THE IMPACT OF CEO CHANGES ON STOCK PRICES

APPLICATIONS OF DATA SCIENCE IN FINANCE

GROUP 22

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EVENT STUDY OBJECTIVE

This event study aims to analyze the impact of CEO changes on the stock prices of major companies in the food and beverage industry, including Starbucks, McDonald's, Chipotle, and others. By examining different CEO changes between 2008 and 2023, the study will evaluate whether the market reacts significantly to these leadership transitions.

EVENT STUDY TEST (APPENDIX A: EVENT DATA)

Null Hypothesis:
There is no statistically significant stock price reaction to CEO changes, implying that the event does not affect the company's market returns in the short term.
Alternate Hypothesis:
There is a statistically significant stock price reaction to CEO changes, indicating that the event impacts the company's market returns in the short term.

Estimation Window: 45 Days (1.5 months)
Event Window: 5 Days (-2 day to event to +2 day to event)

Test: Two-sided test
A two-sided hypothesis test is used as the market return could be in either direction indicating a positive or negative return based on the CEO event change announcement.

KEY METRICS:
The Key metrics used for the CEO Change Event Study are as follows:
1. **P-value**: measures the probability that the observed results are due to chance rather than a true effect of the CEO change event.
2. **SCAAR (Standardized Cumulative Average Abnormal Returns)**: provides a normalized view of abnormal returns, allowing comparison across different stocks and events.
3. **CAAR (Cumulative Average Abnormal Return)**: aggregates abnormal returns over the event window, providing a measure of the overall market reaction.
4. **Standard Deviation**: assesses the volatility of abnormal returns, indicating how much they deviate from expected returns.
5. **T-test**: measures whether the observed abnormal returns (CAAR or SCAAR) are significantly different from zero.

TEST ANALYSIS AND TAKEAWAYS: (APPENDIX B, C, D)

1. **P-value Analysis:** The high p-value (0.9388) indicates a lack of statistical significance. Since it exceeds typical alpha levels (0.01, 0.05, or 0.10), we fail to reject the null hypothesis, suggesting insufficient evidence that CEO changes significantly impact stock returns in the short term.
2. **SCAAR and CAAR Analysis:** The mean SCAAR (-0.0387) is close to zero, indicating negligible abnormal returns around CEO changes. Similarly, the CAAR (-0.0021) is essentially zero, reinforcing the null hypothesis that the market reaction to CEO announcements is insignificant.

3. **Standard Deviation Analysis:**
   The event window standard deviation (1.3754) and estimation window standard deviation (1.2366) confirm minimal deviation in abnormal returns. Small standard deviations indicate low volatility, supporting the idea of an efficient market where CEO announcements have no significant impact.

HYPOTHESIS INSIGHTS AND FINDINGS (APPENDIX B, C, D)

1. **True Null Hypothesis:** The high p-value and near-zero CAAR and SCAAR imply that the null hypothesis is likely correct. CEO changes do not significantly impact the stock returns in the food and beverage sector in the short term.
2. **Implication for Market Efficiency:** This outcome leans toward market efficiency in the semi-strong form, as it suggests that CEO announcements are quickly and accurately incorporated into stock prices, preventing abnormal gains or losses for investors based on this information alone.
3. **T-test Analysis:** Based on the t-test results, the CAAR and SCAAR are near zero, indicating no strong directional bias in returns. This implies that market returns were neither significantly positive nor negative following CEO changes, aligning with the idea of an efficient market where such events do not produce notable abnormal returns in either direction.

Interpretation: The study's results suggest that the market efficiently processes CEO changes without significant short-term impact on stock returns. Thus, this supports the null hypothesis, affirming that in the food and beverage industry, these events are not influential in creating significant opportunities for abnormal returns in the market.

COMPARATIVE ANALYSIS:

Python, Excel, and SAS Results (APPENDIX B, C, D)
Results from Python, Excel, and SAS (Appendices B, C, and D) are consistent, showing high p values, near-zero CAAR, and low SCAAR means. Standard deviations and t-tests across all platforms reinforce the conclusion of an insignificant market reaction to CEO changes. Minor variations in t-statistics and standard deviations are due to different rounding or calculation methods, but overall, all tools support the null hypothesis, affirming market efficiency.

CONCLUSION:
This study concludes that CEO changes in the food and beverage industry (2008-2023) have an insignificant impact on short-term stock returns. High p-values, near-zero CAAR, and SCAAR values across Python, Excel, and SAS consistently support the null hypothesis, indicating no substantial abnormal returns. These results suggest that the market efficiently incorporates information about CEO changes, with no clear bias in returns. This provides evidence of market efficiency, particularly within this industry.

