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

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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 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 shows the evolution of the out-of-sample dynamic correlations and the cumulative returns of the selected index ("portfolio"), when compared against the returns of other industries ("benchmarks"); Forecasted 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 pairwise volatility.

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 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
		$\overline{}$														
S&P 500	1.000															
S&P 400	0.785	1.000														
MID																
CAPS																
S&P 600	0.700	0.964	1.000													
SMALL																
CAPS																
S&P 500	0.960	0.872	0.795	1.000												
VALUE																
S&P 500	0.970	0.668	0.583	0.866	1.000											
GROWTH																
S&P	0.730	0.396	0.338	0.638	0.770	1.000										
COMM																
SVC																
S&P	0.828	0.634	0.581	0.772	0.822	0.703	1.000									
CONS																
DISC																
S&P	0.584	0.407	0.342	0.599	0.533	0.324	0.401	1.000								
CONS																
STA-							N									
PLES																
S&P EN-	0.421	0.630	0.606	0.516	0.321	0.083	0.216	0.251	1.000							
ERGY																
S&P	0.800	0.856	0.809	0.872	0.695	0.452	0.601	0.459	0.595	1.000						
FINAN-																
CIALS																
S&P HEALTH-	0.650	0.449	0.396	0.617	0.634	0.434	0.426	0.650	0.321	0.518	1.000					
CARE S&P	0.796	0.913	0.853	0.879	0.680	0.357	0.573	0.515	0.616	0.841	0.521	1.000				
INDUS-	0.796	0.913	0.853	0.879	0.680	0.357	0.573	0.515	0.616	0.841	0.521	1.000				
TRIALS																
S&P	0.846	0.525	0.443	0.724	0.902	0.697	0.600	0.336	0.102	0.525	0.365	0.524	1.000			
INFO	0.846	0.525	0.445	0.724	0.902	0.097	0.698	0.336	0.102	0.323	0.365	0.324	1.000			
TECH								<u> </u>								
S&P	0.703	0.859	0.802	0.784	0.597	0.248	0.482	0.475	0.613	0.758	0.484	0.858	0.453	1.000		
MATE-	0.703	0.839	0.802	0.764	0.597	0.246	0.462	0.475	0.613	0.758	0.464	0.000	0.455	1.000		
RIALS																
S&P	0.589	0.696	0.657	0.700	0.469	0.299	0.403	0.497	0.411	0.626	0.392	0.684	0.384	0.601	1.000	
REAL	0.365	0.050	0.037	0.700	0.405	0.200	0.403	0.451	0.411	0.020	0.352	0.004	0.364	0.001	1.000	
ESTATE																
S&P	0.379	0.399	0.353	0.476	0.272	0.159	0.185	0.632	0.334	0.380	0.521	0.468	0.083	0.386	0.663	1
UTILI-	0.375	0.355	0.333	0.470	0.212	0.135	0.100	0.032	0.334	0.360	0.021	0.400	0.003	0.360	0.003	1
TIES																

