

Correlation trends of Macro and Financial Variables (Corporate Earnings, GDP, Stock Market Return, Long term Interest Rate, Short term Interest Rate and Inflation)

Corporate Earnings

- Corporate Earnings and GDP both are highly correlated with each other in their current period. Corporate Earnings is not as much related with the lags of GDP, as the lags of Corporate Earnings is related to the present GDP. It implies that **GDP leads the Corporate Earnings cycle**.
- As mentioned above, lags of Corporate Earnings are highly correlated with the current period of GDP. We infer that **Corporate Earnings is dependent on the future expected value of GDP**.
- The correlation between Corporate Earnings and Long run interest rate increases by the lag terms of long run interest rate as shown below (Fig-1). Hence, we can conclude that **long term interest rate lags the Corporate Earning cycle**. The correlation coefficient of the 4th period lag of long term interest rates is highest among the lags.
- The short run interest rates follow the same trend like long run interest rates. As we increase the number of lags the correlation between the two series increases. Hence, **Corporate Earnings lead short term interest rates**.
- Lags of Corporate Earnings show high correlation with current period of inflation. With increase in number of lags of corporate earnings, correlation coefficient does not change significantly with the current inflation. Therefore **inflation is leads the Corporate Earnings cycle**.
- Considering the coefficient of correlation between Corporate earnings and stock market returns, one period lag of return is highly correlated with current Corporate Earnings. Hence it can be concluded that the **Corporate Earnings cycle leads stock market returns with a lead of 1 quarter**.



Fig-1:-Correlation table: Corporate Earnings Vs Corporate Earnings, GDP, Li, Si, Inflation, Return

	<i>Earn</i>	<i>Earn_1</i>	<i>Earn_2</i>	<i>Earn_3</i>	<i>Earn_4</i>	<i>GDP</i>	<i>GDP_1</i>	<i>GDP_2</i>	<i>GDP_3</i>	<i>GDP_4</i>	<i>Li</i>	<i>Li_1</i>	<i>Li_2</i>	<i>Li_3</i>	<i>Li_4</i>
Earn	1.0000	0.9932	0.9841	0.9764	0.9712	0.9593	0.9285	0.9098	0.8990	0.8919	-0.0007	0.0793	0.1430	0.2116	0.2694
Earn_1	0.9932	1.0000	0.9933	0.9843	0.9765	0.9559	0.9469	0.9232	0.9089	0.9001	-0.0110	0.1405	0.1886	0.2427	0.2882
Earn_2	0.9841	0.9933	1.0000	0.9934	0.9843	0.9550	0.9415	0.9385	0.9200	0.9082	-0.0181	0.1259	0.2354	0.2789	0.3127
Earn_3	0.9764	0.9843	0.9934	1.0000	0.9934	0.9569	0.9384	0.9318	0.9330	0.9174	-0.0308	0.1141	0.2182	0.3167	0.3423
Earn_4	0.9712	0.9765	0.9843	0.9934	1.0000	0.9560	0.9379	0.9272	0.9253	0.9285	-0.0499	0.0983	0.2038	0.2984	0.3740

	<i>Si</i>	<i>Si_1</i>	<i>Si_2</i>	<i>Si_3</i>	<i>Si_4</i>	<i>CPI</i>	<i>CPI_1</i>	<i>CPI_2</i>	<i>CPI_3</i>	<i>CPI_4</i>	<i>Return</i>	<i>Return_1</i>	<i>Return_2</i>	<i>Return_3</i>	<i>Return_4</i>
Earn	0.1557	0.1739	0.1824	0.2199	0.2561	0.9022	0.8792	0.8651	0.8560	0.8510	0.9654	0.9712	0.9657	0.9525	0.9351
Earn_1	0.1514	0.2313	0.2314	0.2543	0.2782	0.9030	0.8990	0.8798	0.8670	0.8591	0.9443	0.9662	0.9723	0.9659	0.9523
Earn_2	0.1374	0.2225	0.2790	0.2953	0.3067	0.9041	0.8972	0.8964	0.8791	0.8680	0.9283	0.9457	0.9677	0.9727	0.9658
Earn_3	0.1071	0.2052	0.2666	0.3356	0.3418	0.9059	0.8956	0.8924	0.8931	0.8779	0.9171	0.9298	0.9478	0.9684	0.9727
Earn_4	0.0740	0.1739	0.2466	0.3213	0.3768	0.9086	0.8948	0.8885	0.8872	0.8897	0.9118	0.9186	0.9324	0.9488	0.9686



