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EXAMINATIONOFTHECORRELATIONBETWEENRISKANDRETURNFORSELECTEDINDEX COMPANIES

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Abstract:

Thecurrentresearchwascarriedoutwiththegoalsofanalyzingtheriskreturnconnectionaswellasthevolatilitypatternsinthereturn.Forthepurposesofthisresearch,threewell-establishedinformationtechnologybusinesses,namelyTCSLtd.,WiproLtd.,andInfosysLtd.,as well as the IT Index, of which each of these companies is a component, were analyzed. Afterconverting the closing prices of the chosen firms and the IT Index to log returns, a price seriesanalysis wasperformed onthe closing prices of the ITIndex and the selectedcompanies.Inordertoinvestigatethedegreeofvolatilitypresentinthereturnseries,boththestandarddeviationandtheGARCHmodelhavebeenused.Theinformationgatheredfromthemostrecentfour calendar years, 2019 through 2022,has been analyzed.Informationwas obtainedfrom the Bombay Stock market, which claims the title of being the oldest stock market in all ofAsia. The "More Risk, More Reward" adage does not seem to be followed by the return seriesduring the course of the time under review. Even though the stocks of these firmsand the indexthatwasresearchedperformedwellthroughoutthetimethatwasbeingstudied,thereturnseriesthatwasanalyzeddidnotrevealany specificvolatilitypattern.

Keywords: Return,Risk,Volatility,GARCH

Introduction:

Risk and return are deciding factors for investors to invest in any asset. Investors like morereturn butlessrisk.Arationalinvestorwillassumemore riskonly ifit isaccompaniedbyextrareturn.Moreriskmorerewardisanoldaxiom.Thisstudyaimsatanalysingwhetherthis is still applicable in the Indian Stock market. Standard deviation is considered as thehistorical measure of risk/volatility, but it is still used by many as proxy to volatility. With theadventofAutoregressiveConditionalHeteroscedastic(ARCH)modelanditsgeneralised

versionasGARCH(GeneralisedARCH) model,volatilityisbeinganalysedbyapplyingthesemodels.Presentstudyanalysesvolatilitybyapplyingstandarddeviationaswellas GARCHmodel.TwomajorstockexchangesinIndiaareBombayStockExchangeandNational StockExchange. BombayStockExchangeisthe oldeststockexchange ofAsia.MostofthestudiesinIndiahavebeentakenbyanalysingtheSENSEXorNIFTY50asmarket index whereas sectoralindices are ignored. Infosys and Tata Consultancy Services(TCS), reported financial results that were worse than analysts had anticipated. These resultshighlighttheproblemsthatthesectorisfacingasaconsequenceoftheprotracteddownturnin the developed nations. TCS receives around 95 percent of its income from the Americas,Europe, and the rest of the world (ROW), while Infosys receives more than 97 percent of itsrevenuefromtheseregionscombined.ROWreferstoallotherregionsoutsideofNorthAmerica and Europe. The weakness is also reflectedintheir stockvalues, which, over thecourse of the last year, have done poorly in comparison to the performance of the benchmarkequityindexes.

AsPer**Dr.NaveenPrasadula(2023)**Inthelastyear,uptoApril18,2023,thevalueofashareinInfosysor TCShasdecreasedby22.2percentor11.30percent,respectively.Ontheotherside,overthesametimeperiod,theBSESensexhadagainof4.5percent.SinceApriloflastyear,thesharepricesofotherlarge-capITcompanieslikeasWipro,HCLTechnologies,andTechMahindrahavealsofallenby32%,4%,and 24%,respectively.examinedthecross-sectionalrelationbetweenconditionalbetasandexpectedstockreturnsforasampleperiodofJuly1963toDecember2004.ThestudyusedalltheNYSE,Amex,andNasdaqfinancialandnonfinancialfirmsand datawasobtainedfromtheCenterforResearchinSecurityPrices(CRSP)fortheperiodfromJuly1963throughDecember2004.Researchersuseddailystockreturnstogeneratetheconditionalbetameasures.Compustatdatasetwasalsousedtoobtainthebookvaluesforindividualstocks.Theresultindicatedapositive,significantrelationbetweenconditionalbetasandthecross-sectionofexpectedreturns.Theaveragereturndifferencebetweenhighandlow-betaportfoliosrangesbetween0.89%and1.01%permonth,dependingonthetimevaryingspecificationofconditionalbeta.Aftercontrollingforsize,book-to-market,liquidity,andmomentum,thepositiverelationbetweenmarketbetaandexpectedreturnsremainedeconomicallyandstatisticallysignificant.**MenggenChen,(2021),**throughhisstudythrowslightonfourresearchquestions.First,heexploredthechangesoftherisk-returnrelationshipovertimeintheChinesestockmarkets.Then,differenceinrisk-returnrelationshipbetweenShanghaiandShenzhenstockmarketswereanalysed.Thestudythencomparedthesimilaritiesanddissimilaritiesofthe