APPENDIX

APPENDIX A:
EVENT DATES (RETURNS OF 23 CEO CHANGE EVENTS ACROSS 8 COMPANIES FOR THE TIMEFRAME OF 2008 - 2023)

time	ret1	ret2	ret3	ret4	ret5	ret6	ret7	ret8	ret9	ret10	ret11	ret12	ret13	ret14	ret15	ret16	ret17	ret18	ret19	ret20	ret21	ret22	ret23
-45	-0.031859	-0.040027	0.002759	-0.014316	-0.004233	0.007937	0	-0.018605	-0.005747	-0.008739	0.030114	0.015963	-0.014311	-0.016611	0.016841	-0.022552	-0.019637	-0.00713	0.016174	0.003515	-0.006393	-0.00503	-0.018968
-44	-0.011614	-0.00392	-0.006018	-0.018768	0.013037	0.086614	0.011037	0.004739	-0.031214	-0.02693	0.005186	0.04826	-0.029038	0.005792	0.000808	0.020927	0.004006	-0.011523	0.000719	-0.004139	-0.003854	-0.016429	0.005259
-43	-0.022327	-0.012165	-0.00173	-0.001634	-0.004476	-0.050725	-0.039301	-0.023585	0.0358	0.024614	0	-0.058315	0.007477	0.018234	0.004036	0.011212	0.031001	0.005237	-0.002565	0.010125	0.00631	0.018172	0.001846
-42	-0.000401	-0.023904	0.028938	-0.014152	-0.016393	0.045802	-0.009091	0.012077	0.009217	-0.013727	-0.020731	-0.004587	-0.001855	0.020735	0.008643	-0.006064	-0.020095	-0.009916	0.003189	0.002743	0.004531	-0.030287	-0.007987
-41	-0.033667	-0.000557	-0.017178	-0.022266	-0.007048	-0.10219	-0.020642	0.009547	0.028539	0.006345	-0.048624	-0.111751	-0.011152	0.003232	-0.005978	0.021963	0.009798	-0.01375	-0.00482	-0.008312	0.00246	-0.021937	0.006193
-40	-0.029448	0.02209	-0.013537	-0.023871	0.007481	0.04065	0.018735	0.009456	0.039956	0.009804	0.027417	-0.057069	0	0.002301	0.004812	-0.002047	-0.021662	-0.002926	-0.012057	-0.005836	-0.012589	0.045999	-0.004924
-39	-0.03547	0.012169	0.009727	-0.0088	0.011139	-0.070312	-0.027586	-0.007026	0	0.009104	-0.03297	-0.002751	-0.015038	0.009183	0.010375	-0.001538	0.009379	-0.015191	-0.003755	-0.004696	-0.034889	0.005452	-0.002829
-38	0.025255	-0.004306	-0.0246	-0.011872	0.004049	-0.008403	0.057692	0.002359	0.007471	-0.000359	-0.017297	-0.038621	0.020992	-0.010919	-0.007899	-0.000342	-0.013482	0.017178	-0.020521	-0.011044	0.00248	0.021869	0.006667
-37	0.036733	-0.000362	-0.010053	0.006164	0.003188	-0.101695	0.025	-0.018824	0.050848	-0.001997	0.010276	-0.012912	0.001869	0.01012	-0.002986	0.007705	-0.007952	-0.016371	-0.017317	0.001843	0.009277	-0.006898	-0.008317
-36	0.010838	0.010685	0.027614	0.018586	0.016639	-0.056604	-0.008869	-0.002398	0.03629	-0.00076	-0.010197	-0.053779	0.018657	0.01275	0.012378	-0.001019	-0.010818	0.006833	-0.000653	0.017424	-0.01103	0.036509	0.019724
-35	-0.006186	0.007346	-0.003988	-0.011111	0.002391	0.12	0.017897	0.009615	0.100195	0.000761	-0.01722	0.075269	0.010989	-0.013489	0.007494	-0.002722	0.003413	0.01218	0.000327	0.003723	-0.011487	0.009966	-0.001371
-34	-0.038589	-0.001957	0.003829	-0.014741	-0.005687	-0.080357	0.01978	-0.004762	0.001768	-0.015085	0.002355	0.027143	-0.012681	-0.000912	-0.003523	-0.003582	0.00087	-0.066185	-0.011099	-0.012187	0.011813	-0.007656	0.005948
-33	-0.012948	0.008376	-0.005722	-0.00272	0.006827	-0.15534	-0.021552	-0.009569	0.00794	0.0039	0.009659	0.006954	-0.007339	0.010036	-0.010803	-0.00736	0.03161	0.011782	0.001431	-0.002146	0.002764	-0.016115	-0.001213
-32	0.010057	0.004949	0.010694	0.019828	0.007788	0.007788	-0.183908	-0.004405	-0.014742	-0.022767	0.000971	0.039907	-0.019337	-0.029575	-0.00271	0.000596	0.003449	0.007967	-0.021834	0.004615	-0.001935	0.000428	-0.018644	-0.003036
-31	-0.012554	-0.002286	-0.006592	0.011419	-0.007637	-0.15493	-0.033186	-0.034913	-0.011649	0.003194	0.00984	-0.019718	0.007619	-0.001812	-0.021036	0.043822	-0.000988	-0.025112	-0.019797	-0.013896	-0.005368	0.014382	0.010201
-30	0.011399	0.010929	-0.002445	0.004475	-0.044434	-0.366667	0.011442	0.007752	0.003626	-0.006855	0.015142	0.054598	-0.003781	-0.015427	0.007095	0.015783	0.009053	-0.008205	0.002566	-0.001748	0.010268	-0.04306	-0.000452
-29	-0.038578	0.003313	-0.008577	-0.010429	0.006903	0.026316	-0.024887	0.010256	0.01355	0.014335	-0.037555	-0.049046	-0.03795	0.011981	0.005636	-0.020445	0.020808	0.00808	0.015804	0.001204	0.002269	-0.015914	-0.019903
-28	0.019387	0.000521	0.009004	-0.018316	0.017187	0.538462	-0.016241	-0.020305	-0.019608	-0.000644	-0.008049	0.063037	-0.032381	0	-0.007406	-0.000835	0.008715	0.000954	0.000767	-0.007542	0.002877	-0.015242	0.009077
