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A PORTFOLIO ANALYSIS OF THE NIFTY REALTY INDEX

A report submitted in fulfilment of the project work requirements of the subject “Financial Planning and Portfolio Management”.

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1 INTRODUCTION

The Realty Sector is a lucrative sector in India with a high growth potential and that has had witnessed large financial performance changes in the past years. As such, it is no surprise that the NIFTY Realty Index - the index that reflects the performance of listed companies in the real estate sector - has the best return characteristics across the NSE sectoral indices. The index is constructed using free float market capitalisation method with the top 10 Realty Sector stocks forming part of the NIFTY 500. The index also places a constraint on the maximum weight in each constituent security such that no single stock has a weight greater than 33% and the top 3 stocks have a maximum combined weight of 62% at the time of rebalancing.

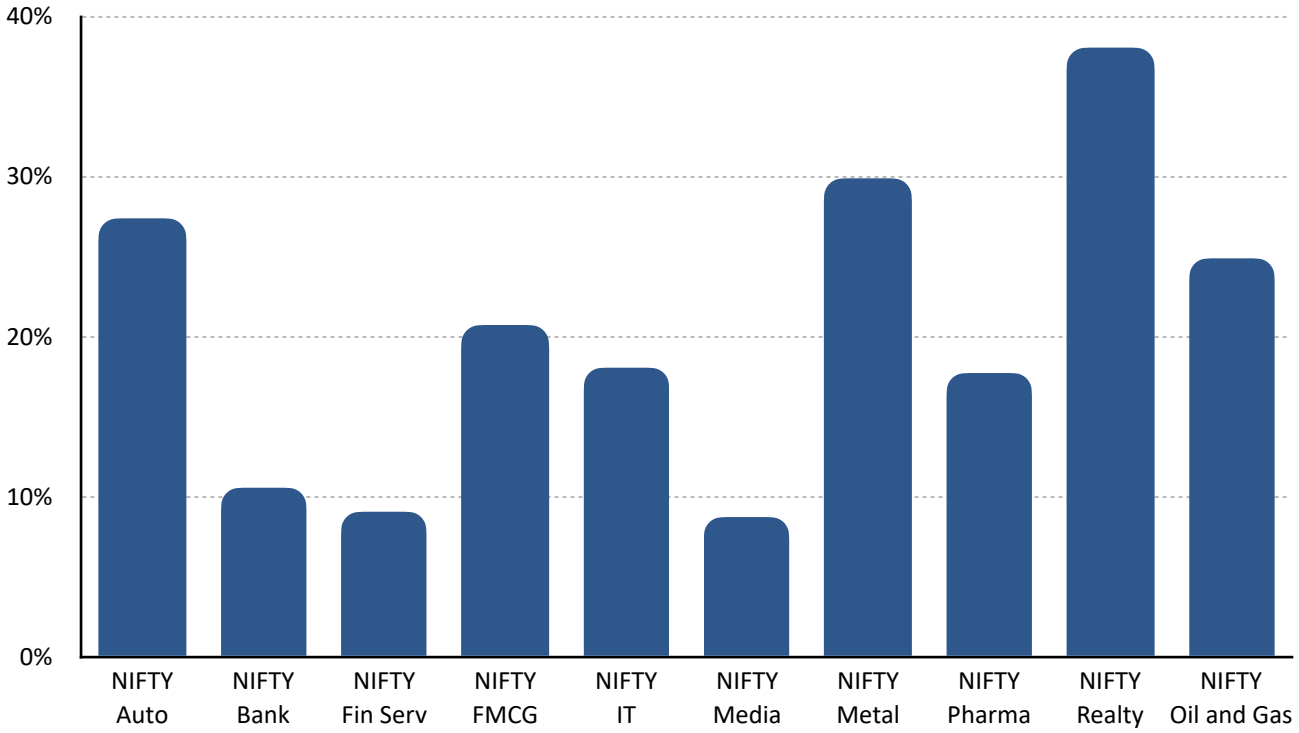

Figure 1: Three Year Return Performance of NIFTY Realty vis-à-vis Other Sectoral Indices

The offerings of the sector are of high value and are of the nature that witness capital appreciation (with real estate assets gaining value consistently over time). Moreover, with the volatility in business fundamentals, the sector is provides a prime investment opportunity for investors and more aggressive investors can tap into large profit potential due to their active portfolio management and greater risk appetite.

With this motivation, this report sets out to analyse the NIFTY Realty Index and its constituent securities in terms of different security and portfolio theories with an eventual objective of identifying a potentially more efficient or optimal portfolio of securities in the Realty Sector.

2
INDEX COMPOSITION

The NIFTY Realty Index is an NSE listed index comprising of the top 10 Realty Sector stocks forming part of the NIFTY 500. The NIFTY Realty Index is rebalanced semi-annually with cut-offs at 31st January and 31st July using average data on Realty Sector stocks for the previous six months (ending on the cut-off date). For our historical analysis of the NIFTY Realty Index, we identified the index composition as on 31st January 2024. Table 1 documents the details of the index's composition.

TABLE 1: NIFTY Realty Index Composition as on 31 January 2024

CONSTITUENT SECURITY	SECURITY CODE	WEIGHT (%)
DLF Ltd.	DLF	27.63%
Godrej Properties Limited	GODREJPROP	14.49%
Macrotech Developers Ltd.	LODHA	13.80%
Phoenix Mills Ltd.	PHOENIXLTD	12.04%
Prestige Estates Projects Ltd.	PRESTIGE	9.50%
Oberoi Realty Ltd.	OBEROIRLTY	8.24%
Brigade Enterprises Ltd.	BRIGADE	6.84%
Sobha Ltd.	SOBHA	2.79%
Swan Energy Ltd.	SWANENERGY	2.44%
Mahindra Lifespace Developers Ltd.	MAHLIFE	2.23%

Source: NIFTY Realty 31 January 2024 Factsheet (Refer Appendix B)

We also derive the summary statistics for the index - considered to be market in relation to the constituent securities - to facilitate the detailed analysis in subsequent chapters of the report.

TABLE 2: NIFTY Realty Index - Monthly Returns and Summary Statistics

DATE	CLOSING PRICE	RETURN
30-Apr-21	309.60	
31-May-21	336.15	8.58%
30-Jun-21	343.95	2.32%
30-Jul-21	398.65	15.90%
31-Aug-21	386.80	-2.97%

TABLE 2: NIFTY Realty Index - Monthly Returns and Summary Statistics		
DATE	CLOSING PRICE	RETURN
30-Sep-21	513.80	32.83%
29-Oct-21	498.70	-2.94%
30-Nov-21	487.60	-2.23%
31-Dec-21	484.15	-0.71%
31-Jan-22	480.25	-0.81%
28-Feb-22	436.40	-9.13%
31-Mar-22	463.55	6.22%
29-Apr-22	443.75	-4.27%
31-May-22	411.70	-7.22%
30-Jun-22	385.30	-6.41%
29-Jul-22	450.95	17.04%
30-Aug-22	463.20	2.72%
30-Sep-22	424.00	-8.46%
31-Oct-22	438.65	3.46%
30-Nov-22	450.15	2.62%
30-Dec-22	431.80	-4.08%
31-Jan-23	411.55	-4.69%
28-Feb-23	393.20	-4.46%
31-Mar-23	387.35	-1.49%
28-Apr-23	445.10	14.91%
31-May-23	478.80	7.57%
30-Jun-23	520.00	8.60%
31-Jul-23	566.75	8.99%
31-Aug-23	558.40	-1.47%
29-Sep-23	575.65	3.09%
31-Oct-23	603.00	4.75%
30-Nov-23	713.60	18.34%
29-Dec-23	783.05	9.73%
31-Jan-24	856.20	9.34%

Source: Yahoo Finance

E (R_M)		3.51%
SD_M (σ_M)		9.18%
Var_M (σ^2_M)		0.008430

3
SECURITY ANALYSIS

To commence the analysis of the portfolio under different relevant security and portfolio theories, we need to compute monthly returns, standard deviation and variance of the market portfolio (NIFTY Realty Index); and the monthly returns, standard deviation and variance of the constituent securities. The former has been performed in Chapter 2 of this report and in this chapter, we take a computational look at the latter. This analysis will then enable us to establish the relationship between each constituent security and the market - estimated through the statistical measures correlation and beta - which in turn will provide us with the key variables for executing models such as the Capital Asset Pricing Model (CAPM) and the Markowitz Model.

Tables 3A and 3B document the prices and Month-on-Month (MoM) returns of the securities constituting the NIFTY Realty Index. Our monthly analysis of the securities covers the month-ends from 30 April 2021 to 31 January 2024 (thus comprising of statistics for 33 months). This is because Macrotech Developers Ltd. (Lodha) was first listed on 19 April 2021 on the NSE and accordingly, 30 April 2021 is the first month-end for which complete data on all constituent securities was available. Table 4 then provides the summary statistics on these securities. The descriptions of the key statistical measures computed in this chapter are as follows:

1. **Average or Mean Return [E (R_i)]:** We have computed the ex-post average return for each security constituting the NIFTY Realty Index based on MoM returns using closing prices. The average or mean return [E (R_i)] is the simple average of the monthly returns observed for 33 months from 31 May 2021 to 31 January 2024.

2. **Variance of Returns (Var_i) (σ^2_i):** The variance is the average of the sum of squared differences of actual monthly returns from the mean return. It measures the dispersion of the actual returns in relation to the mean expected return.

3. **Standard Deviation of Returns (SD_i) (σ_i):** The standard deviation, in simplest terms, is the square root of the variance that gives the dispersion of monthly returns from the mean in percentage (%) form. It enables the comparable mean-variance analysis of securities.

4. **Correlation of Returns with Market ($Corr_{i,M}$) ($r_{i,M}$):** The correlation of security returns with the market measures the magnitude of relationship between the returns on the security and the market. It is essential to the computation of beta.

5. **Beta (β_i):** The beta is a more comprehensive measure of the systematic relationship between the security's return and the market. It is the degree to which the security's return are directly attributable to market returns.

TABLE 3A: Monthly Returns of NIFTY Realty Index Constituent Stocks										
DATE	OBEROIRLTY		PHOENIXLTD		MAHLIFE		DLF		SWANENERGY	
	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return
30-Apr-21	547.25		716.90		166.62		247.30		132.05	
31-May-21	605.45	10.63%	791.20	10.36%	174.12	4.50%	288.45	16.64%	136.90	3.67%
30-Jun-21	629.70	4.01%	815.15	3.03%	201.57	15.76%	281.10	-2.55%	140.65	2.74%
30-Jul-21	672.40	6.78%	863.65	5.95%	254.22	26.12%	337.65	20.12%	146.80	4.37%
31-Aug-21	703.60	4.64%	862.75	-0.10%	253.55	-0.26%	320.55	-5.06%	135.85	-7.46%
30-Sep-21	964.20	37.04%	958.45	11.09%	276.20	8.93%	417.20	30.15%	128.20	-5.63%
29-Oct-21	905.30	-6.11%	964.05	0.58%	275.20	-0.36%	398.60	-4.46%	127.00	-0.94%
30-Nov-21	832.75	-8.01%	947.85	-1.68%	256.40	-6.83%	374.80	-5.97%	117.45	-7.52%
31-Dec-21	861.80	3.49%	985.35	3.96%	242.60	-5.38%	390.45	4.18%	145.80	24.14%
31-Jan-22	915.80	6.27%	995.90	1.07%	250.60	3.30%	390.90	0.12%	167.70	15.02%
28-Feb-22	907.20	-0.94%	959.05	-3.70%	296.10	18.16%	350.75	-10.27%	161.00	-4.00%
31-Mar-22	939.85	3.60%	1,099.95	14.69%	395.20	33.47%	380.45	8.47%	194.25	20.65%
29-Apr-22	960.25	2.17%	1,086.45	-1.23%	378.40	-4.25%	371.85	-2.26%	322.25	65.89%
31-May-22	805.75	-16.09%	1,166.90	7.40%	372.80	-1.48%	345.55	-7.07%	284.00	-11.87%
30-Jun-22	737.65	-8.45%	1,183.70	1.44%	407.80	9.39%	312.70	-9.51%	184.35	-35.09%
29-Jul-22	910.15	23.39%	1,254.00	5.94%	400.20	-1.86%	385.95	23.43%	209.65	13.72%
30-Aug-22	1,006.85	10.62%	1,406.50	12.16%	518.85	29.65%	390.00	1.05%	203.60	-2.89%
30-Sep-22	917.80	-8.84%	1,399.10	-0.53%	472.00	-9.03%	356.70	-8.54%	223.50	9.77%
31-Oct-22	924.65	0.75%	1,427.85	2.05%	401.30	-14.98%	385.50	8.07%	226.50	1.34%