risk-return tradeoff for differentfrequency data. At last,anattemptwasmadebyresearcherto compare the explanation power of different GARCH- M type that are commonly used inexploring the risk-return tradeoff.The researcher used the stock price indices of the ShanghaiComposite Price Index and Shenzhen Component Price Index from April 3, 1991 to July 29,2011. This paper analysed the risk-return tradeoff by using daily, weekly and monthly returndata simultaneously. The empiricalresultsshowedthat the dynamic risk-return relationshipwasquitedifferentbetweenShanghaiandShenzhenstockmarkets.Apositiveandstatistica llysignificantrisk-returnrelationshipwasfoundfor the daily returns in ShenzhenStock Exchange, while the conditional mean of thestockreturns was negatively related to theconditional variance in Shanghai Stock Exchange. The study also found that the risk-returnrelationship usually became much weaker for the lower frequency returns in both markets.**KuangnanFang,JiWu&CuongNguyen(2015)**analysedtherisk-returntrade-off inaliberalized emerging stockmarket Vietnam duringthe period 2007–2014. The research datawas extracted fromDataStream website.Dailyand monthlyindividual stock returns in theVSMfrom2007to2014werecollectedfromthedatabaseaswellasmarketcapitalizationand book to-market ratio (BM). The interbank offered rate was used as the risk-free rate. Thestudy excluded stocks with either daily returns of less than −100 percent or monthly returnsgreater than 200percent, as well as stocks with anegative book-to-market(BM) ratio, in ordertoreducethenoiseincomputingvariablesforeachstock.Stocksthatdidnotcontinuallyhave past-twenty-two-days return records in a particular month were also excluded from thesample. 684 stocks were considered for the study. 42,828 monthly return observations andapproximately1milliondailyreturnobservationswereusedbytheresearcher.Theauthorfoundthat neithertherealizedidiosyncraticvolatilitynortheconditionalidiosyncraticvolatility has been priced. It was also found that the Rational multifactor models could wellexplainthestockportfolioreturns.Flattrendforequal-weightedidiosyncraticvolatility(IVOL), but a downward trend for market volatility was noticed in the study. The results alsoshowed that the idiosyncratic risk played an unimportant role in pricing stocks and that thesystematic risks still dominate asset returns in emerging stock markets. Results implied thatVietnamese investors can get increased benefit from portfolio diversification.**Al Adwani, J.(2016)**used factor models with macro- finance predictors to test the intertemporal risk-returnrelation for 13 European stock markets from 1986 to 2012. Researcher used monthly countryspecific, euro area, and US macro- finance factors to determine the conditional volatility andconditionalreturn.Theresultsconfirmednegativerisk-returntrade-off.TheMarkovswitching model confirmed that time- variation in the above mentioned trade-off between riskandreturnwaslinkedtothestateoftheeconomy, butnotthebusinesscycles.Quantileregressionsexhibitedthattherisk-returntrade-