-27	0.01548	0.001216	0.000875	-0.009798	-0.004915	0	0.014151	-0.028497	0.015455	0.005157	-0.007283	-0.013477	0.021654	-0.004554	0.002622	-0.00986	0.010616	0.010677	0.001533	-0.005066	-0.000141	0.018875	0.019515
-26	0.003484	-0.002776	-0.000699	0.002	0.002634	0.433333	-0.009302	-0.018667	-0.004476	0.011022	-0.001878	0.015027	-0.055877	0.017383	-0.004023	0.000506	-0.028834	0.018676	0.000547	0.006088	0.002634	0.010559	0.000299
-25	0.015191	-0.012178	0.003149	-0.002836	0.009807	0.034884	0.023474	-0.01087	0.016187	-0.007533	0.003917	-0.039608	-0.002041	-0.016187	-0.039176	-0.008435	0.030436	0.001852	-0.005244	-0.014633	0.007272	-0.015032	0.012857
-24	-0.024797	0.001585	-0.006627	0.023283	0.013353	-0.438202	0.045872	-0.043956	0.00531	-0.018135	0.010969	-0.007143	-0.096114	0.009141	0.003783	0.005444	-0.047998	-0.056007	-0.001647	0.012394	-0.026501	-0.017267	0.001624
-23	-0.020605	0.004748	0.009305	-0.013693	-0.004976	0.2	-0.002193	-0.060345	-0.021127	0.024003	0.032425	-0.046043	0.076923	-0.009058	-0.020729	0.002538	-0.006008	-0.006266	-0.008691	-0.012132	-0.013157	0.005157	-0.006779
-22	0.013876	-0.00035	0.003305	-0.016577	0.009446	-0.033333	0.054945	0.015291	-0.003597	-0.000874	-0.013932	-0.049774	-0.044118	0.009141	-0.004276	0.006582	0.024405	0.005123	-0.000777	-0.00082	0.18229	0.00589	-0.006083
-21	0.00883	-0.00035	0.004161	-0.000854	-0.013394	0	0.05625	-0.01506	-0.034296	0.005448	0.001821	0.07619	0.092308	0.006341	0.006871	0.021797	-0.016206	0.050382	-0.029438	0.050574	0.007904	-0.019834	-0.005971
-20	-0.010066	-0.007355	-0.011913	0.009183	-0.004092	-0.051724	0.031558	-0.067278	0.00477	0.01045	-0.024152	0.014749	0.004024	-0.0054	-0.004905	0.004595	0.008123	0.011945	-0.004498	-0.008899	0.001086	-0.004047	0.005106
-19	0.004863	-0.008469	0.004368	0.007089	-0.021662	-0.072727	0.007648	-0.022951	0.002825	0.028349	0.016642	0.031977	0.014028	-0.017195	-0.008358	0.015518	-0.01619	-0.006271	0.008804	0.000757	-0.003822	-0.020704	0.001793
-18	-0.036727	-0.008185	-0.014092	-0.022379	-0.000095	-0.058824	0.068311	0.067114	0.046009	0.026653	-0.031254	-0.012676	-0.019763	0.038674	-0.001081	-0.012225	0.006353	-0.000742	0.018144	0.015242	0.008147	0.033985	0.007457
-17	-0.000694	-0.009867	0.004235	0.003117	-0.012026	-0.0625	0.060391	0.037736	0.001795	0.008938	-0.000179	-0.024251	-0.002016	-0.006206	0.000865	-0.011236	-0.030195	-0.002043	-0.003158	0.001384	-0.005028	0.002484	0.00148
-16	-0.017367	-0.011959	0.002811	-0.002464	-0.018452	0	-0.035176	-0.00303	0.027778	-0.007352	0.016108	0.013158	-0.058586	0.000892	0.001297	0.024704	0.020312	0.013586	-0.007128	0.003083	-0.012939	-0.008578	0.005765
-15	-0.011628	0.001834	-0.024356	-0.03716	0.008268	0.133333	0.005208	-0.045593	0.005251	-0.001	-0.006568	-0.049062	-0.019313	-0.010695	-0.004534	-0.0135	-0.038355	0.021667	-0.013219	-0.00371	-0.003062	0.005576	0.001323
-14	-0.051765	-0.00659	0.02676	0.01517	-0.003417	0.019608	0.008636	0.009554	0.026019	0.012715	-0.017402	0.054628	0.02407	-0.011712	-0.004554	-0.022157	0.014307	0.006111	0.010625	-0.013512	-0.005567	0.038526	-0.011008
-13	0.022333	0.004975	-0.000525	0.017251	-0.006465	-0.038462	0.063356	-0.037855	0.038884	0.001391	0.001676	-0.08777	0.032051	0.003646	0.006174	0.012329	-0.042474	0.006967	0.005257	0.014021	0.005212	0.013808	-0.000742
-12	-0.02767	0.004767	-0.00945	-0.008533	0.015577	-0.14	0.004831	0.042623	-0.003255	0.002266	0.009239	0.020505	0.014493	0.015441	-0.019066	-0.006108	0.021973	0.00479	0.019893	0.002021	-0.006961	0.038557	0.004307
-11	0.024963	0.017883	-0.00212	-0.017976	0.01495	-0.232558	-0.022436	0.034591	0.002449	0.013484	-0.012546	0	-0.032653	-0.088551	-0.007149	0.005275	0.031326	-0.018715	0.008694	0.009341	0.007977	0.027152	0.012718
-10	0.025816	0.000538	0	0.029177	0.004208	-0.030303	-0.04984	-0.00304	0.003257	0.015829	-0.020013	0.05255	0.00211	0.025515	-0.001575	-0.005412	-0.013196	-0.005038	-0.002873	0.005889	0.006475	-0.019241	-0.027307
-9	0.007597	-0.004838	-0.00478	-0.013366	-0.015716	0	0.015385	-0.042683	-0.01461	0.02009	0.038446	-0.024963	0.050526	0.000957	-0.006536	-0.007914	0.02081	0.006691	-0.007092	-0.013591	-0.050417	0.004217	-0.007807