TABLE 3A: Monthly Returns of NIFTY Realty Index Constituent Stocks										
DATE	OBEROIRLTY		PHOENIXLTD		MAHLIFE		DLF		SWANENERGY	
	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return
30-Nov-22	923.90	-0.08%	1,458.45	2.14%	387.45	-3.45%	402.65	4.45%	244.00	7.73%
30-Dec-22	867.95	-6.06%	1,422.50	-2.46%	363.85	-6.09%	375.00	-6.87%	305.95	25.39%
31-Jan-23	820.95	-5.42%	1,368.65	-3.79%	347.45	-4.51%	356.05	-5.05%	330.50	8.02%
28-Feb-23	857.40	4.44%	1,383.10	1.06%	372.35	7.17%	351.65	-1.24%	254.55	-22.98%
31-Mar-23	842.60	-1.73%	1,300.95	-5.94%	352.10	-5.44%	356.70	1.44%	213.80	-16.01%
28-Apr-23	915.10	8.60%	1,445.70	11.13%	372.10	5.68%	426.20	19.48%	220.90	3.32%
31-May-23	930.75	1.71%	1,467.10	1.48%	450.25	21.00%	474.90	11.43%	239.15	8.26%
30-Jun-23	984.80	5.81%	1,563.35	6.56%	465.60	3.41%	490.55	3.30%	260.35	8.86%
31-Jul-23	1,119.55	13.68%	1,730.75	10.71%	517.20	11.08%	518.75	5.75%	219.40	-15.73%
31-Aug-23	1,120.85	0.12%	1,799.85	3.99%	567.50	9.73%	504.10	-2.82%	304.50	38.79%
29-Sep-23	1,154.35	2.99%	1,814.35	0.81%	550.05	-3.07%	530.90	5.32%	287.80	-5.48%
31-Oct-23	1,137.85	-1.43%	1,815.35	0.06%	490.85	-10.76%	563.50	6.14%	385.60	33.98%
30-Nov-23	1,400.85	23.11%	2,371.05	30.61%	528.25	7.62%	625.85	11.06%	422.90	9.67%
29-Dec-23	1,443.35	3.03%	2,244.65	-5.33%	543.45	2.88%	726.40	16.07%	511.00	20.83%
31-Jan-24	1,323.70	-8.29%	2,423.80	7.98%	561.25	3.28%	802.60	10.49%	639.05	25.06%

Source: Yahoo Finance

TABLE 3B: Monthly Returns of NIFTY Realty Index Constituent Stocks										
DATE	PRESTIGE		LODHA		SOBHA		GODREJPROP		BRIGADE	
	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return
30-Apr-21	271.85		296.85		486.10		1,368.35		250.40	
31-May-21	273.20	0.50%	315.58	6.31%	491.25	1.06%	1,369.70	0.10%	258.95	3.41%
30-Jun-21	289.55	5.98%	341.83	8.32%	471.05	-4.11%	1,397.80	2.05%	279.70	8.01%
30-Jul-21	340.65	17.65%	426.90	24.89%	596.25	26.58%	1,602.35	14.63%	326.25	16.64%
31-Aug-21	352.65	3.52%	479.25	12.26%	623.05	4.49%	1,489.00	-7.07%	334.45	2.51%
30-Sep-21	490.85	39.19%	528.75	10.33%	789.85	26.77%	2,311.90	55.27%	410.00	22.59%
29-Oct-21	426.10	-13.19%	532.10	0.63%	770.00	-2.51%	2,233.30	-3.40%	464.15	13.21%
30-Nov-21	421.75	-1.02%	708.90	33.23%	856.55	11.24%	1,996.70	-10.59%	502.45	8.25%
31-Dec-21	474.75	12.57%	616.78	-12.99%	895.45	4.54%	1,871.80	-6.26%	490.30	-2.42%
31-Jan-22	488.30	2.85%	647.08	4.91%	851.10	-4.95%	1,715.15	-8.37%	499.85	1.95%
28-Feb-22	453.70	-7.09%	563.75	-12.88%	772.90	-9.19%	1,502.15	-12.42%	496.95	-0.58%
31-Mar-22	493.80	8.84%	563.10	-0.12%	707.75	-8.43%	1,672.20	11.32%	516.85	4.00%
29-Apr-22	474.65	-3.88%	504.55	-10.40%	648.50	-8.37%	1,573.45	-5.91%	455.80	-11.81%
31-May-22	429.15	-9.59%	484.13	-4.05%	549.60	-15.25%	1,399.50	-11.06%	464.65	1.94%
30-Jun-22	387.15	-9.79%	534.50	10.40%	577.05	4.99%	1,182.95	-15.47%	444.40	-4.36%
29-Jul-22	413.65	6.84%	572.25	7.06%	700.15	21.33%	1,507.60	27.44%	493.55	11.06%
30-Aug-22	457.40	10.58%	548.50	-4.15%	698.80	-0.19%	1,407.70	-6.63%	512.25	3.79%
30-Sep-22	449.80	-1.66%	462.10	-15.75%	645.75	-7.59%	1,193.90	-15.19%	508.70	-0.69%
31-Oct-22	442.00	-1.73%	495.08	7.14%	627.05	-2.90%	1,263.00	5.79%	499.55	-1.80%

TABLE 3B: Monthly Returns of NIFTY Realty Index Constituent Stocks

DATE	PRESTIGE		LODHA		SOBHA		GODREJPROP		BRIGADE	
	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return	Cl. Price	Return
30-Nov-22	474.70	7.40%	492.65	-0.49%	624.75	-0.37%	1,305.15	3.34%	486.25	-2.66%
30-Dec-22	463.55	-2.35%	545.42	10.71%	576.10	-7.79%	1,224.70	-6.16%	465.05	-4.36%
31-Jan-23	419.10	-9.59%	511.17	-6.28%	599.65	4.09%	1,181.60	-3.52%	459.25	-1.25%
28-Feb-23	405.95	-3.14%	410.10	-19.77%	576.20	-3.91%	1,100.40	-6.87%	487.65	6.18%
31-Mar-23	403.20	-0.68%	465.15	13.42%	430.60	-25.27%	1,031.05	-6.30%	474.70	-2.66%
28-Apr-23	490.70	21.70%	464.45	-0.15%	458.55	6.49%	1,315.25	27.56%	501.90	5.73%
31-May-23	483.25	-1.52%	545.45	17.44%	520.65	13.54%	1,390.30	5.71%	562.60	12.09%
30-Jun-23	574.85	18.95%	679.80	24.63%	537.00	3.14%	1,568.45	12.81%	575.20	2.24%
31-Jul-23	588.60	2.39%	759.35	11.70%	619.80	15.42%	1,740.50	10.97%	591.70	2.87%
31-Aug-23	644.15	9.44%	670.35	-11.72%	610.35	-1.52%	1,645.80	-5.44%	592.80	0.19%
29-Sep-23	602.60	-6.45%	799.95	19.33%	705.65	15.61%	1,554.10	-5.57%	567.85	-4.21%
31-Oct-23	765.70	27.07%	787.70	-1.53%	712.85	1.02%	1,659.65	6.79%	615.45	8.38%
30-Nov-23	1,002.90	30.98%	881.70	11.93%	907.25	27.27%	1,876.70	13.08%	816.25	32.63%
29-Dec-23	1,178.90	17.55%	1,023.55	16.09%	985.70	8.65%	2,013.35	7.28%	896.75	9.86%
31-Jan-24	1,265.40	7.34%	1,070.10	4.55%	1,447.75	46.88%	2,377.15	18.07%	1,025.25	14.33%

Source: Yahoo Finance

TABLE 4: Summary Statistics of NIFTY Realty Index Constituent Stocks

	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
E (R_i)	3.19%	3.98%	4.34%	4.10%	6.54%	5.44%	4.70%	4.27%	2.61%	4.70%
SD_i (σ_i)	10.43%	7.15%	11.59%	10.25%	19.23%	12.42%	12.54%	14.26%	14.74%	8.72%
Var_i (σ^2_i)	0.010880	0.005117	0.013426	0.010516	0.036992	0.015436	0.015714	0.020345	0.021732	0.007601
$Corr_{i.M}$ ($r_{i,M}$)	0.812917	0.596804	0.262377	0.933113	0.048681	0.790242	0.417061	0.679904	0.937267	0.706221
$Beta_i$ (β_i)	0.923551	0.464980	0.331128	1.042197	0.101978	1.069357	0.569413	1.056248	1.504906	0.670595

E (R_M)	3.51%
SD_M (σ_M)	9.18%
Var_M (σ^2_M)	0.008430

Prima facie, we observe that:

1. The stock of Swan Energy Ltd. offers the highest average monthly return. However, its risk (measured by standard deviation) is also the highest across the securities.

2. The stock of Godrej Properties Limited offers the lowest average monthly return for a comparatively high risk of 14.74%, making the stocks of Sobha Ltd., Brigade Enterprises Ltd., Macrotech Developers Ltd. (Lodha), Prestige Estates Projects Ltd., DLF Ltd., Mahindra Lifespace Developers Ltd., Phoenix Mills Ltd., and Oberoi Realty Ltd. clearly superior to that of Godrej Properties Limited.

3. The stocks of Phoenix Mills Ltd., DLF Ltd., and Brigade Enterprises Ltd. are all superior to the stock of Oberoi Realty Ltd. as they all offer higher returns for a lesser risk.

4. A more detailed analysis about how the securities perform vis-à-vis their respective expected returns based on the Capital Asset Pricing Model (CAPM) is performed in the chapter that follows.

4
SECURITY ANALYSIS - CAPM

The key premise behind the Capital Asset Pricing Model (CAPM) is that assets (in this case, securities) should provide an excess return that is proportionate to how they are systematically affected by the market. In other words, investors must be rewarded for the systematic risk (measured through beta) because it is non-diversifiable.

The risk-free rate of return is the minimum rate of return desired by all investors. The market provides an excess return - called the market risk premium - for a beta = 1. Thus, a security's return in excess of risk-free rate of return must be a multiple of the market risk premium based on its beta.

As per CAPM, the theoretical expected return of a security is the sum of the risk-free rate of return and the beta multiple of the market risk premium. It is this premise on which the securities constituting the NIFTY Realty Index have been analysed in this chapter.

The above theory lays down some key presumptions about the expectations from our analysis. These are summarised below:

1. No security will have an annualised theoretical (CAPM) expected return that is less than the annualised risk-free rate. In our analysis, the risk-free rate has been taken as 7.15% based on the G-Sec par yield for a 2.75 year (33 months) tenor.

2. The NIFTY Realty Index is considered to be the "market" in relation to its constituent securities. In our analysis in Chapter 2, we identified the average monthly return of the market as 3.51%. This equates to 51.20% annualised market return.

3. The higher the beta, the higher would be the theoretical expected return of the security. Accordingly, Godrej Properties Limited would have the highest expected return under CAPM and Swan Energy Ltd. would have the lowest expected return under CAPM.

4. Since we identified Swan Energy Ltd. to have the highest average monthly return (historical), this would indicate that its stock significantly outperforms its theoretical expectations. In other words, its average returns (historical) would significantly exceed the theoretical (CAPM) returns.

5. We also identified Godrej Properties Limited to have the lowest average monthly return (historical), which given that it has the highest beta indicates that its stock would significantly underperform in comparison to its theoretical expectations. In other words, its average returns (historical) would be significantly less than the theoretical (CAPM) returns.

Table 5 captures the computation of the CAPM returns of the securities.

TABLE 5: Computation of CAPM Returns of Securities and Identification of Inconsistencies in Valuation			
R_F	=	7.15%	(Annualised)
R_M	=	3.51%	(Monthly)
R_M	=	51.20%	(Annualised)

	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
E (R_i) (Monthly)	3.19%	3.98%	4.34%	4.10%	6.54%	5.44%	4.70%	4.27%	2.61%	4.70%
E (R_i) (Annualised)	45.85%	59.82%	66.57%	62.05%	113.76%	88.93%	73.47%	65.08%	36.16%	73.51%
SD_i (σ_i)	10.43%	7.15%	11.59%	10.25%	19.23%	12.42%	12.54%	14.26%	14.74%	8.72%
Var_i (σ^2_i)	0.010880	0.005117	0.013426	0.010516	0.036992	0.015436	0.015714	0.020345	0.021732	0.007601
$Corr_{i.M}$ ($r_{i,M}$)	0.812917	0.596804	0.262377	0.933113	0.048681	0.790242	0.417061	0.679904	0.937267	0.706221
$Beta_i$ (β_i)	0.923551	0.464980	0.331128	1.042197	0.101978	1.069357	0.569413	1.056248	1.504906	0.670595
CAPM E (R_i) (Annualised)	47.84%	27.63%	21.74%	53.06%	11.64%	54.26%	32.23%	53.68%	73.45%	36.69%
E(R)__CAPM	<	>	>	>	>	>	>	>	<	>
Valuation	Overvalued	Undervalued	Undervalued	Undervalued	Undervalued	Undervalued	Undervalued	Undervalued	Overvalued	Undervalued
Conclusion	Sell	Buy	Buy	Buy	Buy	Buy	Buy	Buy	Sell	Buy

We observe the following:

1. Compared to the annualised average market return and the annualised average returns (historical) of the respective securities, the annualised risk-free rate of return (R_F) is quite low. Thus, R_F, as an individual component of the CAPM equation does not have a significant effect in bringing up the CAPM return of the securities.

   However, the low R_F also implies that market risk premium will be high. For securities with a high beta, this would represent a potential for high expected return under CAPM. For securities with low beta, this would not do much to substantially increase the expected return under CAPM, especially if their average returns (historical) are substantially higher than market risk premium. This is true for most of the securities constituting the NIFTY Realty Index (see point 5 below).

2. Consistent with our earlier presumptions, Swan Energy Ltd. has the lowest expected return under CAPM and Godrej Properties Limited has the highest expected return under CAPM.

3. Securities with average returns (historical) lower than CAPM expected return will be discounted at a lower rate and thus would be overvalued in individual analysis based on historical average returns. These securities would consequently be sold.