offwasstrongeratthelowestquantileofthe

conditional return. **Patel, R. (2021)** conducted the study to examine the risk-return tradeoff inthe Indian stock market.The sample period ofstudy was from January 4,2000 toDecember31, 2020.The empirical resultsshowedexistenceofrisk-returntradeoffintheBSE.Apositiverisk-returntradeoffwasfoundfor monthly & annualreturn series.The market hasweakrisk-returnrelationship indailyreturnseries.TheCGARCH(1,1)capturedtheasymmetricvolatilityeffectforallthe differentfrequencybasedreturns.Thestudyhasimplications for the investors. The risk return relationship was stronger and significant inlongerdurationofinvestment.Themarketgavehigherreturnforundertakinghighrisk.**Leirvik, T. (2022)**analyzed the relationship between the volatility of market liquidity andrealized returns of the five largest cryptocurrencies Bitcoin, Litecoin, Ripple, Ethereum andBCH. The sample used in the study analysis covers the period from January 1st, 2016, toDecember 31st, 2020. The researcher used short time period for the study in order to comparecross-sectionally. Data for the study was taken from Coinmarketcap.com website and was atdailyfrequencywhichcontainsopen, high,low,closeprices,volume,andmarketcapitalization.Inordertocontrolforother variables which might impact cryptocurrencyreturns,theVIX-indexandS&P500indexwereincludedinstudy.Inaddition,acryptocurrency indexwas constructedby using twelve different currencies. The currenciesused,inadditiontothefivecurrenciesanalyzedinthepaper,wereEOS.IO(EOS),BinanceCoin (BNB),Cardano (ADA),Stellar (XLM),Monero(XMR),Chainlink(LINK),andTron(TRX).BecauseBitcoinwasmuchlargerincapitalizationthanallothercurrencies,theindexwasequallyweightedsothatanysensitivitytowardstheindex wasnotconfusedwithsensitivitytowardsBitcoin.Theresultsindicatedapositiverelationshipbetweenthevolatilityofliquidityandreturnsingeneral.Thismeansthat investorsconsiderthetime-variation of liquidity as a riskwhich shouldbe compensated with higher returns. For Bitcoin,thelargestcryptocurrency,thisrelationshipvariesovertime,anditwasfoundthattherelationshipbetweenthevolatilityofliquidityandreturnsisthelowest,yetpositive,amongthecurrenciesstudied.This againindicatesthatinvestorsinBitcoinconsiderliquiditylessarisk compared to the other currencies, which might be due to the popularity of the particularcurrency.

ObjectivesoftheStudy: Presentstudyhasbeenundertakenwithfollowingobjectives

1. Tofindoutrelationshipbetweenriskandreturnamongsomeofthe InformationTechnology companieslistedonBombayStockExchange
2. Tofindoutwhethertherelationshipissameamongcompaniesandthe Indexofwhichthese companiesareconstituents

3. Todeterminethevolatilitypatternsofreturnsanalysed

4. Todeterminewhichofthereturnsanalysedishighlyvolatile

Dataforthestudy: BombayStockExchangeistheoldeststockexchangeinIndiaandinformation technology is a booming sector, so three established IT companies listed in S&PBSE Information Technology Index along with this index have been selected for the presentstudy. For sake of simplicity S&P BSE Information Technology Index will be termed as ITIndex in rest of the research paper. Closing prices for 4recent calendar years for all the threecompaniesselectedandtheITIndex,from1stJanuary2019to31stDecember2022,collectedfrom BombayStockExchange,havebeenanalysed.

Table 1 showsthe turnoverofthe three Companiesselectedfor the presentstudy fortheperiodunderstudy