Gross Domestic Product

- GDP is correlated with the current period of Corporate Earnings. Lags of GDP have high correlation with their corresponding lags of Corporate Earnings. Current GDP is more correlated with the lags of Corporate Earnings as compared to Corporate Earnings with the lags of GDP. Therefore we can say *GDP leads Corporate Earnings*.
- *GDP cycle is leading the long term interest rates*. There is high positive correlation of GDP with the 4th lag of Long run Interest rate, while it is negatively correlated with the current long run interest rates. Hence *GDP leads long term interest rates by 4 quarters*.
- GDP leads the short term interest rates cycle.
- GDP and inflation are more strongly correlated with their corresponding temporal series.
- From the coefficient of correlation, GDP series is more related with 2 period lag of return than the other lags. Hence we can deduce that *GDP leads stock market return by 2 quarters*.



Fig-2:- Correlation table: GDP Vs Corporate earnings, GDP, Li, Si, Inflation, Return

	<i>Earn</i>	<i>Earn_1</i>	<i>Earn_2</i>	<i>Earn_3</i>	<i>Earn_4</i>	<i>GDP</i>	<i>GDP_1</i>	<i>GDP_2</i>	<i>GDP_3</i>	<i>GDP_4</i>	<i>Li</i>	<i>Li_1</i>	<i>Li_2</i>	<i>Li_3</i>	<i>Li_4</i>
GDP	0.9593	0.9559	0.9550	0.9569	0.9560	1.0000	0.9330	0.8947	0.9122	0.9186	-0.0073	0.0807	0.1551	0.2346	0.2717
GDP_1	0.9285	0.9469	0.9415	0.9384	0.9379	0.9330	1.0000	0.9417	0.9055	0.9162	-0.0804	0.2389	0.2737	0.3251	0.3669
GDP_2	0.9098	0.9232	0.9385	0.9318	0.9272	0.8947	0.9417	1.0000	0.9474	0.9132	-0.1110	0.1657	0.3852	0.4081	0.4323
GDP_3	0.8990	0.9089	0.9200	0.9330	0.9253	0.9122	0.9055	0.9474	1.0000	0.9523	-0.1757	0.1243	0.3129	0.4923	0.4961
GDP_4	0.8919	0.9001	0.9082	0.9174	0.9285	0.9186	0.9162	0.9132	0.9523	1.0000	-0.2614	0.0566	0.2679	0.4270	0.5675

	<i>Si</i>	<i>Si_1</i>	<i>Si_2</i>	<i>Si_3</i>	<i>Si_4</i>	<i>CPI</i>	<i>CPI_1</i>	<i>CPI_2</i>	<i>CPI_3</i>	<i>CPI_4</i>	<i>Return</i>	<i>Return_1</i>	<i>Return_2</i>	<i>Return_3</i>	<i>Return_4</i>
GDP	0.1623	0.1874	0.1919	0.2447	0.2712	0.9572	0.9280	0.9083	0.8964	0.8828	0.9237	0.9210	0.9176	0.9228	0.9236
GDP_1	0.0843	0.3081	0.3026	0.3195	0.3482	0.9188	0.9634	0.9353	0.9151	0.9019	0.8703	0.9116	0.9090	0.9017	0.9036
GDP_2	0.0558	0.2332	0.4011	0.4047	0.4061	0.9012	0.9327	0.9718	0.9437	0.9233	0.8412	0.8665	0.9039	0.8989	0.8900
GDP_3	-0.0020	0.1962	0.3265	0.4828	0.4750	0.8891	0.9149	0.9432	0.9773	0.9501	0.8273	0.8422	0.8654	0.8982	0.8916
GDP_4	-0.0791	0.1305	0.2794	0.4119	0.5412	0.8699	0.8963	0.9208	0.9470	0.9789	0.8195	0.8304	0.8454	0.8643	0.8936



