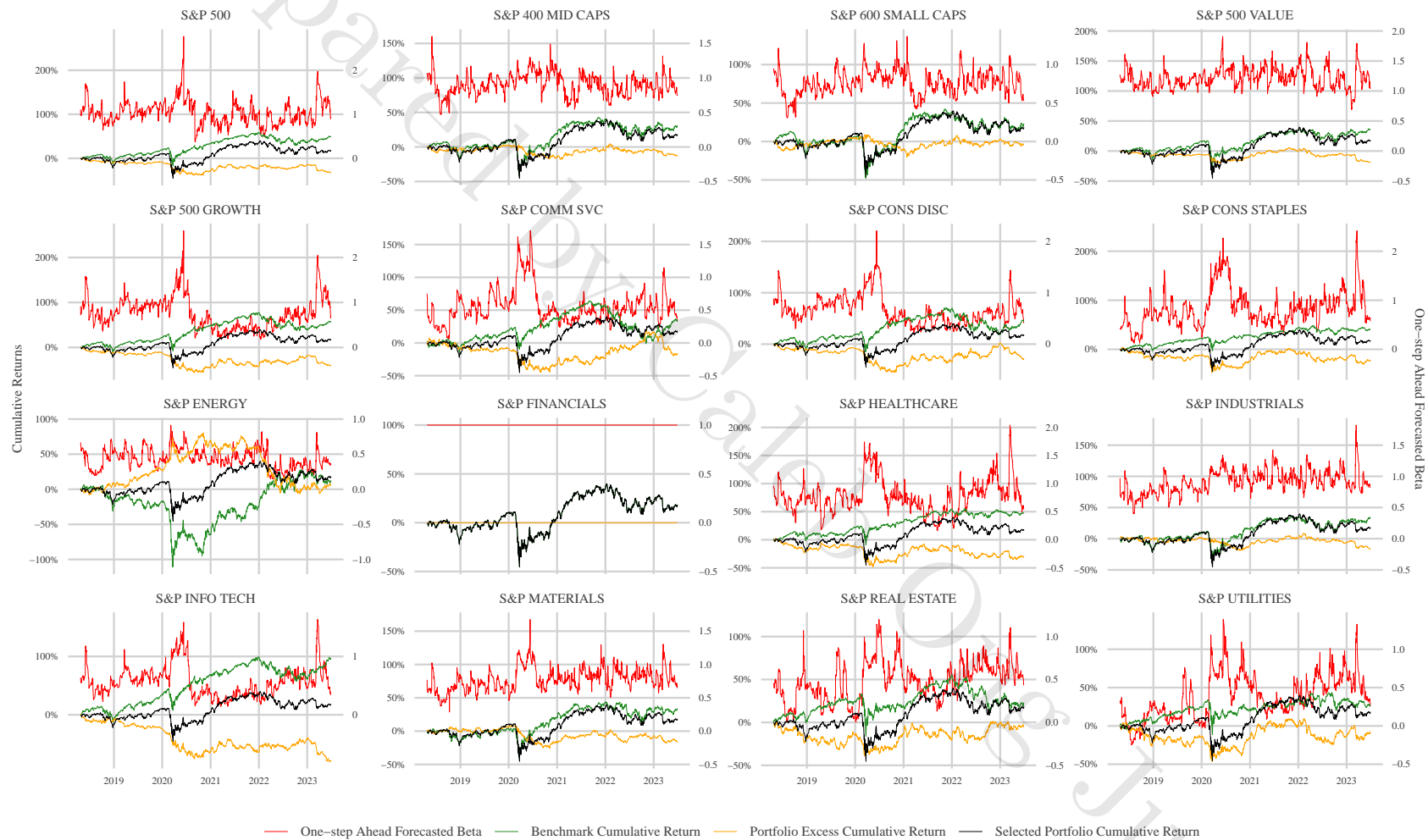
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Figure 4: Comparison of S&P Financials against investment style factors and sectors, with cumulative returns. Beta spikes can serve as imminent indicators of increased pairwise volatility sensitivities, as evident in the March 2020 COVID-19 pandemic onset and subsequent rebound, and the February-March 2023 US Regional Banks crisis.