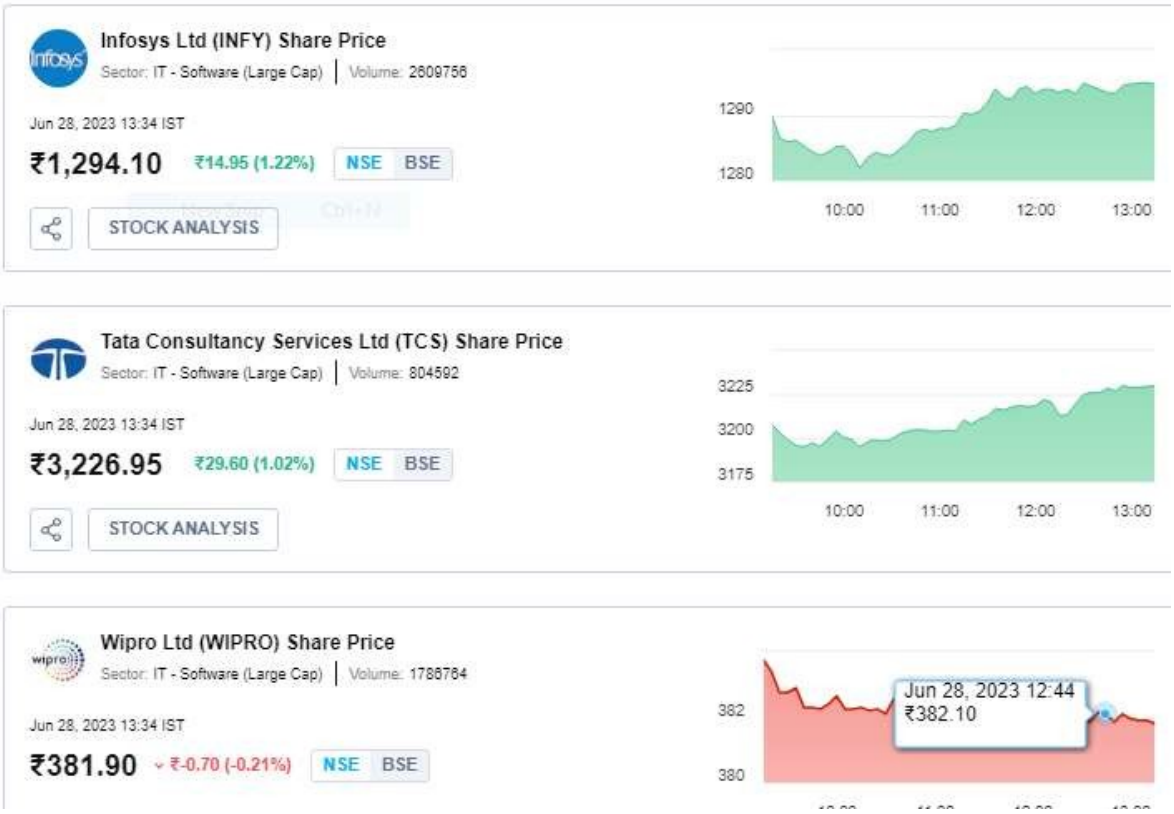


Table1

TotalTurnover(Rs.)			
Year	TCSLtd.	WiproLtd.	InfosysLtd.
2019	73289180385	44021992320	92428935722
2020	94141426396	33871164466	110058310162
2021	128682056993	78840995954	162078893681
2022	136383764860	66547000919	166450601296

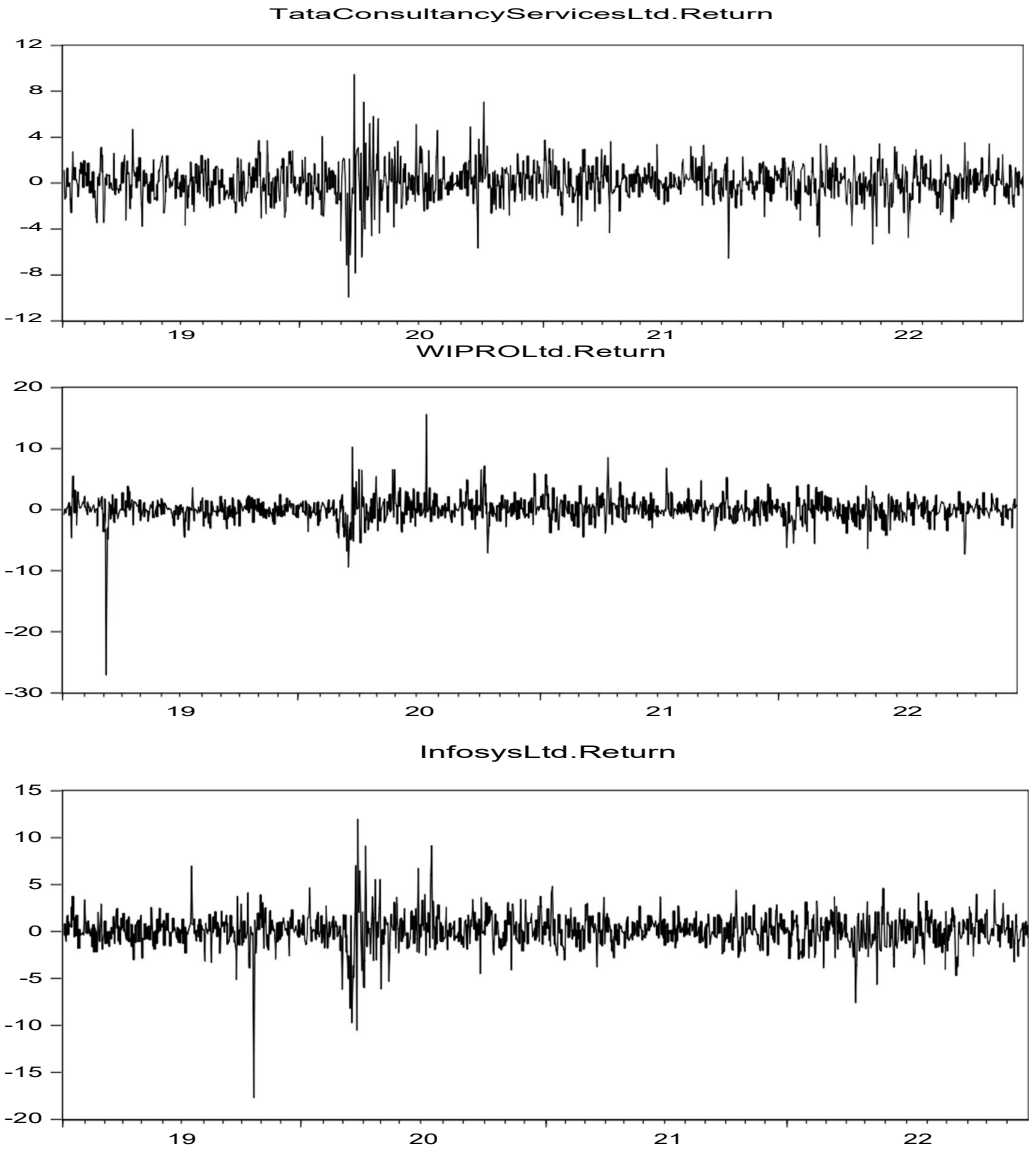
It is clear from the above table that turnover for TCS Ltd. and Infosys Ltd. are on increasingtrendforallthefouryears,whereasforWiproLtd.thetrendismixed.