4. In our analysis, we identify the stocks of Oberoi Realty Ltd. and Godrej Properties Limited as being overvalued. The average returns (historical) of these securities are less than their CAPM returns. Their CAPM returns are higher because the market risk premium is significantly high in comparison to their average returns, which when multiplied by their respective betas is sufficient to explain a higher CAPM return.

5. Phoenix Mills, Mahindra Lifespace, DLF, Swan Energy, Prestige, Macrotech, Sobha and Brigade are all undervalued because their average returns (historical) are very high and their betas are relatively low. These betas are not high enough to increase the market risk premium multiple to be comparable to the average returns (the market risk premium itself is much lower compared to the average returns of these securities).

6. Thus, while the market risk premium may be high for normal expectations, the relatively low beta for the majority securities comprising the index is insufficient to bring about a high multiple increase in the risk premium to significantly add to the risk-free rate for determining CAPM return.

7. Finally, the above findings are demonstrated graphically in Figure 2. The Security Market Line (SML) is the graphical representation of the expected returns under CAPM at different values of beta for the applicable values of R_F (7.15%) and R_M (51.20%). Theoretically, the securities constituting the NIFTY Realty Index should have lied on this line, if they were CAPM compliant on 31 January 2024 for a historical period of 34 months (from 30 April 2021).

However, a mispricing exists and thus, the securities' average returns are not the same as their expected CAPM returns. They thus lie outside the SML with some (like Swan Energy Ltd.) significantly differing from expectations.

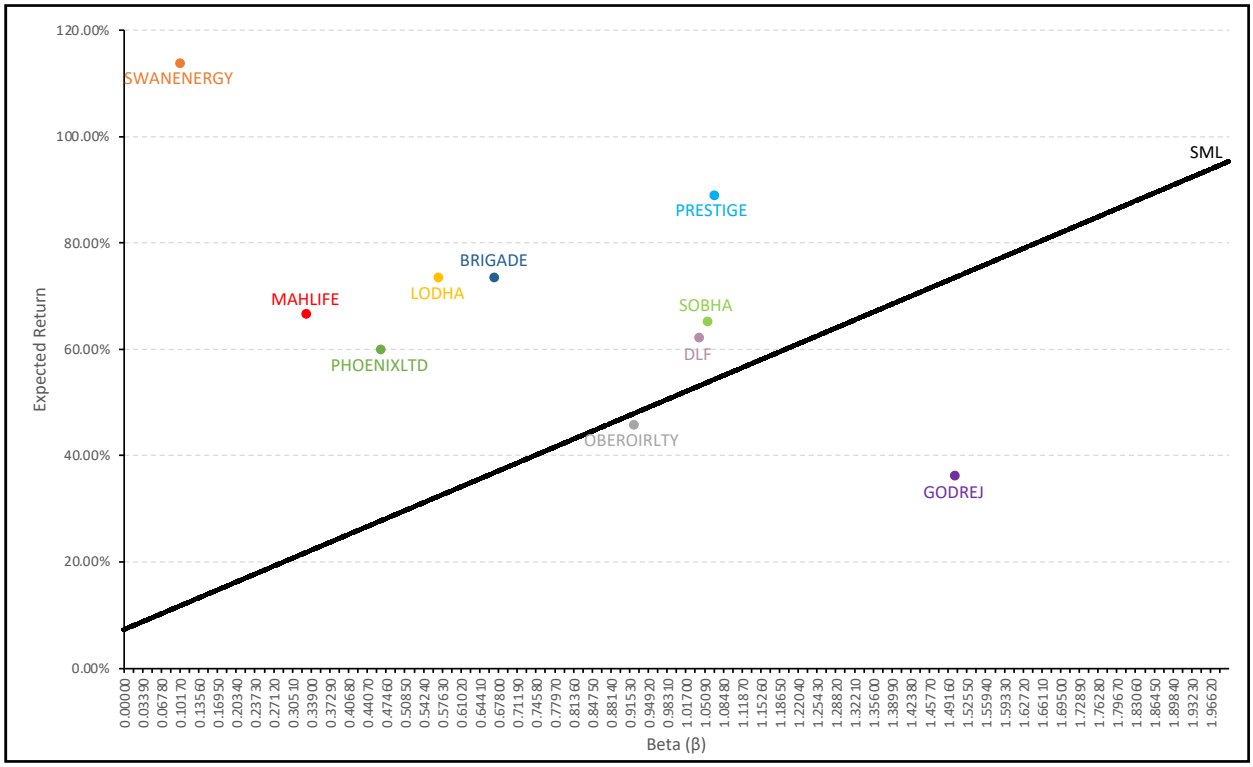

Figure 2: The Security Market Line for Securities Constituting the NIFTY Realty Index

5
INDEX ANALYSIS - MARKOWITZ MODEL

Having analysed the individual securities constituting the index, we now look at models that help us analyse the overall index performance. In this chapter, we use the Markowitz Model of Risk-Return Optimisation to:

1. Understand how the NIFTY Realty Index portfolio is diversified through its constituent securities;
2. Identify the minimum variance portfolio for the given list of securities; and
3. Plot the feasible set and efficient frontier of portfolios for the combination of securities under the model.

5.1 ADDITIONAL DATA REQUIREMENTS

The Markowitz Model is largely driven by the concept of diversification. Diversification refers to the reduction in the overall risk of a portfolio by investing in less correlated or negatively correlated securities. By investing in negatively correlated securities, the risk is minimised due to a reduction in the term "$2 \cdot w_a \cdot w_b \cdot \sigma_a \cdot \sigma_b \cdot r_{ab}$" in the formula for variance/ standard deviation (for complete formula and effect of diversification, refer Appendix C).

This presents us with a new data/variable requirement for this chapter - the computation of covariance (cov) and coefficient of correlation (r) between each pair of securities constituting the index. The covariance is derived as the sum of the product of monthly differences of the two securities from their respective average returns; divided by "n-1" number of observations.

While the covariance helps to identify co-movement between the returns of the two securities, the correlation further quantifies this relationship on a scale from perfectly positively correlated (r = +1) to perfectly negatively correlated (r = -1). The coefficient of correlation is derived by dividing the covariance by the standard deviations of the two securities whose relationship is being quantified.

These variables will then help us to compute and analyse how the risk of a portfolio comprising of the identified constituent securities differs as the weights of these securities change in the portfolio. In other words, we will be able to identify the effects of diversification in a portfolio comprising of the identified securities.

The results of computation of covariance and coefficient of correlation has been summarised in Tables 6 (Variance-Covariance Matrix) and 7 (Correlation Matrix) below (refer attached excel for complete computation).

TABLE 6: Variance-Covariance Matrix

	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
OberoiRlty	0.010880	0.004191	0.003504	0.007793	-0.000217	0.008679	0.002175	0.006392	0.011228	0.004744
PhoenixLtd	0.004191	0.005117	0.003458	0.003308	-0.000348	0.004784	0.000569	0.004431	0.005086	0.003709
MahLife	0.003504	0.003458	0.013426	0.002335	-0.003236	0.002669	0.000681	0.002567	0.003152	0.003099
DLF	0.007793	0.003308	0.002335	0.010516	0.002200	0.008656	0.004030	0.008691	0.013207	0.005058
SwanEnergy	-0.000217	-0.000348	-0.003236	0.002200	0.036992	0.005817	-0.005937	0.000761	0.002625	-0.001686
Prestige	0.008679	0.004784	0.002669	0.008656	0.005817	0.015436	0.002964	0.008018	0.013403	0.006562
Lodha	0.002175	0.000569	0.000681	0.004030	-0.005937	0.002964	0.015714	0.007130	0.004999	0.003496
Sobha	0.006392	0.004431	0.002567	0.008691	0.000761	0.008018	0.007130	0.020345	0.012774	0.008080
GodrejProp	0.011228	0.005086	0.003152	0.013207	0.002625	0.013403	0.004999	0.012774	0.021732	0.007877
Brigade	0.004744	0.003709	0.003099	0.005058	-0.001686	0.006562	0.003496	0.008080	0.007877	0.007601

TABLE 7: Correlation Matrix

	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
OberoiRlty	1.000000	0.561650	0.289940	0.728552	-0.010814	0.669706	0.166369	0.429619	0.730192	0.521652
PhoenixLtd	0.561650	1.000000	0.417213	0.450953	-0.025295	0.538283	0.063441	0.434262	0.482323	0.594717
MahLife	0.289940	0.417213	1.000000	0.196530	-0.145197	0.185396	0.046876	0.155336	0.184527	0.306726
DLF	0.728552	0.450953	0.196530	1.000000	0.111553	0.679385	0.313467	0.594168	0.873650	0.565786
SwanEnergy	-0.010814	-0.025295	-0.145197	0.111553	1.000000	0.243446	-0.246247	0.027742	0.092598	-0.100531
Prestige	0.669706	0.538283	0.185396	0.679385	0.243446	1.000000	0.190308	0.452427	0.731799	0.605840
Lodha	0.166369	0.063441	0.046876	0.313467	-0.246247	0.190308	1.000000	0.398750	0.270539	0.319911
Sobha	0.429619	0.434262	0.155336	0.594168	0.027742	0.452427	0.398750	1.000000	0.607506	0.649740
GodrejProp	0.730192	0.482323	0.184527	0.873650	0.092598	0.731799	0.270539	0.607506	1.000000	0.612899
Brigade	0.521652	0.594717	0.306726	0.565786	-0.100531	0.605840	0.319911	0.649740	0.612899	1.000000

5.2 STATISTICAL BACKGROUND AND METHODOLOGY

We briefly summarise the methodology of deriving Tables 6 and 7 in excel:

1. As described, the covariance is the sum of the product of monthly differences of the two securities from their respective average returns; divided by "n-1" number of observations. Accordingly, we prepare a matrix that lists for each security, the difference of its monthly return from its average return (refer cell range M2:V36 on tab <Summary> in the attached excel file). This range of values (cell range M4:V36) is given the reference "RER".

   The variance-covariance matrix is then populated by taking a matrix multiplication of the range "RER" and its transpose; and dividing it by "n-1" (n being 33 observations for 33 months in our analysis) (refer tab <Summary Statistics> in the attached excel file). The range of values in the variance-covariance matrix (cell range D15:M24 on the tab <Summary Statistics>) is given the reference "VARCOVAR" which is referenced in the formula for the correlation matrix.

2. The correlation matrix is then populated by dividing the values in the variance-covariance matrix by the standard deviations of the corresponding securities. For ease of computation, the denominator is derived by matrix multiplication of the range of standard deviations and its transpose.

5.3 PORTFOLIO CREATION

With the data from Tables 6 and 7, we can now construct different portfolios using the identified securities by varying their weights and compute the risk and return of these portfolios to observe how these change over the different composition characteristics.

We start with a basic, equal weighted portfolio that involves investing equally in each of the 10 securities (10% weight for each security). Table 8 documents the risk and return of such portfolio.

We then create a portfolio that mirrors the current index weights and call this our iteration of the "market portfolio". This portfolio uses weights for investment in each security according to Table 1 (Chapter 2 of this report). Table 9 documents the risk and return of such portfolio.

We then use the solver add-in on excel to identify the weights of investment in each security that will provide us the minimum variance portfolio. Table 10 documents the weights identified for each security and the risk and return of such a portfolio. Consistent with our CAPM analysis, Oberoi Realty Ltd. and Godrej Properties Limited have been excluded from the minimum variance portfolio. Additionally, based on the data for the 33 months, the stocks of DLF Ltd., Prestige Estates Projects Ltd. and Sobha Ltd. have also been excluded from the minimum variance portfolio.

TABLE 8: Risk and Return of Equal Weighted Portfolio

	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
E (R_i) (Monthly)	3.19%	3.98%	4.34%	4.10%	6.54%	5.44%	4.70%	4.27%	2.61%	4.70%
SD_i (σ_i)	10.43%	7.15%	11.59%	10.25%	19.23%	12.42%	12.54%	14.26%	14.74%	8.72%
Var_i (σ^2_i)	0.010880	0.005117	0.013426	0.010516	0.036992	0.015436	0.015714	0.020345	0.021732	0.007601
Weight	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%

E (R_P) (Monthly)	4.39%
E (R_P) (Annualised)	67.41%
SD_P (σ_P)	7.51%
Var_P (σ^2_P)	0.005647

TABLE 9: Risk and Return of Market Weight Portfolio

	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
E (R_i) (Monthly)	3.19%	3.98%	4.34%	4.10%	6.54%	5.44%	4.70%	4.27%	2.61%	4.70%
SD_i (σ_i)	10.43%	7.15%	11.59%	10.25%	19.23%	12.42%	12.54%	14.26%	14.74%	8.72%
Var_i (σ^2_i)	0.010880	0.005117	0.013426	0.010516	0.036992	0.015436	0.015714	0.020345	0.021732	0.007601
Weight	8.24%	12.04%	2.23%	27.63%	2.44%	9.50%	13.80%	2.79%	14.49%	6.84%

E (R_P) (Monthly)	4.12%
E (R_P) (Annualised)	62.28%
SD_P (σ_P)	8.35%
Var_P (σ^2_P)	0.006980

TABLE 10: Risk and Return of Minimum Variance Portfolio										
	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
E (R_i) (Monthly)	3.19%	3.98%	4.34%	4.10%	6.54%	5.44%	4.70%	4.27%	2.61%	4.70%
SD_i (σ_i)	10.43%	7.15%	11.59%	10.25%	19.23%	12.42%	12.54%	14.26%	14.74%	8.72%
Var_i (σ^2_i)	0.010880	0.005117	0.013426	0.010516	0.036992	0.015436	0.015714	0.020345	0.021732	0.007601
Weight	0.00%	46.60%	11.87%	0.00%	13.61%	0.00%	21.29%	0.00%	0.00%	6.63%

E (R_P) (Monthly)	4.57%
E (R_P) (Annualised)	71.03%
SD_P (σ_P)	5.58%
Var_P (σ^2_P)	0.003115

We observe the effects of diversification as follows:

1. On an individual security basis, the stock of Swan Energy Ltd. offers the highest return of 6.54% but also at the highest risk of 19.23%.