Table 2: T+1 Ex-ante Correlation

March Marc																	
SAP 500	Index	S&P 500	MID	SMALL			COMM	CONS	CONS STA-		FINAN-	HEALTH-	INDUS-	INFO	MATE-	REAL	UTILI-
Sep 800 0.760 1.000 AID CAPS SAP 900 0.969 0.964 0.000 SAP 1.000 SAP 1.									1 220								
NATION CAPS	S&P 500	1.000															
SAP 600 609 0,904 0,905		0.780	1.000														
SMALL SMALL SMALL SMALL SMALL SMALL GAPS																	
SARP CAPS SAP 500 0 0.95 0.872 0.798 1.000 VALUE SAP 500 0 0.969 0.657 0.577 0.661 1.000 CONN CONN CONN CONN CONN SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SV SAP 0.828 0.620 0.827 0.820 0.82																	
SAP 500 0.58 0.582 0.782 0.788 1.000 VALUE SAP 500 0.695 0.657 0.797 0.861 1.000 CHOWTH SAP 500 0.695 0.657 0.319 0.619 0.766 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.619 0.766 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.619 0.766 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.619 0.766 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.619 0.766 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.610 0.619 0.766 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.630 0.630 0.632 0.632 0.632 0.601 1.000 CHOWTH SAP 500 0.898 0.620 0.630 0.533 0.522 0.609 0.610 0.000 CHOWTH SAP 500 0.898 0.620 0.630 0.630 0.533 0.522 0.601 1.000 CHOWTH SAP 500 0.898 0.600 0.608 0.600		0.699	0.964	1.000													
NALUE NA																	
NATIUE SKP 500 0.660 0.667 0.577 0.581 1.000 GROWTH SKP 500 0.690 0.657 0.309 0.319 0.619 0.766 1.000 SKP 500 0.721 0.369 0.319 0.619 0.766 1.000 SVC COMM SVC SKP 500 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SVC SKP 500 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SKP 500 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SKP 500 0.828 0.626 0.577 0.768 0.822 0.698 1.000 SKP 500 0.828 0.422 0.340 0.597 0.533 0.322 0.401 1.000 SKP 500 0.828 0.422 0.340 0.597 0.533 0.322 0.401 1.000 SKP 500 0.828 0.422 0.631 0.608 0.520 0.507 0.538 0.322 0.401 1.000 SKP 500 0.429 0.429 0.431 0.608 0.520 0.520 0.320 0.401 0.600 0.405 0.500 0.408 0.500 0.408 0.400 0.4		0.958	0.872	0.798	1.000												
SKP 0.21 0.369 0.319 0.619 0.766 1.000 SKP 0.22 0.369 0.329 0.026 0.577 0.768 0.822 0.098 1.000 SKP 0.82 0.026 0.577 0.768 0.822 0.098 1.000 SKP 0.82 0.82 0.026 0.577 0.768 0.822 0.098 1.000 SKP 0.82 0.82 0.026 0.577 0.533 0.322 0.401 1.000 SKP 0.82 0.82 0.82 0.026 0.340 0.597 0.533 0.322 0.401 1.000 SKP 0.82 0.82 0.82 0.42 0.42 0.42 0.42 0.42 0.42 0.42 0.4																	
S&P	S&P 500	0.969	0.657	0.577	0.861	1.000											
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CARE S&P 0.782 0.915 0.853 0.874 0.659 0.319 0.559 0.502 0.613 0.833 0.531 1.000 INDUS- TRIALS S&P 0.845 0.516 0.438 0.719 0.903 0.694 0.698 0.336 0.102 0.523 0.361 0.507 1.000 INFO TECH S&P 0.703 0.846 0.794 0.779 0.597 0.248 0.482 0.475 0.611 0.755 0.481 0.833 0.453 1.000 MATE- RIALS S&P 0.590 0.693 0.656 0.700 0.468 0.292 0.403 0.497 0.412 0.627 0.395 0.675 0.383 0.601 1.000 REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-		0.045	0.400	0.400	0.022	0.020	0.414	0.424	0.040	0.021	0.020	1.000					
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$																	
TRIALS S&P 0.845 0.516 0.438 0.719 0.903 0.694 0.698 0.336 0.102 0.523 0.361 0.507 1.000 INFO TECH S&P 0.703 0.846 0.794 0.779 0.597 0.248 0.482 0.475 0.611 0.755 0.481 0.833 0.453 1.000 MATE- RIALS S&P 0.590 0.693 0.656 0.700 0.468 0.292 0.403 0.497 0.412 0.627 0.395 0.675 0.383 0.601 1.000 REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-	S&P	0.782	0.915	0.853	0.874	0.659	0.319	0.559	0.502	0.613	0.833	0.531	1.000				
S&P 0.845 0.516 0.438 0.719 0.903 0.694 0.698 0.336 0.102 0.523 0.361 0.507 1.000 INFO TECH S&P 0.703 0.846 0.794 0.779 0.597 0.248 0.482 0.475 0.611 0.755 0.481 0.833 0.453 1.000 MATE-RIALS S&P 0.590 0.693 0.656 0.700 0.468 0.292 0.403 0.497 0.412 0.627 0.395 0.675 0.383 0.601 1.000 REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-	INDUS-																
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$																	
TECH S&P 0.703 0.846 0.794 0.779 0.597 0.248 0.482 0.475 0.611 0.755 0.481 0.833 0.453 1.000 MATE- RIALS S&P 0.590 0.693 0.656 0.700 0.468 0.292 0.403 0.497 0.412 0.627 0.395 0.675 0.383 0.601 1.000 REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-		0.845	0.516	0.438	0.719	0.903	0.694	0.698	0.336	0.102	0.523	0.361	0.507	1.000			
S&P 0.703 0.846 0.794 0.779 0.597 0.248 0.482 0.475 0.611 0.755 0.481 0.833 0.453 1.000 MATE- RIALS S&P 0.590 0.693 0.656 0.700 0.468 0.292 0.403 0.497 0.412 0.627 0.395 0.675 0.383 0.601 1.000 REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-																	
MATE- RIALS S&P 0.590 0.693 0.656 0.700 0.468 0.292 0.403 0.497 0.412 0.627 0.395 0.675 0.383 0.601 1.000 REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-		0.702	0.946	0.704	0.770	0.507	0.249	0.482	0.475	0.611	0.755	0.491	0.000	0.459	1 000		
RIALS $S\&P \qquad 0.590 \qquad 0.693 \qquad 0.656 \qquad 0.700 \qquad 0.468 \qquad 0.292 \qquad 0.403 \qquad 0.497 \qquad 0.412 \qquad 0.627 \qquad 0.395 \qquad 0.675 \qquad 0.383 \qquad 0.601 \qquad 1.000$ REAL ESTATE $S\&P \qquad 0.376 \qquad 0.382 \qquad 0.342 \qquad 0.466 \qquad 0.273 \qquad 0.165 \qquad 0.184 \qquad 0.631 \qquad 0.329 \qquad 0.374 \qquad 0.509 \qquad 0.440 \qquad 0.084 \qquad 0.386 \qquad 0.659 \qquad 1$ UTILI-		0.703	0.340	0.754	0.775	0.551	0.248	0.462	0.475	0.011	0.755	0.461	0.655	0.433	1.000		
REAL ESTATE S&P 0.376 0.382 0.342 0.466 0.273 0.165 0.184 0.631 0.329 0.374 0.509 0.440 0.084 0.386 0.659 1 UTILI-																	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		0.590	0.693	0.656	0.700	0.468	0.292	0.403	0.497	0.412	0.627	0.395	0.675	0.383	0.601	1.000	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	REAL																
UTILI-																	
		0.376	0.382	0.342	0.466	0.273	0.165	0.184	0.631	0.329	0.374	0.509	0.440	0.084	0.386	0.659	1
TIES	TIES																