Long term Interest Rates

- Interestingly, the current long term interest rates are negatively correlated with the lags of Corporate Earnings. The value of correlation increases by increasing the lags of Corporate Earnings but is not significant. There is a peculiar trend in the data which shows that the lags of both the series are positively correlated with each other. We restrict to this point that **Corporate Earnings lead long term interest rates** as the correlation coefficient between the Corporate Earnings and lags of long term interest rate is higher than the correlation coefficient between the long term interest rate and lags of Corporate Earnings.
- Long term interest rates, GDP and its lag values are negatively related with each other. They are more negatively correlated with the past values of GDP than with present values. Besides GDP and long run interest rates are positively correlated with their corresponding time frame. Hence, **we can't infer a meaningful association between GDP and long term interest rates.**
- **Inflation leads long run interest rates.** We infer this by observing increase in correlation between the lags of long run interest rates and inflation.
- With lag terms of stock market return, coefficient of correlation is not significant; all the values are close to zero. Therefore, **there is no significant relation between return and long run interest rates.**



Fig-3:- Correlation table: Long-Run Interest Rates Vs Corporate Earnings, GDP, Li, Si, Inflation, Return

	<i>Earn</i>	<i>Earn_1</i>	<i>Earn_2</i>	<i>Earn_3</i>	<i>Earn_4</i>	<i>GDP</i>	<i>GDP_1</i>	<i>GDP_2</i>	<i>GDP_3</i>	<i>GDP_4</i>	<i>Li</i>	<i>Li_1</i>	<i>Li_2</i>	<i>Li_3</i>	<i>Li_4</i>
Li	-0.0007	-0.0110	-0.0181	-0.0308	-0.0499	-0.0073	-0.0804	-0.1110	-0.1757	-0.2614	1.0000	0.4637	0.1801	-0.0638	-0.3146
Li_1	0.0793	0.1405	0.1259	0.1141	0.0983	0.0807	0.2389	0.1657	0.1243	0.0566	0.4637	1.0000	0.6284	0.4052	0.2002
Li_2	0.1430	0.1886	0.2354	0.2182	0.2038	0.1551	0.2737	0.3852	0.3129	0.2679	0.1801	0.6284	1.0000	0.7146	0.5258
Li_3	0.2116	0.2427	0.2789	0.3167	0.2984	0.2346	0.3251	0.4081	0.4923	0.4270	-0.0638	0.4052	0.7146	1.0000	0.7666
Li_4	0.2694	0.2882	0.3127	0.3423	0.3740	0.2717	0.3669	0.4323	0.4961	0.5675	-0.3146	0.2002	0.5258	0.7666	1.0000

	<i>Si</i>	<i>Si_1</i>	<i>Si_2</i>	<i>Si_3</i>	<i>Si_4</i>	<i>CPI</i>	<i>CPI_1</i>	<i>CPI_2</i>	<i>CPI_3</i>	<i>CPI_4</i>	<i>Return</i>	<i>Return_1</i>	<i>Return_2</i>	<i>Return_3</i>	<i>Return_4</i>
Li	0.8396	0.5052	0.2545	0.0027	-0.2457	0.0450	-0.0435	-0.1085	-0.1857	-0.2684	0.0668	0.0765	0.0884	0.0736	0.0324
Li_1	0.4463	0.8777	0.6224	0.4229	0.2169	0.1106	0.2686	0.1853	0.1222	0.0503	0.0618	0.1843	0.1873	0.1901	0.1728
Li_2	0.1975	0.5833	0.9085	0.6921	0.5218	0.1613	0.2922	0.4106	0.3307	0.2686	0.0930	0.1659	0.2654	0.2634	0.2617
Li_3	-0.0330	0.3776	0.6778	0.9251	0.7421	0.2230	0.3300	0.4320	0.5238	0.4465	0.1476	0.1911	0.2502	0.3355	0.3314
Li_4	-0.2184	0.1666	0.4890	0.7288	0.9361	0.2686	0.3560	0.4417	0.5238	0.5991	0.1922	0.2242	0.2597	0.3103	0.3854