2. The widely observed range of return of 4%-5% comes with a risk ranging from 8.72% to 14.26%.

3. However, even in an equal weighted portfolio, better risk-return combination is achieved with 4.39% return (monthly) at a standard deviation of 7.51%, a significantly lower level of risk compared to any individual security offering a return between 4 and 5% (closest example being Mahindra Lifespace Developers Ltd. offering 4.34% return at a standard deviation of 11.59%).

4. This risk-return combination is further optimised in the minimum variance portfolio which offers a 4.57% return at a standard deviation of 5.58% (a significantly lower level of risk compared to any individual security and the equal weighted portfolio). However, this minimum variance portfolio has been derived without allowing any short-selling.

5. Of these three initial portfolio combinations, the market weight portfolio has a relatively (but not significantly) lower return of 4.12% but at a comparatively significantly higher standard deviation of 8.35%. However, we must note that this is due to the index's condition of assigning weights proportionate to the market cap of the selected securities, with rebalancing performed only every 6 months (during which security risk-return characteristics may change significantly).

   Nonetheless, the market weight portfolio also achieves a better risk-return combination than any individual security.

5.4 KEY CONSIDERATION

It must be noted, however, that the above results have been achieved for a historical analysis spanning 33 months. If a different time period was considered, the results may differ (slightly or even significantly depending on the skewness of data within the time period chosen). As such, while the market weight portfolio may not be the best in terms of diversification in the instant case, it may fare better (if not best) for a different time horizon analysis.

5.5 EFFICIENT FRONTIER

Based on the knowledge and computational work performed in this section, we then proceed to identifying the feasible set and accordingly plotting the efficient frontier for the securities constituting the NIFTY Realty Index. Since we have a larger number of securities than what is used for textbook analysis of efficient frontiers (which generally use 2-3 securities only), we will need a fairly large number of portfolio combinations using the ten identified securities in order to get the best resemblance of the efficient frontier.

Too few trials will give a more dispersed scatter plot of feasible set, in which many portfolios, possibly those on the efficient frontier may not get plotted. To perform the best analysis possible with the resources at hand, we run the maximum number of trials possible with the row count on excel as reduced by two header rows. We run a trial of 10,48,574 portfolio combinations using different weights for the securities using a random array function. The process is described below:

1. Refer tab <Markowitz> in the attached excel file. We create a table with the names of the securities as column headers. We then insert a random array in the first row in the table that fills in random values for each security.

2. The sum of these random values is taken in the cell adjacent to the random value of the last security. Since this value may not necessarily sum up to 1, we calculate weights as the ratio of the random value assigned to a security to the sum of random values.

3. The expected return of the portfolio is calculated using the "SUMPRODUCT" function on the weights and security returns. The standard deviation now uses the weights from this table with the "VARCOVAR" range referenced as before, and variance is calculated as the square of the standard deviation.

4. A short version of 25,000 trials is run on the tab <Markowitz>. However, due to the number of securities and thus the very large number of possible feasible set portfolios, this does not give us a complete efficient portfolio (see tab <Efficient Frontier>).

5. We thus run a larger version of 10,48,574 trials on the tab <10 lakh portfolio trials> which gives us a much better feasible set with a more representative efficient frontier for the securities in our analysis. These portfolio combinations have been plotted on the graph on the tab <Complete Efficient Portfolio>. Figure 3 below also shows this graph of feasible set and efficient frontier.

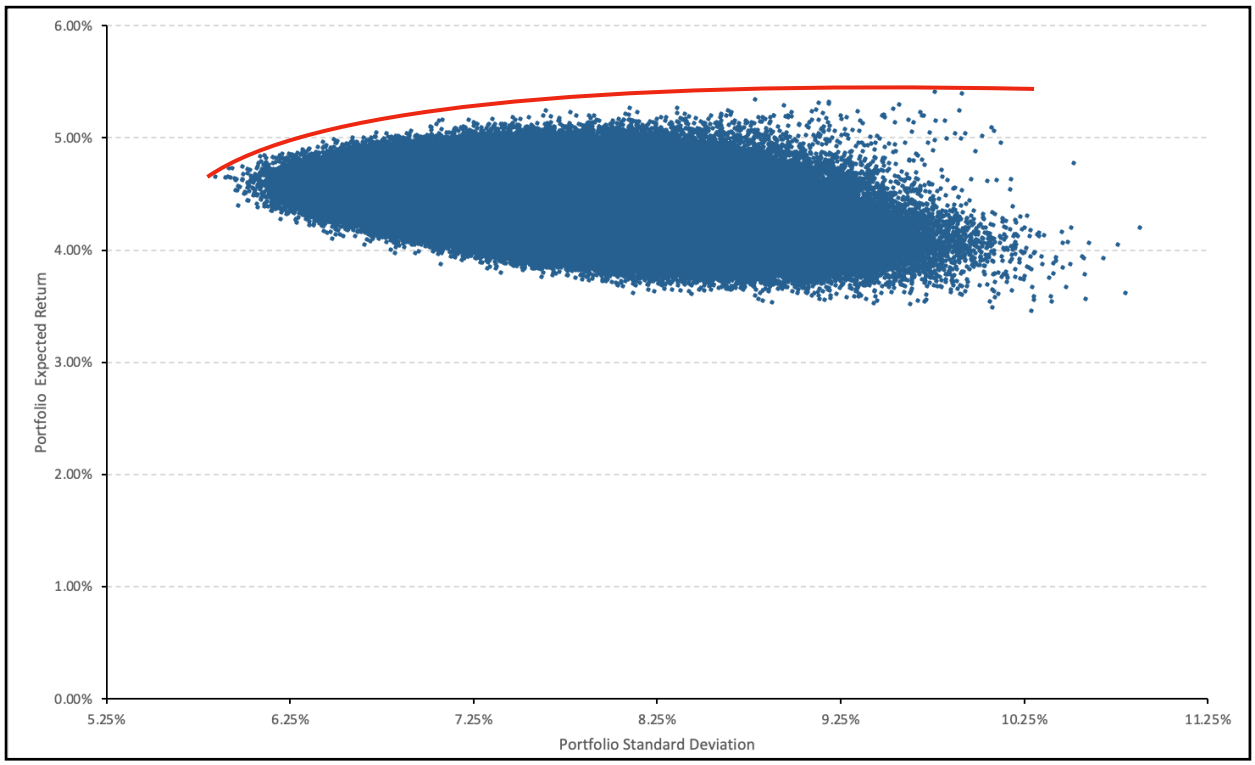

Figure 3: Feasible Set and Efficient Frontier for the Securities Constituting NIFTY Realty Index

6. While we achieved a better efficient frontier due to the large number of trials, there are still gaps in the scatter plot. However, this will require a more computationally efficient device and advance financial analysis softwares or tools that will be able to compute and plot such a large number of portfolio combinations simultaneously.

7. For our purpose, the efficient frontier derived is satisfactory as the extreme left point is close to the identified minimum variance portfolio and thus, is effective in communicating our observations about the effect of diversification on portfolio risk and return and identifying the lower risk portfolios.

8. The efficient frontier derived also suggests that for the time period analysed, the market weight portfolio currently does not lie on the efficient frontier as for a standard deviation of 8.35% (the standard deviation of market weight portfolio), the efficient frontier is above the 5% return mark whereas the market weight portfolio currently offers a return of only 4.12%. Thus, for this analysis period, the market weight portfolio may be considered to be inefficient.

6

INDEX ANALYSIS - ARBITRAGE PRICING THEORY

Our analysis in previous chapters limits the causal relationship of a security's returns to the market only. While the market may be the most important and significant factor affecting security returns, there may be other factors affecting security returns too. Thus, having established the relationship between the index (market) and its constituent securities, we now turn to the Arbitrage Pricing Theory (APT) to consider more factors in our analysis of security returns.

6.1 APT BACKGROUND

The APT equation provides that a security's returns are a sum of:

1. A constant (λ_0) that represents the risk-free rate. This is the minimum return desired by any investor on an investment. Returns in excess of the risk-free rate are proportionate to the sensitivity of the stock to the corresponding factor.

2. The value for factor 1 (λ_1) as multiplied by the security's sensitivity to the factor (β_1).

3. The value for factor 2 (λ_2) as multiplied by the security's sensitivity to the factor (β_2).

4. And so on for the number of factors affecting a security or group of security's returns.

6.2 IDENTIFICATION OF FACTORS

Since the index considered in our analysis relates to the realty sector, we identified the following relevant factors (summarised in Table 11 thereafter):

1. **Real GDP Growth Rate:** It is an economic indicator that provides a general and fair expectation of overall economic and sectoral growth. Realty/ real estate being a key sector in India with high value transactions and that involves high financial participation from a number of economic participants, GDP growth rate would be a good factor to assess how the companies in the sector are responding to general economic conditions.

2. **Inflation:** Inflation, in simple terms, is the rate of sustained increases in price levels in the country. Owing to the high value nature of transactions in the sector, even small changes in inflation could mean a large change in amount (rupee terms) in the transaction values and this could be significant for business performance.

3. **Infrastructure Sector Output Growth:** It measures the growth in output of key infrastructure sectors - including cement and steel production and electricity generation - which are closely related to (support or enable) the activities of the sector in consideration. Thus, it may be appropriate to see if all these sectors are facilitating a cumulative growth.

4. **Market Risk Premium:** Since the market is one of the most direct, important and significant factors that affects the returns of a security, we continue to use it as a relevant factor in our APT model.

TABLE 11: List of Factors for APT Model

FACTOR NAME	FACTOR LABEL	BETA LABEL
Market Risk Premium	λ_1	β_1
Real GDP Growth Rate	λ_2	β_2
Inflation	λ_3	β_3
Infrastructure Sector Output Growth	λ_4	β_4

6.3 METHODOLOGY

For the analysis of the index under APT, we are using quarterly returns data using the pricing information extracted for the purposes of previous chapters. This is because most macroeconomic data is available at annual or quarterly intervals and using quarterly intervals will help us get a better distribution of returns data. The quarterly data for each factor is given in Table 12 below.

TABLE 12: Quarterly Data for Factors in APT Model

QUARTER	Q END DATE	REAL GDP GROWTH RATE	INFLATION	INFRA SECTOR O/P GROWTH	MKT RETURN (QUARTERLY)
Q4 2020-21	31-Mar-21	3.40%	5.52%	12.60%	6.45%
Q1 2021-22	30-Jun-21	21.60%	6.26%	9.40%	2.93%
Q2 2021-22	30-Sep-21	9.10%	4.35%	5.40%	49.38%
Q3 2021-22	31-Dec-21	5.20%	5.66%	4.10%	-5.77%
Q4 2021-22	31-Mar-22	4.00%	6.95%	4.80%	-4.25%
Q1 2022-23	30-Jun-22	12.80%	7.01%	13.10%	-16.88%
Q2 2022-23	30-Sep-22	5.50%	7.41%	8.30%	10.04%
Q3 2022-23	30-Dec-22	4.30%	5.72%	8.30%	1.84%
Q4 2022-23	31-Mar-23	6.20%	5.66%	4.20%	-10.29%
Q1 2023-24	30-Jun-23	8.20%	4.87%	8.40%	34.25%
Q2 2023-24	29-Sep-23	8.10%	5.02%	9.40%	10.70%
Q3 2023-24	29-Dec-23	8.40%	5.69%	4.90%	36.03%
					9.54%

We continue to use an annualised risk-free rate (R_F) of 7.15%. This equates to a quarterly rate of 1.74%. From Table 12, the average quarterly market return is 9.54%, giving the relevant market risk premium of 7.79%.

Tables 13 and 14 that follow, then proceed to document the quarterly price and return data respectively of the constituent securities.