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
								FLES								
S&P 500	0.000															
S&P 400	-0.005	0.000														
MID																
CAPS																
S&P 600	-0.001	0.000	0.000													
SMALL																
CAPS																
S&P 500	-0.002	0.000	0.003	0.000												
VALUE																
S&P 500	-0.001	-0.011	-0.006	-0.006	0.000											
GROWTH																
S&P	-0.010	-0.027	-0.019	-0.019	-0.004	0.000										
COMM																
SVC																
S&P	0.000	-0.008	-0.004	-0.003	0.000	-0.005	0.000									
CONS																
DISC																
S&P	0.000	-0.005	-0.002	-0.003	0.000	-0.002	0.000	0.000								
CONS																
STA-							1									
PLES							<u> </u>									
S&P EN-	0.002	0.001	0.002	0.003	-0.001	-0.008	0.000	0.000	0.000							
ERGY S&P	0.000	-0.002	0.001	0.001	-0.002	-0.012	-0.001	-0.001	0.002	0.000						
FINAN-	0.000	-0.002	0.001	0.001	-0.002	-0.012	-0.001	-0.001	0.002	0.000						
CIALS																
S&P	0.000	0.012	0.010	0.005	-0.006	-0.020	-0.002	-0.004	0.006	0.004	0.000					
HEALTH-	0.000	0.012	0.010	0.003	-0.000	-0.020	-0.002	-0.004	0.000	0.004	0.000					
CARE																
S&P	-0.013	0.002	0.000	-0.005	-0.021	-0.038	-0.014	-0.014	-0.003	-0.008	0.011	0.000				
INDUS-	-0.010	0.002	0.000	-0.000	-0.021	-0.000	-0.014	-0.014	-0.000	-0.000	0.011	0.000				
TRIALS																
S&P	-0.001	-0.009	-0.004	-0.005	0.000	-0.003	0.000	0.000	0.000	-0.002	-0.004	-0.017	0.000			
INFO																
TECH																
S&P	0.000	-0.013	-0.007	-0.004	0.000	-0.001	0.000	0.000	-0.002	-0.002	-0.004	-0.025	0.000	0.000		
MATE-																
RIALS																
S&P	0.001	-0.003	0.000	0.000	0.000	-0.007	0.000	0.000	0.002	0.001	0.003	-0.009	0.000	-0.001	0.000	
REAL																
ESTATE																
S&P	-0.003	-0.017	-0.011	-0.010	0.000	0.006	0.000	-0.001	-0.006	-0.006	-0.012	-0.028	0.001	0.000	-0.005	0
UTILI-																
TIES																