Short term interest rates

- Present short term interest rates and present Corporate Earnings are not significantly correlated with each other. The significance level is increased if we simultaneously change the lag period within both the series. It does not depict any nature, which series leads the other. From the lead and lag correlation matrix, the correlation is more on the lag of Corporate Earnings rather than the leading values. Hence, we may infer that future Corporate Earnings is dependent on the short term rates. Roughly we can say that **short run interest rates are leading Corporate Earnings**.
- The relationship between GDP and short term rates is quite volatile. Lag terms of short term rates are inversely proportional to GDP, whereas present values of both are positively related with insufficient association. At the same time coefficient of correlation between GDP and short term rates is increasing with the number of lags however the association is not effective. Still, we understand that **GDP leads short term rates**.
- Short and long term rates are prominently significant with current sequence moreover level of significance between lags are weak. Same nature of short run interest rate is followed with inflation, besides correlation coefficient is insignificant.
- Short term rates and lags of return have stronger association than the current values of return and their coefficient of correlation is slightly significant. Still we can infer from the table that **short term rates lead the stock market return by two quarters**.



Fig-4:- Correlation table: Short-run Interest Rates Vs Corporate Earnings, GDP, Li, Si, Inflation, Return

	<i>Earn</i>	<i>Earn_1</i>	<i>Earn_2</i>	<i>Earn_3</i>	<i>Earn_4</i>	<i>GDP</i>	<i>GDP_1</i>	<i>GDP_2</i>	<i>GDP_3</i>	<i>GDP_4</i>	<i>Li</i>	<i>Li_1</i>	<i>Li_2</i>	<i>Li_3</i>	<i>Li_4</i>
<i>Si</i>	0.1557	0.1514	0.1374	0.1071	0.0740	0.1623	0.0843	0.0558	-0.0020	-0.0791	0.8396	0.4463	0.1975	-0.0330	-0.2184
<i>Si_1</i>	0.1739	0.2313	0.2225	0.2052	0.1739	0.1874	0.3081	0.2332	0.1962	0.1305	0.5052	0.8777	0.5833	0.3776	0.1666
<i>Si_2</i>	0.1824	0.2314	0.2790	0.2666	0.2466	0.1919	0.3026	0.4011	0.3265	0.2794	0.2545	0.6224	0.9085	0.6778	0.4890
<i>Si_3</i>	0.2199	0.2543	0.2953	0.3356	0.3213	0.2447	0.3195	0.4047	0.4828	0.4119	0.0027	0.4229	0.6921	0.9251	0.7288
<i>Si_4</i>	0.2561	0.2782	0.3067	0.3418	0.3768	0.2712	0.3482	0.4061	0.4750	0.5412	-0.2457	0.2169	0.5218	0.7421	0.9361

	<i>Si</i>	<i>Si_1</i>	<i>Si_2</i>	<i>Si_3</i>	<i>Si_4</i>	<i>CPI</i>	<i>CPI_1</i>	<i>CPI_2</i>	<i>CPI_3</i>	<i>CPI_4</i>	<i>Return</i>	<i>Return_1</i>	<i>Return_2</i>	<i>Return_3</i>	<i>Return_4</i>
<i>Si</i>	1.0000	0.6556	0.3792	0.0977	-0.1366	0.2240	0.1456	0.0837	0.0040	-0.0633	0.1871	0.2343	0.2660	0.2488	0.1884
<i>Si_1</i>	0.6556	1.0000	0.7190	0.4924	0.2445	0.2304	0.3502	0.2731	0.2121	0.1353	0.1167	0.2530	0.2924	0.3140	0.2940
<i>Si_2</i>	0.3792	0.7190	1.0000	0.7697	0.5655	0.2229	0.3286	0.4266	0.3528	0.2924	0.0931	0.1752	0.2986	0.3280	0.3429
<i>Si_3</i>	0.0977	0.4924	0.7697	1.0000	0.8010	0.2575	0.3436	0.4294	0.5096	0.4376	0.1230	0.1674	0.2392	0.3484	0.3726
<i>Si_4</i>	-0.1366	0.2445	0.5655	0.8010	1.0000	0.2841	0.3562	0.4273	0.4993	0.5675	0.1515	0.1839	0.2231	0.2858	0.3846