TABLE 13: Quarterly Price Data for Securities Constituting NIFTY Realty Index

DATE	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
01-Jan-21	584.00	779.00	122.18	232.85	134.70	267.45		409.90	1,432.00	249.10
31-Mar-21	575.15	780.65	189.78	287.05	135.55	305.60		436.95	1,406.75	277.85
30-Apr-21	547.25	716.90	166.62	247.30	132.05	271.85	234.00	486.10	1,368.35	250.40
30-Jun-21	629.70	815.15	201.57	281.10	140.65	289.55	341.83	471.05	1,397.80	279.70
30-Sep-21	964.20	958.45	276.20	417.20	128.20	490.85	528.75	789.85	2,311.90	410.00
31-Dec-21	861.80	985.35	242.60	390.45	145.80	474.75	616.78	895.45	1,871.80	490.30
31-Mar-22	939.85	1099.95	395.20	380.45	194.25	493.80	563.10	707.75	1,672.20	516.85
30-Jun-22	737.65	1183.70	407.80	312.70	184.35	387.15	534.50	577.05	1,182.95	444.40
30-Sep-22	917.80	1399.10	472.00	356.70	223.50	449.80	462.10	645.75	1,193.90	508.70
30-Dec-22	867.95	1422.50	363.85	375.00	305.95	463.55	545.42	576.10	1,224.70	465.05
31-Mar-23	842.60	1,300.95	352.10	356.70	213.80	403.20	465.15	430.60	1,031.05	474.70
30-Jun-23	984.80	1,563.35	465.60	490.55	260.35	574.85	679.80	537.00	1,568.45	575.20
29-Sep-23	1,154.35	1,814.35	550.05	530.90	287.80	602.60	799.95	705.65	1,554.10	567.85
29-Dec-23	1,443.35	2,244.65	543.45	726.40	511.00	1,178.90	1,023.55	985.70	2,013.35	896.75

TABLE 14: Quarterly Returns Data and Summary Statistics for Securities Constituting NIFTY Realty Index										
	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
31-Mar-21	-1.52%	0.21%	55.33%	23.28%	0.63%	14.26%		6.60%	-1.76%	11.54%
30-Jun-21	9.48%	4.42%	6.21%	-2.07%	3.76%	-5.25%	58.24%	7.80%	-0.64%	0.67%
30-Sep-21	53.12%	17.58%	37.02%	48.42%	-8.85%	69.52%	54.68%	67.68%	65.40%	46.59%
31-Dec-21	-10.62%	2.81%	-12.17%	-6.41%	13.73%	-3.28%	16.65%	13.37%	-19.04%	19.59%
31-Mar-22	9.06%	11.63%	62.90%	-2.56%	33.23%	4.01%	-8.70%	-20.96%	-10.66%	5.42%
30-Jun-22	-21.51%	7.61%	3.19%	-17.81%	-5.10%	-21.60%	-5.08%	-18.47%	-29.26%	-14.02%
30-Sep-22	24.42%	18.20%	15.74%	14.07%	21.24%	16.18%	-13.55%	11.91%	0.93%	14.47%
30-Dec-22	-5.43%	1.67%	-22.91%	5.13%	36.89%	3.06%	18.03%	-10.79%	2.58%	-8.58%
31-Mar-23	-2.92%	-8.54%	-3.23%	-4.88%	-30.12%	-13.02%	-14.72%	-25.26%	-15.81%	2.08%
30-Jun-23	16.88%	20.17%	32.24%	37.52%	21.77%	42.57%	46.15%	24.71%	52.12%	21.17%
29-Sep-23	17.22%	16.06%	18.14%	8.23%	10.54%	4.83%	17.67%	31.41%	-0.91%	-1.28%
29-Dec-23	25.04%	23.72%	-1.20%	36.82%	77.55%	95.64%	27.95%	39.69%	29.55%	57.92%
$E(R_i)$	9.43%	9.63%	15.94%	11.64%	14.61%	17.24%	17.94%	10.64%	6.04%	12.96%
SD_i (σ_i)	19.88%	9.78%	26.44%	20.69%	27.25%	34.92%	26.78%	27.56%	28.64%	21.30%
Var_i (σ^2_i)	0.039510	0.009559	0.069907	0.042798	0.074274	0.121928	0.071693	0.075938	0.082024	0.045353
$Corr_{i,M}$ ($r_{i,M}$)	0.87	0.72	0.26	0.96	0.33	0.92	0.67	0.89	0.97	0.82
$Beta_i$ (β_i)	0.86	0.35	0.34	0.98	0.45	1.58	0.88	1.21	1.37	0.86

If the APT model were constructed using market risk premium as the only factor, it would be the same as the CAPM. Thus, the measure of beta for the market risk premium must be consistent across the models. For this reason, we have to treat the risk-free rate, "λ_1" and "β_1" in our equation constant.

This implies that the betas for the remaining factors will be quantified on the basis of returns that are unexplained by the risk-free rate and the market risk premium, i.e. betas for the other factors express the relationship between the residual returns "E (R_i) - R_F - (λ_1 . β_1)" and the respective factor, where "λ_1" is the market risk premium and "β_1" is the sensitivity of the stock to the market. Thus, our next step is to compute the residual returns of the securities.

TABLE 15: Computation of Residual Returns (Returns Explained by Factors λ_2, λ_3, and λ_4)

R_F	=	1.74%	(Quarterly)
R_M	=	9.54%	(Quarterly)

DATE	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
31-Mar-21	-9.93%	-4.24%	50.95%	13.88%	-4.58%	0.20%		-4.58%	-14.16%	3.09%
30-Jun-21	1.07%	-0.04%	1.83%	-11.47%	-1.45%	-19.31%	49.66%	-3.38%	-13.03%	-7.79%
30-Sep-21	44.71%	13.12%	32.65%	39.02%	-14.06%	55.46%	46.10%	56.50%	53.00%	38.13%
31-Dec-21	-19.03%	-1.65%	-16.54%	-15.81%	8.52%	-17.34%	8.07%	2.19%	-31.43%	11.13%
31-Mar-22	0.64%	7.17%	58.52%	-11.96%	28.02%	-10.05%	-17.28%	-32.14%	-23.06%	-3.04%
30-Jun-22	-29.93%	3.16%	-1.19%	-27.21%	-10.31%	-35.66%	-13.66%	-29.65%	-41.65%	-22.47%
30-Sep-22	16.01%	13.74%	11.36%	4.67%	16.03%	2.12%	-22.13%	0.72%	-11.47%	6.02%
30-Dec-22	-13.84%	-2.78%	-27.29%	-4.27%	31.68%	-11.01%	9.45%	-21.97%	-9.81%	-17.03%
31-Mar-23	-11.33%	-13.00%	-7.61%	-14.28%	-35.33%	-27.08%	-23.30%	-36.44%	-28.21%	-6.38%
30-Jun-23	8.46%	15.71%	27.86%	28.12%	16.56%	28.51%	37.56%	13.53%	39.73%	12.72%
29-Sep-23	8.80%	11.60%	13.76%	-1.18%	5.33%	-9.23%	9.09%	20.23%	-13.31%	-9.73%
29-Dec-23	16.62%	19.26%	-5.58%	27.42%	72.34%	81.57%	19.37%	28.51%	17.16%	49.47%

We then run a regression taking these residual returns as the dependent "Y" variable and the factors "λ_2", "λ_3", and "λ_4" as the independent "X" variables, with constant "0" to determine the relationship between the security returns and the factors. This is done on excel by choosing the "Data Analysis" function on the Data Tab. Within Data Analysis, we select Regression. We select the Y variables as the range of quarterly returns of the securities and the X variables as the range of values for the factors. We set the constant to zero using the option provided. This is essential because we want a fixed constant equal to the risk-free rate of return which we have accounted for in previous steps. The results of the regression analysis have been documented in the tab <Regressions> in the attached excel.

6.4 COMPUTATIONAL RESULTS

We compute the APT returns and compare these with average quarterly returns to identify mispricing and arbitrage opportunity as demonstrated in Table 16 below (also refer tab <APT Summary> in the attached excel file).

TABLE 16: APT Returns, Mispricing and Arbitrage Profits

DATE	β_1	β_2	β_3	β_4	E (R)	AVG RETURN	E(R) __ AVG (R)	CONCLUSION	29-DEC-23	31-JAN-24	BUY PRICE	SELL PRICE	P/L
OberoiRlty	0.8560	0.8746	0.8026	-1.5403	12.78%	9.43%	>	Overvalued	Sell	Buy	1323.70	1,443.35	119.65
PhoenixLtd	0.3482	0.2114	0.7399	-0.1413	9.75%	9.63%	>	Overvalued	Sell	Buy	2423.80	2,244.65	-179.15
MahLife	0.3383	-1.2511	0.8614	2.0926	9.02%	15.94%	<	Undervalued	Buy	Sell	543.45	561.25	17.8
DLF	0.9828	-0.0862	-0.6781	0.6571	8.04%	11.64%	<	Undervalued	Buy	Sell	726.40	802.60	76.2
SwanEnergy	0.4450	-0.7359	5.0356	-1.8155	18.79%	14.61%	>	Overvalued	Sell	Buy	639.05	511.00	-128.05
Prestige	1.5808	0.5612	1.9289	-1.9456	20.22%	17.24%	>	Overvalued	Sell	Buy	1265.40	1,178.90	-86.5
Lodha	0.8777	3.1482	-3.3677	-0.1408	15.17%	17.94%	<	Undervalued	Buy	Sell	1023.55	1,070.10	46.55
Sobha	1.2111	1.4696	-2.5738	0.0461	9.11%	10.64%	<	Undervalued	Buy	Sell	985.70	1,447.75	462.05
GodrejProp	1.3667	1.1325	-2.7275	-0.2507	5.16%	6.04%	<	Undervalued	Buy	Sell	2,013.35	2,377.15	363.8
Brigade	0.8611	0.4646	3.2108	-2.5240	18.26%	12.96%	>	Overvalued	Sell	Buy	1,025.25	896.75	-128.5
												Arbitrage Profit	**563.85**

6.5 NOTES AND OBSERVATIONS

1. Our APT analysis is based on quarterly data ending on 29 December 2023. Thus, we have computed the expected return under APT based on factor values on 29 December 2023. This allows us to comment on the valuation of the securities as on 29 December 2023. Therefore, the conclusions about security valuations are as of 29 December 2023.

2. Based on our conclusions about security valuations as of 29 December 2023, we recommend buying or selling of the securities on that date.

3. We then demonstrate the potential for arbitrage profit taking a cutoff of 31 January 2024, the date upto which we have used data on the securities in previous chapters. Note that this date is within 3 months of 29 December 2023 and while most securities have started correcting (moving in the opposite direction of their mispricing), not all have.

   As of 31 January 2024, Phoenix Mills Ltd., Swan Energy Limited, Prestige Estates Projects Limited and Brigade Enterprises Limited are still APT inconsistent. The relatively lower amount of losses on these may indicate that their prices have started correcting but have not fully corrected (which should ideally happen within a maximum of three months in the case of quarterly analysis - i.e. by 31 March 2024). However, it may also be the case that the prices may have corrected between 29 December 2023 and 31 January 2024, and that this is a new mispricing that has occurred since.

   While this is a current limitation, the circumstances around it (as explained above) do not compromise the argument about inconsistencies in security pricing under APT allowing for arbitrage opportunities as demonstrated.

4. Overall, the evidence of mispricing is prevalent and persuasive, and depending on the span of time the securities take to correct and the different price levels observed in this process, arbitrage profits may differ.

7
INDEX ANALYSIS - SHARPE SINGLE INDEX MODEL

This chapter is focused on the final theoretical analysis of the index and aims to identify a more optimal portfolio using some or all of the identified securities using the Sharpe Single Index Model. The Sharpe Single Index Model simplifies security and portfolio analysis by quantifying its (security's or portfolio's) relation to the market and its performance independent of the market.

Thus, our objective in this chapter is to identify a more optimal portfolio comprising of one or more of the identified securities using the Single Index Model. We identify the data requirements for this purpose, the process of constructing such a portfolio and finally evaluate such a portfolio.

7.1 DATA REQUIREMENTS

Since the Single Index Model analyses all securities and the portfolio in terms of their performance dependent on the market and their performance independent of the market, there are certain specific data requirements of this model. We list these variables and their significance below:

1. **Security return (R_i):** For portfolio optimisation under the Single Index Model, we need the average returns of the securities that are to be analysed for inclusion in the portfolio. We have in Chapter 3 already computed monthly returns of the identified securities and we will use the same for this purpose.

2. **Risk-free rate (R_F):** This is the minimum rate of return required by investors on any investment. We have identified the annualised risk-free rate to be 7.15%. This equates to a monthly rate of 0.58%.

3. **Market return (R_M):** The market return is the average monthly return on the NIFTY Realty Index. This was computed to be 3.51% in Chapter 2.

4. **Standard deviation (σ_i) and variance (σ^2_i) of securities:** The standard deviation and variance measure the dispersion of security returns from their expected returns. We use the same values of standard deviations and variances of securities as were computed in Chapter 3.

5. **Standard deviation (σ_M) and variance (σ^2_M) of the market:** The standard deviation and variance measure the dispersion of market returns from its expected returns. We use the same values of these variables as were computed in Chapter 2.

6. **Securities' sensitivity to the market (β_i):** The beta of the securities measures the sensitivity of the security's returns to the market and is a measure of the systematic relationship between the security and the market.

7. From the above, the following variables will be derived:

   a. **Systematic risk ($\beta^2_i \cdot \sigma^2_M$):** The systematic risk is that component of total risk that is directly related to variation in the market. It is a product of the squared beta of the security and the variance of the market.

   b. **Unsystematic risk (σ^2_{ei}):** The unsystematic risk is that component of total risk that is unrelated to variations in the market. It is the difference between the variance of the security and the systematic risk.

   c. **Excess return to beta [$(R_i - R_F)/\beta_i$]:** The excess return to beta of a security is the ratio of the security's return in excess of the risk-free rate of return to its beta. It is a measure of the excess return that the security gives per unit of beta.

7.2 PROCESS OF PORTFOLIO IDENTIFICATION

1. Once the data has been organised in a structured manner for use in the Single Index Model, the first step in identifying the optimal portfolio is to evaluate and rank the securities according to their excess return to beta ratio - rank 1 corresponding to the highest ratio and rank 10 corresponding to the security with the lowest ratio.

   The derived variables mentioned in section 7.1 above and the ranks of securities have been computed in Table 17.