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 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 S&P 400 MID	1.000 1.067	0.578 1.000	0.383 0.716	0.978 1.207	0.888 0.830	0.468 0.345	0.525 0.546	0.488 0.463	0.196 0.398	0.673 0.979	0.483 0.453	0.691 1.076	0.589 0.497	0.388 0.644	0.420 0.674	0.254 0.365
CAPS S&P 600 SMALL CAPS	1.281	1.297	1.000	1,482	0.976	0.396	0.674	0.523	0.515	1.246	0.538	1.354	0.564	0.809	0.856	0.434
S&P 500 VALUE	0.942	0.630	0.427	1.000	0.778	0.401	0.480	0.493	0.236	0.721	0.450	0.749	0.495	0.424	0.489	0.314
S&P 500 GROWTH	1.061	0.537	0.348	0.965	1.000	0.539	0.570	0.488	0.163	0.640	0.515	0.645	0.688	0.360	0.365	0.200
S&P COMM	1.141	0.456	0.289	1.015	1.100	1.000	0.696	0.424	0.060	0.595	0.504	0.484	0.759	0.214	0.333	0.166
SVC S&P CONS DISC	1.307	0.736	0.501	1.240	1.186	0.710	1.000	0.530	0.159	0.798	0.499	0.784	0.767	0.420	0.453	0.196
S&P CONS STA- PLES	0.697	0.358	0.223	0.730	0.583	0.248	0.304	1.000	0.140	0.462	0.577	0.534	0.279	0.313	0.423	0.507
S&P EN- ERGY	0.905	0.997	0.712	1.132	0.632	0.114	0.295	0.453	1.000	1.078	0.514	1.149	0.153	0.727	0.629	0.483
S&P FINAN- CIALS	0.950	0.748	0.525	1.055	0.755	0.344	0.452	0.456	0.328	1.000	0.457	0.867	0.434	0.496	0.530	0.303
S&P HEALTH-	0.874	0.445	0.291	0.846	0.781	0.374	0.363	0.732	0.201	0.588	1.000	0.608	0.342	0.360	0.376	0.471
CARE S&P INDUS-	0.917	0.774	0.537	1.032	0.717	0.263	0.418	0.497	0.330	0.816	0.446	1.000	0.421	0.545	0.562	0.362
TRIALS S&P INFO	1.213	0.555	0.347	1.058	1.185	0.641	0.635	0.403	0.068	0.634	0.389	0.652	1.000	0.358	0.392	0.080
TECH S&P MATE- RIALS	1.275	1.146	0.794	1.447	0.990	0.288	0.554	0.720	0.516	1.156	0.652	1.349	0.572	1.000	0.777	0.470
S&P REAL ESTATE	0.827	0.719	0.504	1.001	0.602	0.269	0.358	0.584	0.268	0.740	0.409	0.834	0.375	0.466	1.000	0.626
S&P UTILI- TIES	0.564	0.437	0.287	0.721	0.371	0.151	0.174	0.787	0.231	0.476	0.576	0.605	0.086	0.317	0.703	1.000

Note

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Columns indicate the hanchmark whose forecasted variance are used in the forecasted heta calculation