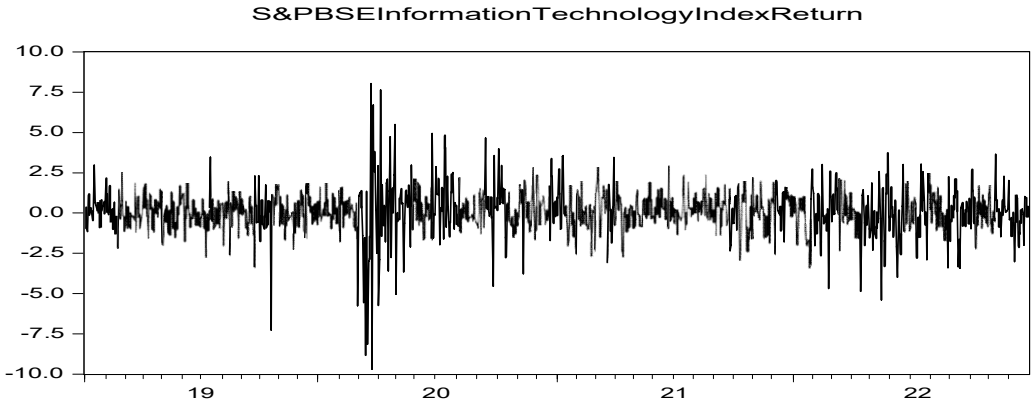
Return:

ClosingpricesofallthethreecompaniesaswellasITIndexwereconvertedtologreturnwiththehelpoffol lowing formula

Return=$(Logofclosikgprices_t - Logofclosikgprices_{t-1}) * 100$

WherelogisthenaturallogandtisthetimeperiodAllthere turnseriesarepresentedgraphically.