2. Listing the securities as per their rank in Table 18, we compute the variable "C" for each security. It is computed in a successive manner for each security based on some cumulative value of variables at that point and is mathematically given as:

$$C_i = \frac{\sigma^2_m \cdot \sum \frac{(R_i - R_f)\,\beta_i}{\sigma^2_{ei}}}{1 + \sigma^2_m \cdot \sum \frac{\beta^2_i}{\sigma^2_{ei}}}$$

   The cut-off point (C*) of securities to be selected for investment is determined at the security with the highest value of C. Beyond this point, the value of C declines.

3. Once the securities to be included in the optimal portfolio are identified, we determine the weights of investment in these securities in Table 19, using the variable "Z", which is mathematically calculated as:

$$z_i = \frac{\beta_i}{\sigma^2_{ei}} \left[\frac{(R_i - R_f)}{\beta_i} - C^* \right]$$

   The weights of investment in each security are calculated as the ratio of the "Z" corresponding to the security to the total "Z".

TABLE 17: Computation of Derived Variables and Ranks for Securities			
R_F	=	7.15%	(Annualised)
R_F	=	0.58%	(Monthly)
R_M	=	3.51%	(Monthly)
σ_M	=	9.18%	
σ^2_M	=	0.008430	

DATE	OberoiRlty	PhoenixLtd	MahLife	DLF	SwanEnergy	Prestige	Lodha	Sobha	GodrejProp	Brigade
R_i	3.19%	3.98%	4.34%	4.10%	6.54%	5.44%	4.70%	4.27%	2.61%	4.70%
σ_i	10.43%	7.15%	11.59%	10.25%	19.23%	12.42%	12.54%	14.26%	14.74%	8.72%
σ^2_i	0.010880	0.005117	0.013426	0.010516	0.036992	0.015436	0.015714	0.020345	0.021732	0.007601
β_i	0.923551	0.464980	0.331128	1.042197	0.101978	1.069357	0.569413	1.056248	1.504906	0.670595
β^2_i	0.852946	0.216206	0.109646	1.086175	0.010399	1.143524	0.324231	1.115660	2.264743	0.449697
$\beta^2_i \cdot \sigma^2_M$	0.007190	0.001823	0.000924	0.009156	0.000088	0.009640	0.002733	0.009405	0.019091	0.003791
σ^2_{ei}	0.003690	0.003294	0.012502	0.001360	0.036905	0.005797	0.012980	0.010940	0.002641	0.003810
$(R_i - R_f) / \beta_i$	2.83%	7.33%	11.38%	3.38%	58.43%	4.55%	7.24%	3.49%	1.35%	6.15%
Rank	9	3	2	8	1	6	4	7	10	5

Consistent with our previous analyses, Oberoi Realty Ltd. and Godrej Properties Limited are the most inferior stocks, with the securities having the lowest ranks. It is evident that securities with low betas (betas less than 0.7 in our dataset) have better excess return to beta ratios and thus higher ranks.

TABLE 18: Identification of Securities to be Selected in the Optimal Portfolio

RANK	SECURITY	R_I	β_I	σ^2_{ei}	$[(R_I - R_F) . \beta_I] / \sigma^2_{ei}$	Cum. (4)	(5) . σ^2_M	$\beta^2_I . \sigma^2_{ei}$	Cum. (7)	1 + [(8) . σ^2_M]	C = (6)/(9)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	SWANENERGY	6.54%	0.1020	0.0369	0.1646	0.1646	0.0014	0.2818	0.2818	1.0024	0.0014
2	MAHLIFE	4.34%	0.3311	0.0125	0.9977	1.1623	0.0098	8.7702	9.0520	1.0763	0.0091
3	PHOENIXLTD	3.98%	0.4650	0.0033	4.8094	5.9717	0.0503	65.6264	74.6784	1.6295	0.0309
4	LODHA	4.70%	0.5694	0.0130	1.8074	7.7791	0.0656	24.9787	99.6571	1.8401	0.0356
5	BRIGADE	4.70%	0.6706	0.0038	7.2559	15.0351	0.1267	118.0343	217.6914	2.8351	0.0447
6	PRESTIGE	5.44%	1.0694	0.0058	8.9794	24.0145	0.2024	197.2757	414.9670	4.4981	0.0450
7	SOBHA	4.27%	1.0562	0.0109	3.5612	27.5757	0.2325	101.9798	516.9468	5.3578	0.0434
8	DLF	4.10%	1.0422	0.0014	27.0394	54.6150	0.4604	798.8226	1315.7694	12.0917	0.0381
9	OBEROIRLTY	3.19%	0.9236	0.0037	6.5513	61.1664	0.5156	231.1330	1546.9023	14.0401	0.0367
10	GODREJPROP	2.61%	1.5049	0.0026	11.5575	72.7239	0.6130	857.4759	2,404.3783	21.2684	0.0288

1. In Table 18 above, we list the securities by their ranks determined in Table 17.

2. We then compute the numerator for the variable “C” in column (6) as the product of the variance of the market and the cumulative product of excess return of the security and its beta divided by its unsystematic risk.

3. We compute the denominator for the variable “C” in column (9) as the cumulative product of the squared beta and the unsystematic risk, and the variance of market; added to 1.

4. The variable “C” is computed for each security by dividing the numerator by the denominator identified in columns (6) and (9) respectively, with C* identified as 0.0450 indicating rank 6 - Prestige Estates Projects Ltd. as the cut-off security. Thus, the Sharpe Optimal Portfolio will not include the stocks of Sobha Ltd., DLF Ltd., Oberoi Realty Ltd. and Godrej Properties Limited.

TABLE 19: Determination of Weights of Securities to be Selected in the Optimal Portfolio

RANK	SECURITY	R_I	β_I	σ^2_{ei}	β_I / σ^2_{ei}	$[(R_I - R_F) / \beta_I] - C^*$	Z_I	W_I	$W_I . R_I$	$W_i . \beta_i$	$W^2_I . \sigma^2_{ei}$
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	SWANENERGY	6.54%	0.1020	0.0369	2.7633	0.5393	1.4901	0.1296	0.0085	0.0132	0.0006
2	MAHLIFE	4.34%	0.3311	0.0125	26.4859	0.0688	1.8209	0.1584	0.0069	0.0525	0.0003
3	PHOENIXLTD	3.98%	0.4650	0.0033	141.1383	0.0283	3.9913	0.3472	0.0138	0.1614	0.0004
4	LODHA	4.70%	0.5694	0.0130	43.8685	0.0274	1.2000	0.1044	0.0049	0.0594	0.0001
5	BRIGADE	4.70%	0.6706	0.0038	176.0143	0.0165	2.8986	0.2522	0.0118	0.1691	0.0002
6	PRESTIGE	5.44%	1.0694	0.0058	184.4807	0.0005	0.0944	0.0082	0.0004	0.0088	0.0000

Expected Return of Sharpe Optimal Portfolio	$\Sigma w_i . R_i$	4.64%
Variance of Sharpe Optimal Portfolio	$[(\Sigma w_i . \beta_i)^2 . \sigma^2_M] + [\Sigma w^2_i . \sigma^2_{ei}]$	0.0035
Risk of Sharpe Optimal Portfolio		5.94%
Beta of Sharpe Optimal Portfolio	$\Sigma w_i . \beta_i$	0.464435

1. We compute the weights of the securities to be included in the Sharpe Optimal Portfolio by using the variable "Z" calculated in column (6) of Table 19 as the product of columns (4) (beta to unsystematic risk) and (5) (excess return to beta ratio reduced by the cut-off value).

2. Weights for each security are calculated as the ratio of the security's "Z" value by the total "Z" value.

3. We have calculated the weighted average returns of the securities (the sum of which is expected return of the Sharpe Optimal Portfolio) in column (8), the weighted average betas of the securities (the sum of which is the beta of the portfolio) in column (9), and the product of the squared weights and the unsystematic risk in column (10) which enables our computation of the variance of the Sharpe Optimal Portfolio.

4. Before we evaluate the portfolio in the next section, we can prima facie observe that the Sharpe Optimal Portfolio offers a return of 4.64% at a risk of 5.94% which is superior to the equal weighted and market weight portfolios identified in section 5.3 of Chapter 5. It does not outperform the minimum variance portfolio. However, it is not as significantly inferior to the minimum variance portfolio as the other portfolios constructed are. A more comprehensive evaluation based on portfolio evaluation ratios follows in the next section.

7.3 PORTFOLIO EVALUATION

We finally evaluate the Sharpe Optimal Portfolio and compare its performance vis-à-vis the minimum variance portfolio and the market. We perform this analysis using the following measures:

1. **Sharpe ratio:** It measures the portfolio's excess return (over the risk-free rate of return) to its standard deviation. A higher Sharpe ratio is often preferred as it indicates more excess return per unit of risk.

2. **Treynor ratio:** It measures the portfolio's excess return (over the risk-free rate of return) to its beta. A higher Treynor ratio is often preferred as it indicates more excess return per unit of beta.

3. **Jensen Alpha:** It measures the excess of the portfolio's average/expected return to its expected return as per CAPM. A positive alpha implies a higher average return observed on the security as compared to its CAPM expectations and is thus favourable.

TABLE 20: Portfolio Evaluation Ratios

RATIO	FORMULA	OPTIMAL PORTFOLIO	MINIMUM VARIANCE PORTFOLIO	MARKET
Sharpe Ratio	$(R_P - R_F) / \sigma_P$	0.6835	0.7162	0.3189
Treynor Ratio	$(R_P - R_F) / \beta_P$	0.0875	0.0918	0.0293
CAPM E(R)	$R_F + (R_M - R_F) . \beta_P$	1.94%	1.85%	2.93%
Jensen Alpha	R_P - CAPM E(R)	2.70%	2.72%	0.58%

Consistent with our initial observation about the Sharpe Optimal Portfolio's performance vis-à-vis the minimum variance portfolio, the Sharpe Optimal Portfolio's Sharpe ratio, Treynor ratio and Alpha are all lower than the minimum variance portfolio.

However since the Sharpe Optimal Portfolio's Sharpe ratio, Treynor ratio and Alpha are all significantly superior to the market's ratios and Alpha, the Sharpe Optimal Portfolio is evidently superior to the market.

8
CONCLUSION

Based on a comprehensive analysis of the NIFTY Realty Index and its constituent securities under different financial theories and models, we conclude the following:

1. In general, most theories have similar conclusions about the performance of individual securities. We notice this in the way the stocks of Oberoi Realty Ltd. and Godrej Properties Limited have been consistently identified as underperforming to their expectations or significantly inferior to the other securities constituting the index.

2. While the CAPM enables us to identify a mispricing of securities individually, it does little to suggest a way to structure this in the creation of a portfolio. To this effect, the Sharpe Optimal Portfolio is more comprehensive as it offers a complete mechanism to construct a portfolio based on the individual securities' performance.

3. On a similar note, while the APT too does not provide a mechanism for the creation of a structured portfolio, it suggests buying undervalued securities and selling overvalued securities. The combined positions arising out of this, while is similar to having a portfolio of assets, is not a structured portfolio that is based on a certain logic of assigning weights, or rebalancing thereof.

4. The Markowitz Model provides the mechanism for creation of a feasible set of portfolios and identify the efficient portfolios out of these. To this effect, it also helps us to identify the minimum variance portfolio. In this instance, the minimum variance portfolio also offers a competitive return, thus yielding it favourable Sharpe and Treynor ratios.

5. However, an important point of consideration is the time horizon being assessed. The results achieved are largely based on observations for 33 months ending 31 January 2024. The data set for this time period has specific characteristics which may differ if a different time period was selected for analysis.

6. Thus, this report provides highly relevant insights to investors with a similar investment horizon and thus the same time period analysis. For investors with different investment objectives, this report continues to provide a highly relevant methodology and framework of analysis for the NIFTY Realty Index and other indices.

7. We thus conclude and recommend that the methodology described and illustrated in this report is highly relevant to index, portfolio and security analysis. This is true in case of long-term and short-term analyses and is especially more important in short-term analysis as data distributions smooth out in the long-term but may be more dispersed/volatile in the short-term.