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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 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 S&P 400 MID	1.000 1.070	0.568 1.000	0.378 0.716	0.969 1.211	0.888 0.825	0.437 0.307	0.528 0.547	0.492 0.465	0.194 0.398	0.667 0.977	0.480 0.467	0.668 1.072	0.588 0.493	0.385 0.636	0.418 0.674	0.248 0.347
CAPS S&P 600 SMALL CAPS	1.291	1.297	1.000	1.491	0.977	0.358	0.680	0.529	0.516	1.248	0.555	1.346	0.563	0.805	0.859	0.418
S&P 500 VALUE	0.947	0.628	0.427	1.000	0.779	0.371	0.484	0.497	0.236	0.720	0.454	0.738	0.495	0.422	0.491	0.305
S&P 500 GROWTH	1.058	0.523	0.341	0.951	1.000	0.508	0.572	0.491	0.161	0.631	0.508	0.615	0.686	0.358	0.362	0.197
S&P COMM	1.188	0.443	0.285	1.032	1.157	1.000	0.733	0.448	0.057	0.606	0.505	0.449	0.797	0.224	0.341	0.180
SVC S&P CONS DISC	1.299	0.716	0.490	1.220	1.181	0.664	1.000	0.531	0.156	0.785	0.492	0.749	0.763	0.415	0.448	0.191
S&P CONS STA-	0.692	0.347	0.218	0.716	0.579	0.232	0.303	1.000	0.137	0.453	0.566	0.508	0.277	0.309	0.418	0.495
PLES S&P EN- ERGY	0.920	1.001	0.716	1.145	0.639	0.099	0.300	0.461	1.000	1.084	0.526	1.140	0.155	0.730	0.636	0.473
S&P FINAN-	0.959	0.746	0.525	1.058	0.760	0.320	0.458	0.463	0.329	1.000	0.463	0.853	0.436	0.496	0.533	0.296
CIALS S&P HEALTH-	0.878	0.454	0.297	0.851	0.779	0.340	0.365	0.736	0.203	0.590	1.000	0.614	0.340	0.357	0.378	0.455
CARE S&P INDUS-	0.916	0.780	0.540	1.035	0.706	0.226	0.417	0.495	0.330	0.813	0.460	1.000	0.413	0.535	0.560	0.341
TRIALS S&P INFO	1.213	0.540	0.340	1.045	1.187	0.605	0.639	0.407	0.067	0.626	0.384	0.622	1.000	0.357	0.390	0.079
TECH S&P MATE-	1.282	1.124	0.784	1.438	0.998	0.274	0.561	0.730	0.512	1.150	0.648	1.298	0.575	1.000	0.777	0.465
RIALS S&P REAL	0.833	0.713	0.501	1.000	0.605	0.250	0.362	0.591	0.267	0.739	0.412	0.814	0.376	0.465	1.000	0.615
ESTATE S&P UTILI- TIES	0.568	0.421	0.280	0.713	0.378	0.151	0.178	0.804	0.228	0.471	0.569	0.568	0.088	0.320	0.706	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	-0.009	-0.004	-0.008	0.000	-0.031	0.003	0.004	-0.002	-0.006	-0.003	-0.022	-0.001	-0.003	-0.001	-0.006
S&P 400 MID	0.003	0.000	0.000	0.004	-0.005	-0.038	0.001	0.002	0.000	-0.002	0.014	-0.004	-0.004	-0.008	0.000	-0.018
CAPS S&P 600 SMALL	0.011	0.000	0.000	0.009	0.001	-0.039	0.006	0.006	0.001	0.002	0.017	-0.008	-0.001	-0.004	0.004	-0.017
CAPS S&P 500 VALUE	0.005	-0.002	0.000	0.000	0.001	-0.030	0.004	0.005	0.000	-0.001	0.005	-0.011	0.000	-0.002	0.001	-0.009
S&P 500 GROWTH	-0.002	-0.015	-0.007	-0.014	0.000	-0.032	0.002	0.003	-0.003	-0.009	-0.008	-0.030	-0.001	-0.002	-0.003	-0.003
S&P COMM SVC	0.047	-0.012	-0.004	0.017	0.056	0.000	0.037	0.024	-0.004	0.010	0.001	-0.035	0.038	0.010	0.009	0.013
S&P CONS DISC	-0.007	-0.020	-0.011	-0.020	-0.005	-0.046	0.000	0.002	-0.003	-0.013	-0.007	-0.035	-0.005	-0.004	-0.004	-0.004
S&P CONS STA-	-0.006	-0.011	-0.005	-0.014	-0.004	-0.016	0.000	0.000	-0.003	-0.008	-0.011	-0.026	-0.002	-0.004	-0.005	-0.013
PLES S&P EN- ERGY	0.015	0.004	0.004	0.013	0.006	-0.015	0.005	0.009	0.000	0.007	0.013	-0.009	0.001	0.002	0.007	-0.010
S&P FINAN- CIALS	0.009	-0.002	0.000	0.003	0.005	-0.024	0.006	0.007	0.000	0.000	0.006	-0.014	0.002	0.000	0.003	-0.007
S&P HEALTH-	0.004	0.009	0.006	0.005	-0.002	-0.034	0.002	0.004	0.002	0.002	0.000	0.006	-0.002	-0.003	0.003	-0.016
CARE S&P INDUS-	-0.001	0.006	0.003	0.003	-0.010	-0.037	-0.002	-0.002	0.000	-0.003	0.014	0.000	-0.007	-0.011	-0.002	-0.022
TRIALS S&P INFO	0.000	-0.014	-0.007	-0.013	0.002	-0.036	0.004	0.004	-0.001	-0.007	-0.005	-0.030	0.000	-0.002	-0.002	0.000
TECH S&P MATE- RIALS	0.007	-0.022	-0.010	-0.009	0.008	-0.014	0.007	0.010	-0.005	-0.007	-0.004	-0.052	0.004	0.000	0.000	-0.005
S&P REAL ESTATE	0.006	-0.006	-0.002	-0.001	0.003	-0.019	0.004	0.007	-0.001	-0.002	0.003	-0.020	0.001	-0.001	0.000	-0.011
S&P UTILI- TIES	0.004	-0.016	-0.008	-0.008	0.007	0.000	0.003	0.017	-0.003	-0.005	-0.007	-0.037	0.002	0.003	0.002	0.000