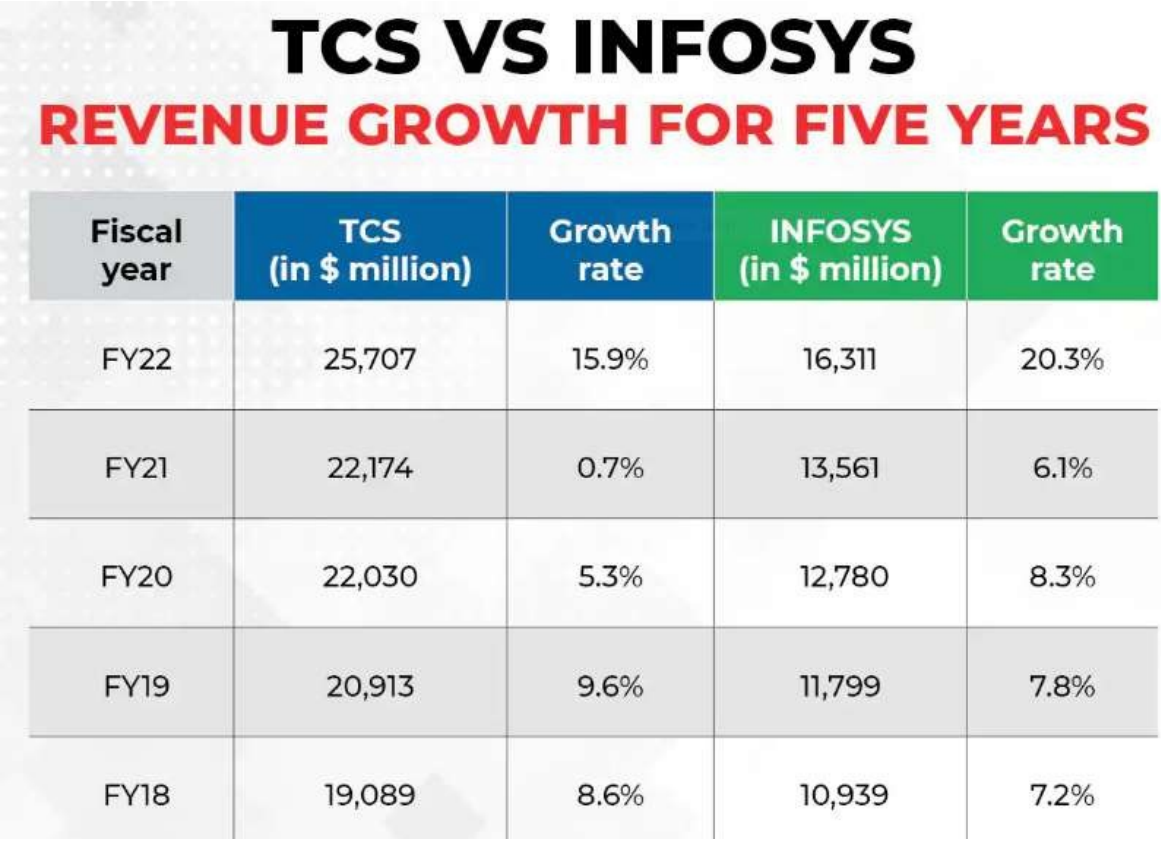




Table

2DescriptiveStatisticsofReturn

Statistic	Tata Consultancy Ltd.	Wiproafteradjustingforoutlier	InfosysafteradjustingforOutlier	S&P BSE InformationTechnologyIndex
Mean	0.054275	0.042344	0.100955	0.071241
Median	0.055945	0.056084	0.123131	0.107359
Maximum	9.435958	15.56413	11.94903	8.029748
Minimum	-9.92652	-9.39433	-10.4895	-9.68986
Std.Dev.	1.655707	1.876742	1.810902	1.517803
Skewness	-0.26074	0.667892	0.074208	-0.56622
Kurtosis	7.405526	10.71179	9.137117	9.441243
Jarque-Bera	813.465	2531.918	1557.698	1767.91
Probability	0	0	0	0
Observations	992	992	992	992



Fiscal year	TCS (in $ million)	Growth rate	INFOSYS (in $ million)	Growth rate
FY22	25,707	15.9%	16,311	20.3%
FY21	22,174	0.7%	13,561	6.1%
FY20	22,030	5.3%	12,780	8.3%
FY19	20,913	9.6%	11,799	7.8%
FY18	19,089	8.6%	10,939	7.2%

AbovegraphsaswellastheDescriptivestatisticsshowthattherearesomecommonpatternsin the return series of all the three companies and the Index returns. All the return series arenegatively skewedandhighly kurtotic i.e. allare not normallydistributed. While analysingtimeseriesdatawearelessconcernedwithnormalityandmoreconcernedwithautocorrelatio n. Some outlier is visible in graph of Wipro Ltd. return and Infosys Ltd. return.The return series for these two companies were modified by replacing the outliers with theaveragevalueofpreviousandnextperiodreturnandthedescriptivestatisticsfortheserieswas calculated again. Further analysis was carried on the modified series of returns of WiproLtd. andInfosys Ltd. Ifwe comparethereturnand standard deviation oftheseries, wefindthat Infosys Ltd. has highest return but not the highest standard deviation whereas Wipro Ltd.has lowest return but not thelowest standard deviation, i.e.more riskmorereward axiom isnot followed by these series if we consider standard deviation as a measure of risk. S&P BSEInformationTechnologyIndexhasloweststandarddeviationconfirmingthatriskmaybeminimise dwithdiversification.