APPENDIX A: NSE INDEX DASHBOARD - EQUITY

NSE Indices

Nifty50

Index Dashboard

February 29, 2024

Based on Total Return Index

Index Name	Returns (%) 1M	3M	1 Yr	3 Yr	5 Yr	Volatility (%) 1 Yr	Beta 1 Yr	Correlation 1 Yr	R^2 1 Yr	P/E	P/B	Dividend Yield
Broad Market Indices												
Nifty 50	1.32	9.38	28.49	16.16	16.66	9.98	1.00	1.00	1.00	22.70	3.85	1.22
Nifty Next 50	6.78	22.97	59.33	20.89	18.40	12.12	0.89	0.73	0.54	25.52	4.74	1.29
Nifty 100	2.28	11.69	33.26	16.68	16.82	9.88	0.98	0.99	0.98	23.37	4.02	1.21
Nifty 200	1.85	11.87	37.02	18.29	17.90	9.98	0.98	0.97	0.95	23.62	3.99	1.15
Nifty 500	1.57	11.85	39.71	19.40	18.81	9.98	0.96	0.96	0.91	24.37	4.04	1.11
Nifty Midcap 150	-0.20	11.83	57.28	27.50	25.45	11.97	0.87	0.73	0.53	26.96	4.23	0.85
Nifty Midcap 50	1.04	12.82	63.84	27.81	25.77	13.24	0.98	0.74	0.54	21.03	3.73	1.10
Nifty Smallcap 250	-0.56	13.06	68.80	30.58	26.17	13.32	0.87	0.65	0.42	28.85	3.86	0.83
Nifty Smallcap 50	-1.02	12.56	79.35	22.66	21.84	15.38	1.01	0.65	0.43	29.22	3.78	0.86
Nifty LargeMidcap 250	1.01	11.75	45.02	22.10	21.17	10.35	0.93	0.89	0.80	25.05	4.12	1.03
Nifty MidSmallcap 400	-0.33	12.27	61.22	28.54	25.71	12.20	0.87	0.71	0.51	27.61	4.09	0.84
Nifty Midcap 100	-0.37	12.78	61.56	28.72	24.79	12.74	0.93	0.73	0.53	25.06	3.87	0.83
Nifty Smallcap 100	-0.20	12.88	75.62	26.76	23.10	14.67	0.95	0.65	0.42	29.44	3.94	0.77
Nifty500 Multicap 50:25:25	0.91	12.07	47.70	22.91	21.45	10.49	0.93	0.88	0.77	25.46	4.03	1.02
Nifty Microcap 250	-1.33	13.08	96.79	46.12	32.94	15.86	0.88	0.55	0.31	28.76	3.19	0.61
Nifty Midcap Select	1.32	12.00	60.72	22.04	21.72	12.66	0.92	0.73	0.53	19.54	4.17	0.94
Nifty Total Market	1.46	11.90	41.14	20.02	19.16	10.04	0.95	0.95	0.90	24.50	4.00	1.09
Thematic Indices												
Nifty Commodities	2.34	19.01	52.86	25.51	21.66	13.81	1.10	0.79	0.63	15.21	2.36	1.96
Nifty CPSE	7.89	37.59	105.55	51.62	27.23	18.41	1.03	0.56	0.31	12.44	2.43	3.28
Nifty Energy	6.22	33.25	81.72	29.89	23.96	15.68	1.07	0.68	0.47	13.13	2.50	2.23
Nifty India Consumption	2.00	9.28	39.01	20.55	17.15	9.23	0.70	0.75	0.57	44.86	8.40	1.05
Nifty Infrastructure	3.07	23.01	62.62	26.78	24.41	11.76	0.98	0.83	0.70	20.29	3.17	1.20
Nifty MNC	3.33	10.83	33.34	18.27	15.46	9.72	0.69	0.71	0.50	41.43	8.70	1.84
Nifty PSE	6.11	35.71	112.20	46.61	27.25	18.37	1.07	0.58	0.34	10.27	2.36	3.07
Nifty Services Sector	1.15	8.30	22.10	11.73	14.49	10.96	1.04	0.95	0.90	21.85	4.07	1.17
Nifty100 Liquid 15	2.81	14.40	44.54	20.04	12.18	11.32	1.02	0.90	0.81	26.08	3.55	0.77
Nifty Midcap Liquid 15	-0.31	10.09	55.05	26.32	24.77	13.91	0.98	0.70	0.49	18.99	3.24	0.94
Nifty Aditya Birla Group	-3.39	6.83	37.54	17.07	17.36	16.47	1.08	0.65	0.43	-	3.15	0.47
Nifty Mahindra Group	6.63	10.62	36.49	26.20	18.43	17.26	1.08	0.62	0.39	24.50	3.64	1.66
Nifty Tata Group	6.22	19.18	47.10	24.60	25.14	12.96	0.89	0.68	0.47	40.17	8.76	1.14
Nifty Tata Group 25% Cap	6.06	20.69	62.65	30.72	30.07	11.85	0.89	0.75	0.56	49.16	6.57	0.90
Nifty Shariah 25	2.98	14.13	37.69	17.07	15.68	10.83	0.88	0.81	0.66	27.34	5.02	1.82
Nifty50 Shariah	2.13	12.82	30.58	15.47	16.99	12.22	0.95	0.77	0.60	29.43	5.13	1.84
Nifty500 Shariah	1.95	12.90	38.25	19.62	20.32	10.35	0.86	0.83	0.69	32.81	5.42	1.33
Nifty SME Emerge	1.59	18.48	93.92	90.70	53.58	12.40	0.44	0.35	0.13	67.70	7.64	0.11
Nifty100 ESG	2.28	11.37	36.25	16.14	17.55	9.90	0.93	0.94	0.88	25.13	4.48	1.10
Nifty100 Enhanced ESG	2.28	11.30	36.08	16.14	17.32	9.90	0.93	0.94	0.88	25.12	4.48	1.10
Nifty100 ESG Sector Leaders	2.10	10.75	31.69	15.26	16.12	9.73	0.94	0.97	0.94	26.69	4.27	0.97
Nifty India Manufacturing	4.23	14.13	48.92	24.08	21.54	10.27	0.81	0.79	0.62	26.30	4.40	1.15
Nifty Non-Cyclical Consumer	1.64	7.51	37.06	20.29	18.01	9.47	0.67	0.70	0.49	59.94	11.34	0.90
Nifty Mobility	5.87	22.14	70.71	26.19	22.89	12.76	0.92	0.72	0.52	25.41	5.65	0.90
Nifty India Digital	1.84	13.85	51.23	17.75	20.31	14.63	1.02	0.70	0.49	-	9.96	1.01
Nifty India Defence	3.49	22.34	112.95	70.27	47.30	21.03	0.90	0.43	0.18	45.80	10.66	0.67
Nifty Housing	1.31	12.40	42.26	19.77	19.79	11.52	1.00	0.87	0.76	25.62	3.34	0.88
Nifty Transportation & Logistics	5.81	19.40	67.32	27.90	23.52	12.69	0.89	0.70	0.49	29.03	6.14	0.70
Nifty MidSmall India Consumption	1.64	7.90	51.77	22.23	23.44	11.75	0.73	0.62	0.38	66.62	7.28	0.40
Nifty REITs & InvITs	2.73	8.18	14.45	10.43	-	9.74	0.10	0.10	0.01	32.80	1.64	7.04
Strategy Indices												
Nifty Alpha 50	-1.15	19.03	85.32	30.30	32.77	15.55	1.00	0.64	0.41	27.23	4.19	0.75
Nifty Alpha Low-Volatility 30	5.13	19.43	56.45	25.36	19.42	9.58	0.77	0.80	0.65	23.49	4.59	1.37
Nifty Alpha Quality Low-Volatility 30	4.53	16.67	52.82	22.28	18.92	10.14	0.73	0.72	0.52	28.09	7.47	1.61
Nifty Alpha Quality Value Low-Volatility 30	2.21	18.38	65.38	29.56	23.10	11.47	0.87	0.76	0.57	18.93	4.61	2.12
Nifty Dividend Opportunities 50	2.34	18.17	52.62	27.76	20.70	11.66	0.96	0.82	0.67	17.26	3.63	2.71
Nifty Growth Sectors 15	2.47	10.14	32.44	18.76	14.40	10.05	0.75	0.74	0.55	33.75	8.54	1.74
Nifty High Beta 50	0.78	20.73	79.14	28.05	20.48	17.15	1.26	0.73	0.54	16.96	2.16	1.45
Nifty Low Volatility 50	2.64	12.69	43.07	20.13	19.29	8.72	0.74	0.85	0.72	26.80	4.76	1.25
Nifty100 Quality 30	2.01	9.16	34.80	17.81	16.08	9.95	0.83	0.83	0.69	30.58	8.31	1.80
Nifty Quality Low-Volatility 30	2.62	10.23	36.30	18.46	16.37	9.44	0.75	0.79	0.62	30.72	7.88	1.54
Nifty200 Quality 30	1.10	8.95	35.06	18.22	16.50	10.13	0.78	0.77	0.60	32.68	9.67	1.88
Nifty50 Equal Weight	2.36	12.20	43.75	22.45	20.11	9.90	0.93	0.93	0.87	22.58	3.78	1.37
Nifty100 Equal Weight	4.50	17.34	50.95	21.02	19.32	10.56	0.90	0.85	0.73	24.83	4.31	1.28
Nifty100 Low Volatility 30	3.46	13.42	41.19	19.97	18.27	8.84	0.77	0.86	0.75	26.11	5.54	1.45
Nifty50 Value 20	2.94	14.96	36.01	22.80	20.89	11.31	0.94	0.83	0.68	19.62	3.58	2.18
Nifty100 Alpha 30	7.50	25.13	73.52	23.94	21.32	11.68	0.89	0.76	0.58	24.07	4.68	1.22
Nifty500 Value 50	3.41	26.88	89.83	41.36	28.53	17.02	1.15	0.68	0.46	10.05	1.62	3.58
Nifty Midcap150 Quality 50	-0.85	6.50	32.41	15.54	17.62	9.91	0.68	0.69	0.47	28.50	7.03	1.43
Nifty200 Momentum 30	3.46	19.92	68.89	29.42	24.13	13.31	0.93	0.70	0.49	20.90	4.08	1.35
Nifty200 Alpha 30	3.59	20.14	84.46	34.06	27.06	15.31	1.02	0.66	0.44	32.83	4.46	1.03
Nifty Midcap150 Momentum 50	-0.29	14.70	69.22	36.44	32.24	13.23	0.84	0.63	0.40	23.55	3.92	0.88
Nifty Smallcap250 Quality 50	-1.34	12.29	60.19	33.00	28.22	14.09	0.91	0.64	0.42	23.92	4.70	1.50
Nifty Smallcap250 Momentum Quality 100	-0.61	13.96	67.24	31.21	28.44	14.15	0.89	0.62	0.39	26.93	4.45	0.88
Nifty MidSmallcap400 Momentum Quality 100	0.09	13.47	60.36	30.04	26.92	12.61	0.85	0.67	0.45	22.79	4.60	1.18

- Index Returns, Volatility Beta, Correlation and R^2 are calculated based on total returns index values

- Returns for the period upto one year are absolute returns. Returns for period greater than one year are CAGR returns.

- P/E, P/B & Dividend Yield as on the last trading day of month

Index Dashboard

February 29, 2024

Index Name	Returns (%) 1M	3M	1 Yr	3 Yr	5 Yr	Volatility (%) 1 Yr	Beta 1 Yr	Correlation 1 Yr	R^2 1 Yr	P/E	P/B	Dividend Yield
Sectoral Indices												
Nifty Auto	6.20	16.34	61.51	27.34	20.95	13.16	0.85	0.64	0.41	26.10	5.84	0.86
Nifty Bank	0.27	3.68	15.50	10.58	12.03	13.12	1.10	0.83	0.69	15.31	2.68	0.80
Nifty Financial Services	-0.41	1.79	14.57	9.12	13.42	12.51	1.07	0.86	0.73	17.02	3.19	0.82
Nifty FMCG	-1.42	2.40	21.78	20.73	15.01	10.97	0.62	0.56	0.32	43.14	11.21	1.93
Nifty IT	2.97	16.11	29.58	18.04	21.52	18.52	1.09	0.59	0.35	32.26	8.19	1.88
Nifty Media	-4.58	-10.63	20.70	8.76	-2.81	26.40	1.00	0.38	0.14	-	2.19	0.48
Nifty Metal	-0.58	12.99	50.98	29.83	24.70	19.34	1.28	0.66	0.44	26.11	2.32	2.47
Nifty Pharma	6.16	17.27	63.02	17.69	17.35	12.59	0.45	0.36	0.13	36.28	5.18	0.71
Nifty Private Bank	-2.08	-0.14	13.06	8.20	9.09	13.38	1.10	0.82	0.68	16.22	2.66	0.64
Nifty PSU Bank	10.50	37.47	90.83	44.16	21.02	24.45	1.33	0.54	0.30	9.46	1.60	1.53
Nifty Realty	6.36	27.61	132.46	38.01	32.19	21.73	1.17	0.54	0.29	56.97	5.79	0.25
Nifty Financial Services 25/50	-0.20	4.54	30.20	13.17	15.63	12.25	1.04	0.85	0.72	16.84	3.18	0.89
Nifty Consumer Durables	1.86	8.90	34.29	15.65	18.66	11.18	0.61	0.55	0.30	71.31	10.12	0.41
Nifty Oil & Gas	7.07	35.52	66.24	24.93	21.67	16.16	1.10	0.68	0.46	9.25	2.06	2.54
Nifty Healthcare Index	4.84	16.37	60.48	19.62	19.47	12.52	0.48	0.38	0.15	41.15	5.70	0.58
Nifty Financial Services Ex-Bank	-0.35	4.04	42.94	14.33	15.83	13.83	0.98	0.71	0.50	21.30	3.65	0.85
Nifty MidSmall Financial Services	-2.02	7.84	64.55	18.80	13.52	16.72	1.11	0.66	0.44	15.67	2.27	1.02
Nifty MidSmall Healthcare	1.42	12.51	69.87	17.19	22.72	12.26	0.51	0.42	0.17	47.04	5.42	0.50
Nifty MidSmall IT & Telecom	3.38	17.04	70.57	37.05	36.57	16.36	0.98	0.60	0.36	-	17.05	0.89

About NSE Indices Limited

(Formerly known as India Index Services & Products Limited-IISL)

NSE Indices Limited, a subsidiary of NSE, provides a variety of indices and index related services for the capital markets. The company focuses on the index as a core product. The company owns and manages a portfolio of indices under the Nifty brand of NSE, including the flagship index, the Nifty 50. Nifty equity indices comprises of broad-based benchmark indices, sectoral indices, strategy indices, thematic indices and customised indices. NSE Indices Limited also maintains fixed income indices based on Government of India securities, corporate bonds, money market instruments and hybrid indices. Many investment products based on Nifty indices have been developed within India and abroad. These include index based derivatives traded on NSE and NSE International Exchange IFSC Limited (NSE IX) and a number of index funds and exchange traded funds. The flagship 'Nifty 50' index is widely tracked and traded as the benchmark for Indian Capital.