-8	-0.01885	0.006302	0.01441	-0.016388	-0.008128	0.03125	-0.058923	0.015924	0.023888	0.001775	0.006116	0.021084	-0.006012	0.00478	-0.00431	0.014625	-0.07387	0.00952	-0.010603	0.002438	-0.000301	0.011503	0.006204
-7	-0.017291	-0.000716	0.001578	-0.061868	-0.021463	0.060606	0.0322	-0.015674	0	0.009934	-0.013846	-0.010325	-0.01417	-0.03806	-0.002962	-0.003931	-0.023519	-0.01726	-0.01393	-0.004123	-0.016013	0.020397	0.015338
-6	-0.016129	0.017189	0.001926	0.005446	-0.009173	-0.057143	0.005199	-0.009554	0.004827	0.005606	-0.031125	-0.044709	0.016427	-0.024833	0.014168	0.009867	-0.0036	0.008329	0.008101	0	-0.007193	-0.012206	0.003406
-5	0.01689	0.007393	0.00367	0.042857	-0.003019	0.121212	0.039655	0.009646	0.020016	-0.044051	-0.001769	-0.017161	-0.016162	0	-0.008112	0.005048	0.001376	0.006464	-0.002603	0.001274	-0.014542	0.005014	-0.00738
-4	-0.056668	0.002097	-0.090719	-0.005023	0.003835	0.054054	0.026534	-0.012739	0.05102	0.01288	-0.022292	0.026984	-0.003918	0.004543	-0.004375	-0.014088	0.007137	0.011121	0.007104	0.00438	0.006949	-0.0229	
-3	-0.03159	0.003313	-0.03064	-0.050826	-0.001207	-0.051282	0.050081	0	0.050037	-0.005793	0.008601	0.054096	0.028513	-0.003933	0.006106	0.011717	0.046615	-0.019841	-0.008642	0.038745	0.022168	0.013095	-0.009283
-2	-0.031551	0.010775	0.012248	-0.041581	0.010972	0.081081	0.050769	-0.009677	-0.025605	0.002203	-0.051031	0.005865	-0.023762	0.012833	0.017982	0.002413	0.041375	-0.006055	-0.001698	0.017231	-0.000965	0.003668	0.003072
-1	0.014909	0.003955	-0.011319	0.048304	-0.017226	0.1	-0.002928	0.029316	0.013869	0.000284	-0.044874	0.007289	-0.022312	0.010721	-0.01391	-0.001765	0.007595	-0.009337	0.003969	-0.00613	-0.014031	-0.007483	-0.012404
0	0.080522	0.000856	-0.005527	0.015612	0.011651	0.568182	-0.024963	-0.031646	-0.007199	-0.004146	0.038817	-0.001447	0.014523	-0.005786	0.005822	0.006108	-0.008251	-0.017557	-0.005083	0.011122	-0.027225	0.097843	-0.010234
1	-0.020141	-0.002053	-0.010719	0.00286	0.00691	-0.086957	-0.019578	0.003268	0.029006	-0.003096	-0.020734	-0.015942	-0.006135	0.00388	0.034633	0.015018	-0.00856	0.008841	0.005677	-0.0026	0.018658	0.016611	0.00188
2	0.043679	-0.001715	-0.026083	0.022131	-0.014124	-0.142857	-0.004608	-0.003257	-0.043693	-0.008532	0.027222	0.014728	0.018518	-0.000972	-0.012159	0.012435	0.023804	0.00578	0.008128	0.005113	0.010407	-0.008798	0.002033
3	-0.025603	-0.005153	0.006386	-0.03058	-0.007062	0.055556	0.322531	0.006536	0.012528	0.005077	-0.032588	-0.011611	0.00404	-0.008755	0.009501	0.000933	-0.00867	-0.016685	0.004031	-0.011372	-0.005665	-0.00111	0.006398
4	-0.012127	0.001727	0.004299	0.011858	-0.000813	-0.105263	0.012836	0.003247	0.011645	-0.003152	0.000293	-0.007342	-0.016097	0.022571	-0.001925	-0.005902	0.001113	-0.014517	0.001561	-0.019978	0.002745	-0.003174	-0.02388
5	-0.036317	-0.001206	-0.005911	-0.019001	0.003254	-0.019608	0.038018	0.012945	-0.009352	-0.02113	-0.023962	-0.011834	0.006135	-0.03167	0.025718	0.005937	-0.0036	0.008021	0.029271	0.005011	0.005971	-0.00501	-0.006779
6	0.024416	-0.001208	-0.003281	0.010438	0.000608	-0.18	0.053274	-0.00639	0.022513	0.02669	0.006355	-0.040419	0.018293	0.004955	-0.01191	-0.007611	-0.004243	0.008364	-0.007978	-0.014533	0.003322	0.003685	-0.02524
7	-0.012953	-0.005183	0.007612	0.003788	0.019246	0.170732	-0.040042	-0.006431	0.007812	-0.002253	-0.031544	-0.017964	-0.003945	-0.007824	-0.015652	-0.007397	-0.010138	0.026807	-0.013812	0.008899	-0.000638	-0.00838	0.00779
8	-0.020472	-0.001216	0.018783	0.010635	0.006957	0.020833	-0.049396	-0.009709	-0.044397	0.008494	0.008366	0.014308	-0.018293	0.013861	-0.002771	0.020989	-0.028511	0.02216	0.003916	0.013585	-0.005128	0.001437	0.000165
9	0.000536	0.009911	0.010421	0.032247	0.027734	-0.163265	-0.002309	0.03268	-0.015487	-0.007854	0.039927	0.021944	0.010352	0.006836	0.008976	-0.023361	-0.04719	-0.002004	-0.006935	0.001039	-0.000155	-0.00941	0.010241
10	0.076058	0.004649	-0.005553	-0.002192	0.006914	0	0.017361	-0.031646	0.042697	0.010208	-0.013169	0.001534	0.022541	-0.00582	-0.007626	0.010365	-0.002188	-0.009127	0.002619	0.008303	0.001598	0.007728	0.00932