GARCHModel: UnlikeClassicalLinearRegressionModel(CLRM),GARCHModelsdon'tassumet hevarianceoferrorstobeconstantovertime.(Brooks,2018)Beforeapplying

ARCH/GARCHmodel, ARCHeffectinresidualsistested,ifARCHeffectispresentinresiduals, appropriate GARCH model is applied. For applying GARCH model, two equationsaretobespecified,themeanequationandthevarianceequation,whereasinCLRM(Classical Linear Regression Model) only meanequationisspecified,asvarianceoferrortermsisassumedtobeconstant.Varianceequationfor GARCH(1,1)modelis:

$$\sigma_t^2 = {}_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2$$

Whereσ_t^2isknownasconditionalvarianceforperiodt,$\alpha_1 u_{t-1}^2$ istheinformationfor volatilityduringpreviousperiodand$\beta\sigma_{t-1}^2$ isthepreviousperiodvariance.

GARCH in Mean: To study the risk-return relationship, GARCH-in-Mean model has beenappliedinthepresentstudyandstandarddeviationhasbeenintroducedinthemeanequation.Sofort he presentstudymeanequationhasbeenspecifiedas:

$$Returk = c + \delta\sigma_{t-1} + u_t$$

Whereδspecifieswhetherinvestorsarerewardedforassumingmoreriskornot,ifδispositiveandsignific ant,itindicatesthatmoreriskcontributestohigheraveragereturn.

Empirical Results: Data for the present study has been analysed with the help of eviews9software. After preliminary analysis of data through graphs and descriptive statistics,all thereturnserieswereregressedoncandtheARCHeffectwasstudiedinresiduals.Nullhypothesis of the testapplied is "ARCH effectisnot present in the residuals". Results of thetestare presented inTable2.

Table3

ResultsofHeteroskedasticityTest:ARCH

	Infosys Ltd.	TCS Ltd.	Wipro Ltd.	IT Index		Infosys	TCS	WiproLtd.	IT Index
F-statistic	**123.39**	**29.90**	**4.23**	**91.99**	**Prob. F(1,989)**	**0.000**	**0.000**	**0.040**	**0.000**

On the basis of probability value of the test statistic (probability value of F-statistics less than0.05),nullhypothesisof"noARCHeffectpresentinresiduals"mayberejectedat5%levelof significance and GARCH model may be applied on the return series. As already discussed,GARCH-in-Mean modelhas been applied to study the risk return relationship and the resultsare presented inTables4through7.

Table4

ResultsofGARCH-in-MeanModelforTCSLtd.Return

DependentVariable:RETURN				
Sample(adjusted):1/02/201912/30/2022				
GARCH=C(3)+C(4)*RESID(-1)^2+C(5)*GARCH(-1)				
Variable	Coefficient	Std.Error	z-Statistic	Prob.
MeanEquation				

@SQRT(GARCH)	0.12864	0.153526	0.837908	0.4021
C	-0.13059	0.229555	-0.56888	0.5694
VarianceEquation				
C	0.206165	0.05481	3.761429	0.0002
RESID(-1)^2	0.105387	0.020335	5.182614	0
GARCH(-1)	0.81494	0.037173	21.92309	0

Table5

ResultsofGARCH-in-MeanModelforWiproLtd.Return

DependentVariable:RETURN				
Sample(adjusted):1/02/201912/30/2022				
GARCH=C(3)+C(4)*RESID(-1)^2+C(5)*GARCH(-1)				
Variable	Coefficient	Std.Error	z-Statistic	Prob.
MeanEquation				
@SQRT(GARCH)	0.239574	0.169449	1.413844	0.1574
C	-0.37131	0.295401	-1.25696	0.2088
VarianceEquation				
C	0.694165	0.104375	6.65069	0
RESID(-1)^2	0.166607	0.025602	6.507624	0
GARCH(-1)	0.64455	0.047029	13.70536	0

Table6

ResultsofGARCH-in-MeanModelforInfosysLtd.Return

DependentVariable:RETURN				
Sample(adjusted):1/02/201912/30/2022				
Includedobservations:992afteradjustments				
GARCH=C(3)+C(4)*RESID(-1)^2+C(5)*GARCH(-1)				
Variable	Coefficient	Std.Error	z-Statistic	Prob.
MeanEquation				
@SQRT(GARCH)	-0.01117	0.164064	-0.06807	0.9457
C	0.151515	0.260125	0.582471	0.5602
VarianceEquation				
C	0.204106	0.047787	4.271126	0
RESID(-1)^2	0.083831	0.013936	6.015404	0
GARCH(-1)	0.846186	0.027508	30.76165	0