Inflation

- **Inflation leads stock market return.** We can see this from *Fig-5*, as lags of Corporate Earnings increase correlation coefficient between both the factors (CPI and Corporate Earnings) increases slightly.
- **Inflation leads long term rates as well as short term rates.** *Fig-5* depicts lags of long term interest rates and inflation is more associated and the relation between the two increases if we also consider lags of inflation. Peculiar behaviour which can be seen here is that the present long term interest rate is negatively correlated with the lags of inflation except the present value of inflation.
- **Inflation leads stock market return.** All the higher lags have significant correlation coefficient with the inflation rate. Correlation is significantly increasing as lags increase.
- We may conclude, **inflation leads all the variables.**



Fig-5:- Correlation table: Inflation Vs Corporate Earnings, GDP, Li, Si, Inflation, Return

	<i>Earn</i>	<i>Earn_1</i>	<i>Earn_2</i>	<i>Earn_3</i>	<i>Earn_4</i>	<i>GDP</i>	<i>GDP_1</i>	<i>GDP_2</i>	<i>GDP_3</i>	<i>GDP_4</i>	<i>Li</i>	<i>Li_1</i>	<i>Li_2</i>	<i>Li_3</i>	<i>Li_4</i>
CPI	0.9022	0.9030	0.9041	0.9059	0.9086	0.9572	0.9188	0.9012	0.8891	0.8699	0.0450	0.1106	0.1613	0.2230	0.2686
CPI_1	0.8792	0.8990	0.8972	0.8956	0.8948	0.9280	0.9634	0.9327	0.9149	0.8963	-0.0435	0.2686	0.2922	0.3300	0.3560
CPI_2	0.8651	0.8798	0.8964	0.8924	0.8885	0.9083	0.9353	0.9718	0.9432	0.9208	-0.1085	0.1853	0.4106	0.4320	0.4417
CPI_3	0.8560	0.8670	0.8791	0.8931	0.8872	0.8964	0.9151	0.9437	0.9773	0.9470	-0.1857	0.1222	0.3307	0.5238	0.5238
CPI_4	0.8510	0.8591	0.8680	0.8779	0.8897	0.8828	0.9019	0.9233	0.9501	0.9789	-0.2684	0.0503	0.2686	0.4465	0.5991

	<i>Si</i>	<i>Si_1</i>	<i>Si_2</i>	<i>Si_3</i>	<i>Si_4</i>	<i>CPI</i>	<i>CPI_1</i>	<i>CPI_2</i>	<i>CPI_3</i>	<i>CPI_4</i>	<i>Return</i>	<i>Return_1</i>	<i>Return_2</i>	<i>Return_3</i>	<i>Return_4</i>
CPI	0.2240	0.2304	0.2229	0.2575	0.2841	1.0000	0.9620	0.9307	0.9065	0.8870	0.8568	0.8605	0.8665	0.8695	0.8713
CPI_1	0.1456	0.3502	0.3286	0.3436	0.3562	0.9620	1.0000	0.9645	0.9349	0.9112	0.8192	0.8546	0.8598	0.8599	0.8587
CPI_2	0.0837	0.2731	0.4266	0.4294	0.4273	0.9307	0.9645	1.0000	0.9668	0.9385	0.7980	0.8213	0.8568	0.8566	0.8531
CPI_3	0.0040	0.2121	0.3528	0.5096	0.4993	0.9065	0.9349	0.9668	1.0000	0.9686	0.7834	0.8018	0.8254	0.8550	0.8516
CPI_4	-0.0633	0.1353	0.2924	0.4376	0.5675	0.8870	0.9112	0.9385	0.9686	1.0000	0.7756	0.7884	0.8074	0.8260	0.8518



Stock Market Return

- **Return lags behind Corporate Earnings cycle with one period lag i.e. 1 quarter.** We can see from the following table that current Corporate Earnings is strongly correlated through one period lag.
- **Return lags behind the GDP.** All the lagging terms of return have strong correlation with the present GDP while it is very less with all the past value of GDP.
- **Return runs ahead of long term interest rates.** Having unappreciable relation with the return and long run interest rates, their correlation improves by increasing the lags of long run interest rates. Thus both factors are more related to their past values.
- The association between both the short run interest rates and returns is high for the current period among all the values.
- **Inflation leads stock market return.** Both the series are predominantly correlated when the lag values of inflation is more than or equal to the lag values of return.