APPENDIX B: PYTHON RESULTS
1. KEY METRICS: SCAAR VALUE

```python
scaar = []

for i in range(1,12):
    estimation_ret = t.iloc[0:45,i:i+1]
    estimation_mean = np.mean(estimation_ret)
    event_ret = t.iloc[46:50,i:i+1]
    ab = event_ret - estimation_mean
    caar = np.mean(ab)
    event_std = np.std(ab, ddof=1)
    scaar_event_std = caar / (event_std / np.sqrt(4))
    scaar.append(scaar_event_std)
```

```
print(scaar)
```

```
[ret1     0.277336
dtype: float64, ret2     -1.370411
dtype: float64, ret3     -0.504816
dtype: float64, ret4      0.608092
dtype: float64, ret5     -0.516346
dtype: float64, ret6     -1.373028
dtype: float64, ret7      0.828769
dtype: float64, ret8      4.165346
dtype: float64, ret9     -0.529338
dtype: float64, ret10     -1.852771
dtype: float64, ret11     -0.15816
dtype: float64]
```

2. KEY METRICS: CAAR, MEAN-SCAAR AND P-VALUE

```python
# p-value for 2-sided test
p_value = 2*stats.t.sf(abs(t), dof)
print(f'P-value: {p_value}')
print(f'Mean SCAAR {mean_scaar}')
print(f'CAAR: {caar}')
```

```
P-value: 0.9387516768448106
Mean SCAAR -0.03866616887938618
CAAR: -0.0020755055555555547
```