For more information, please visit: **www.niftyindices.com**

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APPENDIX B: NIFTY REALTY 31 JANUARY 2024 FACTSHEET

NSE Indexogram

Nifty Realty

January 31, 2024

Nifty Realty Index is designed to reflect the behaviour and performance of Real Estate companies. The Index comprises of 10 companies listed on National Stock Exchange of India (NSE).

Nifty Realty Index is computed using free float market capitalization method, wherein the level of the index reflects the total free float market value of all the stocks in the index relative to particular base market capitalization value.

Nifty Realty Index can be used for a variety of purposes such as benchmarking fund portfolios, launching of index funds, ETFs and structured products.

Index Variant: Nifty Realty Total Returns Index.

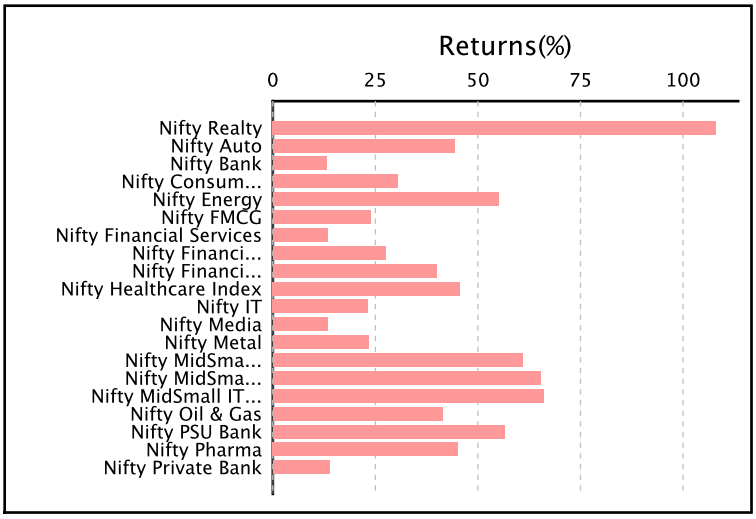
Portfolio Characteristics

Methodology	Periodic Capped Free Float
No. of Constituents	10
Launch Date	August 30, 2007
Base Date	December 29, 2006
Base Value	1000
Calculation Frequency	Real-Time
Index Rebalancing	Semi-Annually

Index Returns (%)	QTD	YTD	1 Year	5 Years	Since Inception
Price Return	9.34	9.34	108.04	30.23	-0.90
Total Return	9.34	9.34	108.8	30.77	-0.33

Statistics ##	1 Year	5 Years	Since Inception
Std. Deviation *	21.87	30.20	40.00
Beta (NIFTY 50)	1.10	1.10	1.40
Correlation (NIFTY 50)	0.51	0.70	0.75

1 Year Performance Comparison of Sector Indices



Fundamentals

P/E	P/B	Dividend Yield
55.9	5.44	0.25

Top constituents by weightage

Company's Name	Weight(%)
DLF Ltd.	27.63
Godrej Properties Ltd.	14.49
Macrotech Developers Ltd.	13.80
Phoenix Mills Ltd.	12.04
Prestige Estates Projects Ltd.	9.50
Oberoi Realty Ltd.	8.24
Brigade Enterprises Ltd.	6.84
Sobha Ltd.	2.79
Swan Energy Ltd.	2.44
Mahindra Lifespace Developers Ltd.	2.23

Based on Price Return Index.

 # QTD,YTD and 1 year returns are absolute returns.Returns for greater than one year are CAGR returns.

** Average daily standard deviation annualised*

January 31, 2024

Index Methodology

Eligibility Criteria for Selection of Constituent Stocks:

i. Companies should form part of Nifty 500 at the time of review. In case, the number of eligible stocks representing a particular sector within Nifty 500 falls below 10, then deficit number of stocks shall be selected from the universe of stocks ranked within top 800 based on both average daily turnover and average daily full market capitalisation based on previous six months period data used for index rebalancing of Nifty 500.

ii. Companies should form part of Realty Sector.

iii. The company's trading frequency should be at least 90% in the last six months.

iv. The Company should have a minimum listing history of 1 month as on the cutoff date.

v. Final selection of 10 companies shall be done based on the free-float market capitalisation of the companies.

vi. Weightage of each stock in the index is calculated based on its free-float market capitalization such that no single stock shall be more than 33% and weightage of top 3 stocks cumulatively shall not be more than 62% at the time of rebalancing.

Index Re-Balancing:

Index is re-balanced on semi-annual basis. The cut-off date is January 31 and July 31 of each year, i.e. For semi-annual review of indices, average data for six months ending the cut-off date is considered. Four weeks prior notice is given to market from the date of change.

Index Governance:

A professional team manages all NSE indices. There is a three-tier governance structure comprising the Board of Directors of NSE Indices Limited, the Index Advisory Committee (Equity) and the Index Maintenance Sub-Committee.

Key Indices

Broad Market	Sectoral Indices	Thematic Indices	Strategy Indices	Fixed Income
Nifty 50	Nifty Bank	Nifty CPSE	Nifty100 Equal Weight	Nifty 10 yr Benchmark G-Sec
Nifty Next 50	Nifty IT	Nifty Commodities	Nifty50 PR 1x Inverse	Nifty 8-13 yr G-Sec
Nifty 100	Nifty PSU Bank	Nifty Energy	Nifty50 PR 2x Leverage	Nifty 4-8 yr G-Sec
Nifty 200	Nifty FMCG	Nifty Shariah 25	Nifty50 Value 20	Nifty 11-15 yr G-Sec
Nifty 500	Nifty Private Bank	Nifty 100 Liquid15	Nifty100 Quality 30	Nifty 15 yr and above G-Sec
Nifty Midcap 50	Nifty Metal	Nifty Infrastructure	Nifty Low Volatility 50	Nifty Composite G-Sec
Nifty Midcap 100	Nifty Financial Services	Nifty Corporate Group	Nifty Alpha 50	Nifty 1D Rate

APPENDIX C: FORMULAE USED

1. **Average monthly returns:** It is a summary statistic calculated in Chapters 1 (for the market - NIFTY Realty Index) and 2 (for the constituent securities). It is average of the month-on-month returns computed for the market and each security respectively. It is the mean expected return.

$$\text{Expected Return } (R_i)\ (\%) = \frac{\Sigma\, X_i}{n}$$

where "X_i" is the monthly return observed for the security and "n" is the number of returns computed.

2. **Standard deviation and variance:** These have also been calculated in Chapters 1 (for the market - NIFTY Realty Index) and 2 (for the constituent securities). They represent the risk of the securities or the market - i.e. they measure the dispersion of the securities' and market's monthly returns around their respective average returns.

$$\text{Variance } (\sigma^2_i)\ (\%) = \frac{\Sigma\, (X_i - R_i)^2}{n}$$

$$\text{Standard Deviation } (\sigma_i)\ (\%) = \sqrt{\frac{\Sigma\, (X_i - R_i)^2}{n}}$$

where "X_i" is the monthly return observed for the security, "R_i" is the average monthly return of the security and "n" is the number of returns computed.

3. **Covariance and correlation:** The covariance and correlation are statistical measures used to identify and quantify the relationship (co-movement) between two variables. These have been computed for measuring each security's relation with the market (in Chapters 3 and 4); and to measure the interrelationship between each pair of securities (in Chapter 5).

$$\text{Covariance } (cov_{xy})\ (\%^2) = \frac{\Sigma\, (X_i - R_{Xi})\,(Y_i - R_{Yi})}{n}$$

$$\text{Coefficient of correlation } (r_{xy}) = \frac{cov_{xy}}{\sigma_x \,.\, \sigma_y}$$

where "X_i" is the monthly return observed for the security "X", "R_{Xi}" is the average monthly return for the security "X", "Y_i" is the monthly return observed for the security "Y", "R_{Yi}" is the average monthly return for the security "Y", "σ_x" and "σ_Y" are the respective standard deviations of securities "X" and "Y", and "n" is the number of returns computed.

4. **Beta:** It has been computed in Chapters 3 and 4 to measure the systematic relationship between a security's return with the market. It is computed as follows:

$$\text{Beta } (\beta) = \frac{r_{xm} \,.\, \sigma_x \,.\, \sigma_m}{\sigma^2_m}$$

5. **Return of a portfolio:** The return of a portfolio is the weighted average of the returns of the individual securities that constitute it.

$$\text{Return of the Portfolio } (R_p) = \Sigma\, w_i \,.\, R_i$$

6. **Risk of a portfolio:** The risk of a portfolio is not the weighted average of the risks of the individual securities as it is affected by the correlation between the securities. In other words, by choosing less correlated securities, the combined risk of the portfolio can be reduced. Risk is measured in terms of variance and standard deviation, which are computed as follows:

$$\text{Variance of portfolio } (\sigma^2_p) = (w^2_a \,.\, \sigma^2_a) + (w^2_b \,.\, \sigma^2_b) + (2 \,.\, w_a \,.\, w_b \,.\, \sigma_a \,.\, \sigma_b \,.\, r_{ab})$$

$$\text{Risk of portfolio } (\sigma_p) = \sqrt{(w^2_a \,.\, \sigma^2_a) + (w^2_b \,.\, \sigma^2_b) + (2 \,.\, w_a \,.\, w_b \,.\, \sigma_a \,.\, \sigma_b \,.\, r_{ab})}$$

7. **Beta of a portfolio:** The beta of a portfolio is the weighted average of the betas of the individual securities that constitute it.

$$\text{Beta of the Portfolio } (\beta_p) = \Sigma\, w_i \,.\, \beta_i$$

8. **Systematic risk:** The systematic risk is that part of the total risk (measured through variance) that represents the variability in security returns that are directly related to changes in the market. It is computed as

$$\text{Systematic risk} = \beta^2_i \,.\, \sigma^2_M$$

9. **Unsystematic risk:** It is that part of total risk that is not related to the market and is generally calculated as a residual value - i.e. total risk reduced by systematic risk.

$$\text{Unsystematic risk } (\sigma^2_{ei}) = \sigma^2_i - (\beta^2_i \,.\, \sigma^2_M)$$

10. **Excess return:** The excess return is computed as the security/market/portfolio's return in excess of the risk-free rate of return. For the market, this is the market risk premium.

$$\text{Excess return} = R_i - R_F$$

11. **Excess return to beta (Treynor ratio):** It is a measure of evaluation of a security/portfolio's performance. It gives us the excess return of a security per unit of beta. Thus, a higher Treynor ratio would mean that the security offers a high additional risk for every additional unit of beta the investor is exposed to. It is computed as

$$\text{Treynor ratio (excess return to beta)} = (R_i - R_F) \,/\, \beta_i$$

12. **Capital Asset Pricing Model (CAPM):** The theory forms the premise of Chapter 4 of this report. The theory states that assets (in this case, securities) should provide an excess return that is proportionate to how they are systematically affected by the market. In other words, investors must be rewarded for the systematic risk (measured through beta) because it is non-diversifiable. The CAPM equation is given below for a security and for a portfolio:

$$\text{Required rate of return} = R_f + \beta_x \,.\, (R_m - R_f)$$

$$\text{Required rate of return on the portfolio} = R_f + \beta_P \,.\, (R_m - R_f)$$

13. **Portfolio diversification through selection of perfectly negatively correlated securities:** Portfolio diversification is the act of reducing the risk of the portfolio by including 2 or more securities that are less correlated.

    a. If an individual invests in a portfolio of two securities which are perfectly positively correlated, the individual has failed to reduce the risk of his/her portfolio. The risk of such portfolio is the weighted average of the risks of the constituent securities. If, $r_{AB} = +1$,

    Risk of portfolio (σ_p) $= \sqrt{(w^2_a \cdot \sigma^2_a) + (w^2_b \cdot \sigma^2_b) + (2 \cdot w_a \cdot w_b \cdot \sigma_a \cdot \sigma_b \cdot 1)}$

    Risk of portfolio (σ_p) $= \sqrt{[(w_a \cdot \sigma_a) + (w_b \cdot \sigma_b)]^2}$

    Risk of portfolio (σ_p) $= (w_a \cdot \sigma_a) + (w_b \cdot \sigma_b)$

    b. If two perfectly negatively correlated securities are selected in a portfolio, then the risk of the portfolio is minimum and is equal to the difference of the weighted risks of the two securities. If, $r_{AB} = -1$,

    Risk of portfolio (σ_p) $= \sqrt{(w^2_a \cdot \sigma^2_a) + (w^2_b \cdot \sigma^2_b) + (2 \cdot w_a \cdot w_b \cdot \sigma_a \cdot \sigma_b \cdot -1)}$

    Risk of portfolio (σ_p) $= \sqrt{[(w_a \cdot \sigma_a) - (w_b \cdot \sigma_b)]^2}$

    Risk of portfolio (σ_p) $= (w_a \cdot \sigma_a) + (w_b \cdot \sigma_b)$

    The above computations demonstrate the effects of diversification by selection of less correlated securities.