Fig-6:- Correlation table: Stock Market Index Return Vs Corporate Earnings, GDP, Li, Si, Inflation, Return

	<i>Earn</i>	<i>Earn_1</i>	<i>Earn_2</i>	<i>Earn_3</i>	<i>Earn_4</i>	<i>GDP</i>	<i>GDP_1</i>	<i>GDP_2</i>	<i>GDP_3</i>	<i>GDP_4</i>	<i>Li</i>	<i>Li_1</i>	<i>Li_2</i>	<i>Li_3</i>	<i>Li_4</i>
Return	0.9654	0.9443	0.9283	0.9171	0.9118	0.9237	0.8703	0.8412	0.8273	0.8195	0.0668	0.0618	0.0930	0.1476	0.1922
Return_1	0.9712	0.9662	0.9457	0.9298	0.9186	0.9210	0.9116	0.8665	0.8422	0.8304	0.0765	0.1843	0.1659	0.1911	0.2242
Return_2	0.9657	0.9723	0.9677	0.9478	0.9324	0.9176	0.9090	0.9039	0.8654	0.8454	0.0884	0.1873	0.2654	0.2502	0.2597
Return_3	0.9525	0.9659	0.9727	0.9684	0.9488	0.9228	0.9017	0.8989	0.8982	0.8643	0.0736	0.1901	0.2634	0.3355	0.3103
Return_4	0.9351	0.9523	0.9658	0.9727	0.9686	0.9236	0.9036	0.8900	0.8916	0.8936	0.0324	0.1728	0.2617	0.3314	0.3854

	<i>Si</i>	<i>Si_1</i>	<i>Si_2</i>	<i>Si_3</i>	<i>Si_4</i>	<i>CPI</i>	<i>CPI_1</i>	<i>CPI_2</i>	<i>CPI_3</i>	<i>CPI_4</i>	<i>Return</i>	<i>Return_1</i>	<i>Return_2</i>	<i>Return_3</i>	<i>Return_4</i>
Return	0.1871	0.1167	0.0931	0.1230	0.1515	0.8568	0.8192	0.7980	0.7834	0.7756	1.0000	0.9681	0.9263	0.8885	0.8593
Return_1	0.2343	0.2530	0.1752	0.1674	0.1839	0.8605	0.8546	0.8213	0.8018	0.7884	0.9681	1.0000	0.9691	0.9276	0.8898
Return_2	0.2660	0.2924	0.2986	0.2392	0.2231	0.8665	0.8598	0.8568	0.8254	0.8074	0.9263	0.9691	1.0000	0.9699	0.9292
Return_3	0.2488	0.3140	0.3280	0.3484	0.2858	0.8695	0.8599	0.8566	0.8550	0.8260	0.8885	0.9276	0.9699	1.0000	0.9703
Return_4	0.1884	0.2940	0.3429	0.3726	0.3846	0.8713	0.8587	0.8531	0.8516	0.8518	0.8593	0.8898	0.9292	0.9703	1.0000



CONCLUSION

Order of occurrence among these macroeconomic variables can be justified by the above correlation analysis with tables.

Inflation < GDP < short term rates < Corporate Earnings < return < long term rates

Reference: David J. Corliss, "leading and lagging indicators in SAS, NESUG 2012, University of Toronto



This report has been prepared by Investment Committee:

Mukesh Jindal CFA, CAIA, CFP
Partner, Alpha Capital

Shruti Singh
Senior Analyst, Research Desk

Pankaj Kumar
Senior Analyst

Akhil Bhardwaj
Partner, Alpha Capital

Rovind Kumar
Senior Analyst, Research Desk

Special thanks for contribution from **Ashita Kumari**.

For further queries and clarification please contact: research@alphacapital.in



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