APPENDIX C: EXCEL RESULTS

1. EXCEL SUMMARY STATISTICS

	ret1	ret2	ret3	ret4	ret5	ret6	ret7	ret8	ret9	ret10	ret11	ret12	ret13	ret14	ret15	ret16	ret17	ret18	ret19	ret20	ret21	ret22	ret23
Return:																							
Expected:	-0.00798	0.00013	-0.00272	-0.00537	-0.00146	-0.01029	0.009963	-0.0061	0.01077	0.002775	-0.00438	-0.00377	-0.00269	-0.00018	-0.00159	0.002152	-0.0006	-0.00208	-0.00153	0.001424	-0.00265	0.000907	-0.00043
abnormal:	0.088503	0.008837	0.002454	0.059593	0.019632	0.576163	-0.01698	-0.02367	0.000782	0.003835	0.046798	0.006534	0.022504	0.002195	0.013803	0.014089	-0.00027	-0.00958	0.002898	0.019103	-0.01924	0.105824	-0.00225
abnormal:	-0.01216	0.005928	-0.00274	0.010841	0.014891	-0.07898	-0.0116	0.011249	0.036987	0.004885	-0.01275	-0.00796	0.001846	0.011861	0.051614	0.022999	-0.00058	0.016822	0.013658	0.005381	0.026639	0.024592	0.009861
abnormal:	0.05166	0.006266	-0.0181	0.030112	-0.00614	-0.13488	0.003373	0.004724	-0.03571	-0.00055	0.035203	0.022709	0.026499	0.007009	-0.00418	0.020416	0.031785	0.013761	0.016109	0.013094	0.018388	-0.00082	0.010014
abnormal:	-0.01762	0.002828	0.014367	-0.0226	0.000919	0.063537	0.330512	0.014517	0.020509	0.013058	-0.02461	-0.00363	0.012021	-0.00077	0.017482	0.008914	-0.00069	-0.0087	0.012012	-0.00339	0.002316	0.006871	0.014379
abnormal:	-0.00415	0.009708	0.01228	0.019839	0.007168	-0.09728	0.020817	0.011228	0.019626	0.004829	0.008274	0.000639	-0.00812	0.030552	0.006056	0.002079	0.009094	-0.00654	0.009542	-0.012	0.010726	0.004807	-0.0159
abnormal:	-0.02834	0.006775	0.00207	-0.01102	0.011235	-0.01163	0.045999	0.020926	-0.00137	-0.01315	-0.01598	-0.00385	0.014116	-0.02369	0.033699	0.013918	-4E-05	0.037252	0.012992	0.013952	0.002971	0.001614	0.002421
abnormal:	0.032397	0.006773	0.0047	0.018419	0.008589	-0.17202	0.061255	0.001591	0.030494	0.034671	0.014336	-0.03244	0.026274	0.012936	-0.00393	0.00037	0.003738	0.016345	2.84E-06	-0.00655	0.011303	0.011666	-0.01726
abnormal:	-0.00497	0.002798	0.015593	0.011769	0.027227	0.178713	-0.03206	0.00155	0.015793	0.005728	-0.02356	-0.01074	-0.00998	0.004036	0.000157	-0.00767	0.000584	-0.00216	0.034788	-0.00583	0.01688	0.007343	-4.9E-05
abnormal:	-0.01249	0.006765	0.026764	0.018616	0.014938	0.028814	-0.04142	-0.00173	-0.03642	0.016475	0.016347	0.022289	-0.01031	0.021842	0.00521	0.02897	-0.02053	0.030141	0.011897	0.021566	0.002853	0.009418	0.008146
abnormal:	0.008517	0.017892	0.018402	0.040228	0.035715	-0.15528	0.005672	0.040661	-0.00751	0.000127	0.047908	0.029925	0.018333	0.014817	0.016957	-0.01538	-0.03921	0.005977	0.001046	0.00902	0.007826	-0.00143	0.018222
abnormal:	0.084039	0.01263	0.002428	0.005789	0.014895	0.007981	0.025342	-0.02367	0.050678	0.018189	-0.00519	0.009515	0.030522	0.002161	0.000355	0.018346	0.005793	-0.00115	0.0106	0.016284	0.009579	0.015709	0.017301
mean (CAAR):	0.021247	0.006713	0.001652	0.019557	0.007293	0.065713	0.065224	0.00361	0.008438	0.005211	0.010583	0.003658	0.010951	0.010168	0.016955	0.013699	0.007868	0.001153	0.010844	0.004438	0.007765	0.028255	0.00322
std (sigma hat) from event window:	0.04669	0.002711	0.013084	0.029864	0.010382	0.295086	0.149026	0.015657	0.027811	0.004922	0.030438	0.011921	0.014342	0.012366	0.021076	0.00851	0.014003	0.012999	0.005046	0.012473	0.017586	0.044392	0.012352
std (sigma hat) from estimation window:	0.026406	0.010526	0.018036	0.02279	0.012543	0.180727	0.031818	0.026415	0.025702	0.013499	0.022718	0.04225	0.032091	0.018231	0.010587	0.012889	0.02448	0.018821	0.010247	0.012711	0.013341	0.023921	0.01028
normalized (CAAR/ sigma hat) using event window std:	0.910117	4.953222	0.252529	1.309735	1.404968	0.445383	0.875345	0.461204	0.606832	2.117261	0.695369	0.613714	1.52704	1.644612	1.608935	3.219562	1.123772	0.177439	4.298155	0.711605	0.883088	1.272985	0.521418
normalized (CAAR/ sigma hat) using estimation window std:	1.609239	1.275606	0.183192	1.716269	1.162961	0.727206	4.099865	0.273362	0.656621	0.772038	0.931661	0.173163	0.682478	1.115528	3.203127	2.125681	0.642802	0.122547	2.116448	0.698263	1.164023	2.362352	0.626527
overall mean (SCAAR) using event window std:	1.375404																						
overall mean (SCAAR) using estimation window std:	1.236563																						
overall std (std of normalized CAAR) using event window std:	1.232742																						
overall std (std of normalized CAAR) using estimation window std:	0.998386																						
overall std of mean (std of SCAAR) using event window std:	0.371686																						
overall std of mean (std of SCAAR) using estimation window std:	0.301025																						
t-test using event window std:	3.700449																						
t-test using estimation window std:	4.107846																						