Note

Columns indicate the henchmark whose forecasted variance are used in the forecasted heta calculation

Out-of-Sample One-step Ahead Correlation Forecasts and Relative Returns Forecasts are based on rolling windows Selected Portfolio for Comparison: S&P 500 S&P 500 VALUE S&P 400 MID CAPS S&P 600 SMALL CAPS 1.00 0.75 S&P COMM SVC S&P 500 GROWTH S&P CONS DISC S&P CONS STAPLES S&P ENERGY S&P FINANCIALS S&P INDUSTRIALS 100% -0.5 S&P INFO TECH S&P MATERIALS S&P REAL ESTATE S&P UTILITIES 2023 2019 2020 2021 2022 2023 2020 2021 2022 2023 2022 2022 Selected Portfolio Cumulative Return One-step Ahead Forecasted Correlation — Benchmark Cumulative Return Excess Cumulative Return

Figure 1: Comparison of forecasted pairwise correlations of S&P500, with cumulative returns. Correlation divergences and convergences can serve as early indicators of relative overperformance or underperformance, and volatility interactions, of asset pairs, for further analysis.

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

Forecasts are based on rolling windows Selected Portfolio for Comparison: S&P FINANCIALS

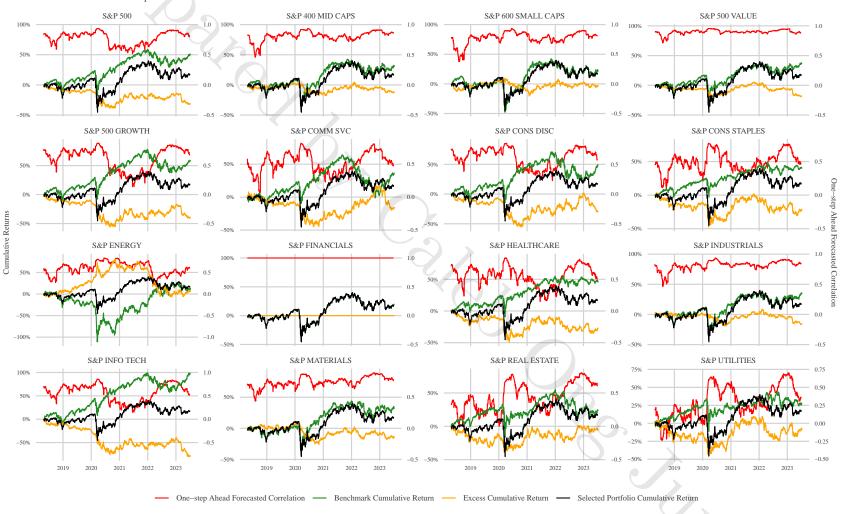


Figure 2: Comparison of forecasted pairwise correlations of S&P Financials, with cumulative returns. Correlation divergences and convergences can serve as early indicators of relative overperformance or underperformance, and volatility interactions, of asset pairs, for further analysis.

4 Ending Notes

Correlation and sensitivity estimates can provide pre-emptive insights on the co-movements of trends and volatility across different assets and industries, for the next steps of investigation.