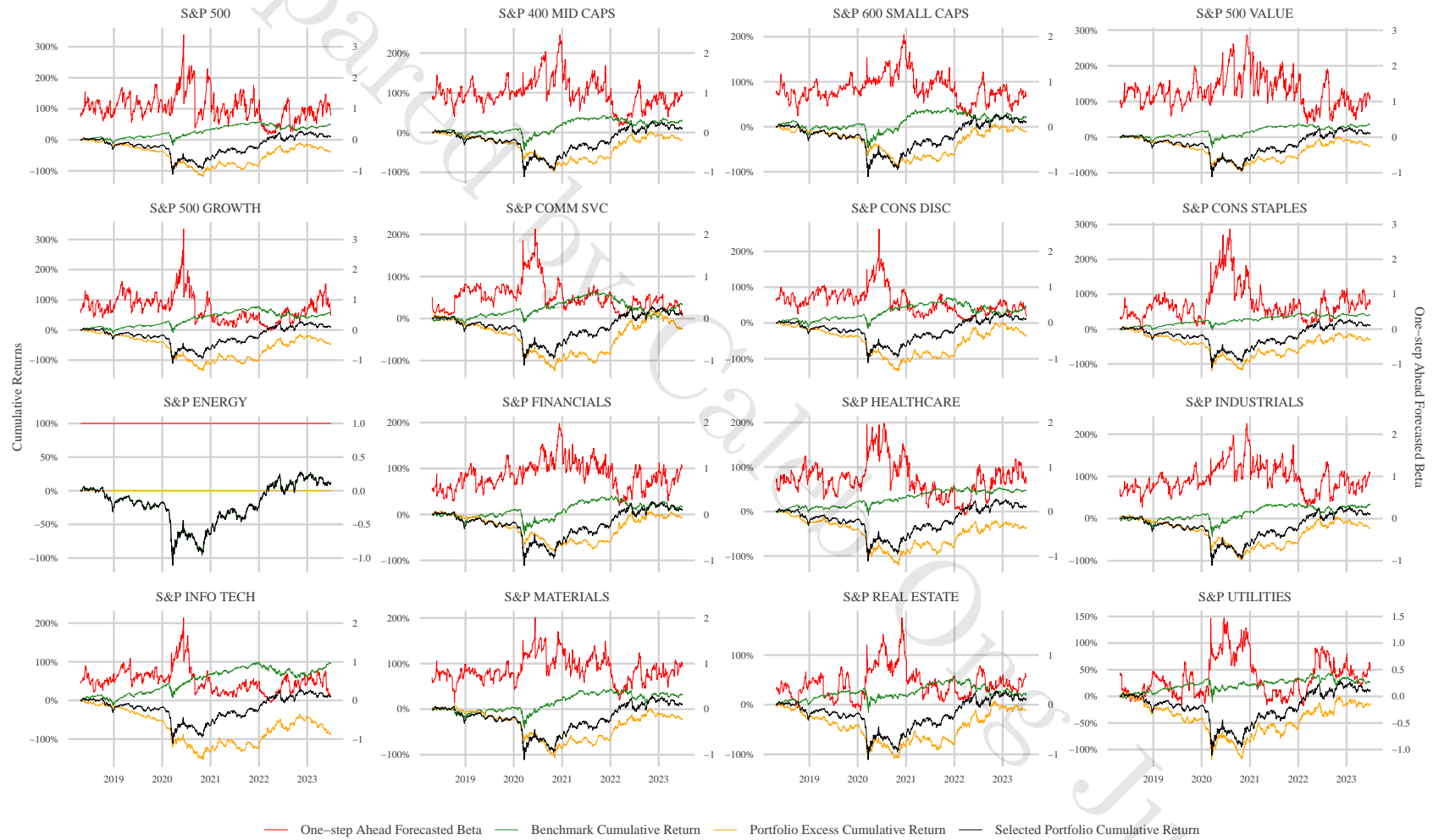
Figure 5: Comparison of S&P Energy, a typically volatile sector, against investment style factors and sectors, with cumulative returns. Time-varying beta trends can serve to form expectations on the magnitude of return sensitivities between asset pairs, for further analysis.

4 Ending Notes

Correlation and sensitivity estimates can provide insights on the co-movements of trends and relative volatility across different assets and industries, for the next steps of investigation. Ex-ante correlation and beta changes of a large magnitude are usually associated with a divergence or convergence in the pairwise relative performances, or a general increase in relative pairwise volatility. The magnitudes and changes in correlation and sensitivity estimates can help set expectations on asset and volatility trends.