2. EXCEL SUMMARY GRAPHS

vwretd	sprtrn	mktrf	smb	hml	rf	umd	Average	CAR
							0.040068	0.040068
							0.00623	0.046297
							0.004815	0.051112
							0.019662	0.070774
							0.001882	0.072656
							0.00482	0.077476
							0.002768	0.080244
							0.009823	0.090067
							0.007311	0.097378
							0.005149	0.102528
							0.014267	0.116794

Average Abnormal Return

CAR
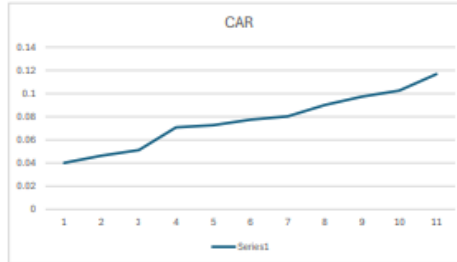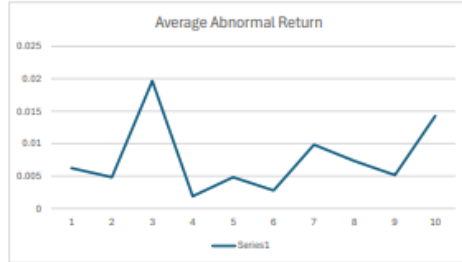
APPENDIX D: SAS RESULTS

1. SAS OUTPUT

The CONTENTS Procedure

Data Set Name	FILE.EVENTS	Observations	56
Member Type	DATA	Variables	24
Engine	V9	Indexes	0
Created	11/10/2024 22:40:31	Observation Length	192
Last Modified	11/10/2024 22:40:31	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information

Data Set Page Size	131072
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	682
Obs in First Data Page	56
Number of Data Set Repairs	0
Filename	/home/u45026002/events.sas7bdat
Release Created	9.0401M7
Host Created	Linux
Inode Number	12081302673
Access Permission	rw-r--r--
Owner Name	u45026002
File Size	256KB
File Size (bytes)	262144

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat
2	ret1	Num	8	BEST12.	BEST32.
3	ret2	Num	8	BEST12.	BEST32.
4	ret3	Num	8	BEST12.	BEST32.
5	ret4	Num	8	BEST12.	BEST32.
6	ret5	Num	8	BEST12.	BEST32.
7	ret6	Num	8	BEST12.	BEST32.
8	ret7	Num	8	BEST12.	BEST32.
9	ret8	Num	8	BEST12.	BEST32.
10	ret9	Num	8	BEST12.	BEST32.
11	ret10	Num	8	BEST12.	BEST32.
12	ret11	Num	8	BEST12.	BEST32.
13	ret12	Num	8	BEST12.	BEST32.
14	ret13	Num	8	BEST12.	BEST32.
15	ret14	Num	8	BEST12.	BEST32.
16	ret15	Num	8	BEST12.	BEST32.
17	ret16	Num	8	BEST12.	BEST32.
18	ret17	Num	8	BEST12.	BEST32.
19	ret18	Num	8	BEST12.	BEST32.
20	ret19	Num	8	BEST12.	BEST32.

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Informat
21	ret20	Num	8	BEST12.	BEST32.
22	ret21	Num	8	BEST12.	BEST32.
23	ret22	Num	8	BEST12.	BEST32.
24	ret23	Num	8	BEST12.	BEST32.
1	time	Num	8	BEST12.	BEST32.

ttest		std_scaar		std_mean_scaar	
0.7091531	2.0252982	1.0008128	1.1629369	0.2086839	0.2424891

2. SAS CODE

```
/* Generated Code (IMPORT) */
/* Source File: event_study_dataset.csv */
/* Source Path: /home/u45026002 */
/* Code generated on: 11/10/24, 1:14 AM */

%web_drop_table(file.events);


FILENAME REFFILE '/home/u45026002/event_study_dataset.csv';

PROC IMPORT DATAFILE=REFFILE
    DBMS=CSV
    OUT=file.events;
    GETNAMES=YES;
RUN;

PROC CONTENTS DATA=file.events; RUN;


%web_open_table(file.events);

proc iml;
use file.events;
read all into returns;
do i=1 to 23;
estimation_ret =returns[1:45,i+1];
estimation_mean=estimation_ret[:];
estimation_std=std(estimation_ret);
ab= returns[46:50,i+1]-estimation_mean;
event_std=std(ab);
caar=ab[:];
scaar_event_std=caar/(event_std/sqrt(nrow(ab)));
scaar_estimation_std=caar/(estimation_std/sqrt(nrow(ab)));
collect=collect//( scaar_event_std || scaar_estimation_std );
end;
std_scaar=std(collect);
std_mean_scaar=std(collect)/sqrt(nrow(collect));
ttest=collect[:,]/std_mean_scaar;
print ttest std_scaar std_mean_scaar;
prob_t=2*(1-probt(ttest,nrow(collect-1)));
print prob_t
```

3. SAS LOG

```
1        OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK;
68
69       /* Generated Code (IMPORT) */
70       /* Source File: event_study_dataset.csv */
71       /* Source Path: /home/u45026002 */
72       /* Code generated on: 11/10/24, 1:14 AM */
73
74       %web_drop_table(file.events);
NOTE: Table FILE.EVENTS has been dropped.
NOTE: PROCEDURE SQL used (Total process time):
      real time              0.00 seconds
      user cpu time          0.00 seconds
      system cpu time        0.00 seconds
      memory                 205.75k
      OS Memory              24488.00k
      Timestamp              11/11/2024 03:40:30 AM
      Step Count                        60  Switch Count  2
      Page Faults                       0
      Page Reclaims                     14
      Page Swaps                        0
      Voluntary Context Switches        19
      Involuntary Context Switches      1
      Block Input Operations            0
      Block Output Operations           0


75
76
77       FILENAME REFFILE '/home/u45026002/event_study_dataset.csv';
78
79       PROC IMPORT DATAFILE=REFFILE
80       DBMS=CSV
81       OUT=file.events;
82       GETNAMES=YES;
83       RUN;

NOTE: Unable to open parameter catalog: SASUSER.PARMS.PARMS.SLIST in update mode. Temporary parameter values will be saved to
WORK.PARMS.PARMS.SLIST.
84        /*********************************************************************
85        *   PRODUCT:   SAS
86        *   VERSION:   9.4
87        *   CREATOR:   External File Interface
88        *   DATE:      11NOV24
89        *   DESC:      Generated SAS Datastep Code
90        *   TEMPLATE SOURCE:  (None Specified.)
91        *********************************************************************/
92          data FILE.EVENTS    ;
93          %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
94          infile REFFILE delimiter = ',' MISSOVER DSD  firstobs=2 ;
95             informat time best32. ;
96             informat ret1 best32. ;
97             informat ret2 best32. ;
98             informat ret3 best32. ;
99             informat ret4 best32. ;
100            informat ret5 best32. ;
101            informat ret6 best32. ;
102            informat ret7 best32. ;
103            informat ret8 best32. ;
104            informat ret9 best32. ;
105            informat ret10 best32. ;
106            informat ret11 best32. ;
107            informat ret12 best32. ;
108            informat ret13 best32. ;
109            informat ret14 best32. ;
110            informat ret15 best32. ;
111            informat ret16 best32. ;
112            informat ret17 best32. ;
113            informat ret18 best32. ;
114            informat ret19 best32. ;
115            informat ret20 best32. ;
116            informat ret21 best32. ;
117            informat ret22 best32. ;
118            informat ret23 best32. ;
119            format time best12. ;
120            format ret1 best12. ;
121            format ret2 best12. ;
122            format ret3 best12. ;
123            format ret4 best12. ;
```