Table7

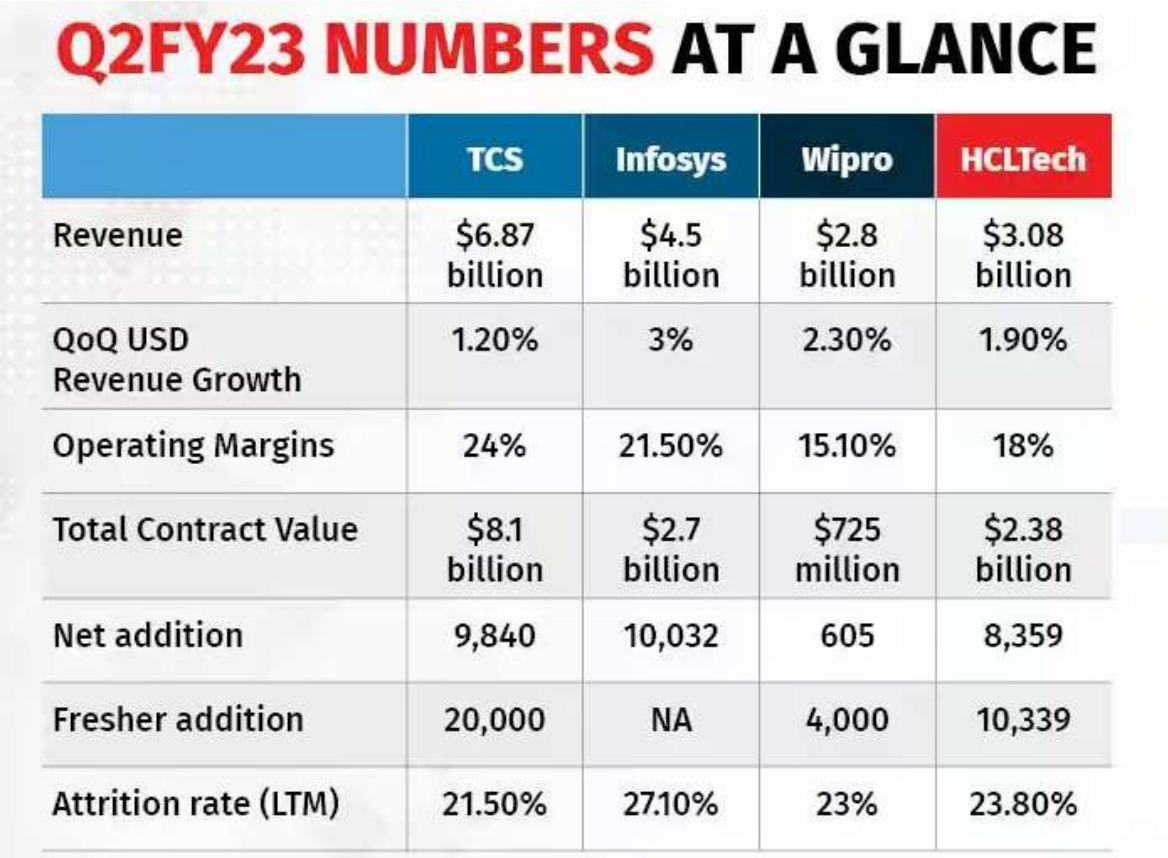
ResultsofGARCH-in-MeanModelforITIndexReturn

DependentVariable:RETURN
Sample(adjusted):1/02/201912/30/2022
GARCH=C(3)+C(4)*RESID(-1)^2+C(5)*GARCH(-1)

Variable	Coefficient	Std.Error	z-Statistic	Prob.
MeanEquation				
@SQRT(GARCH)	0.117244	0.155929	0.751908	0.4521
C	-0.05128	0.205205	-0.24989	0.8027
VarianceEquation				
C	0.10802	0.026269	4.112018	0
RESID(-1)^2	0.075793	0.011688	6.484836	0
GARCH(-1)	0.871759	0.021235	41.05259	0

In the above four tables i.e. fromTable4 to Table7,in the meanequation, @SQRT(GARCH)is an indicator of reward for more risk assumed by the investor, C is the average return. Invarianceequation,RESID(-1)^2istheinformationforpreviousperiodvolatilityandGARCH(-1) is previous period variance estimated from the model applied in the present study. If weobservethecoefficientsofthese,itcanbesaidthatcoefficientof@SQRT(GARCH) ispositive for TCSLtd.return, WiproLtd.return and ITIndex return but itisnot significantat5% level of significance (Probability value greater than 0.05) for any of these returns. ForInfosysLtd.returnitisnegativebutagainnotsignificantat5%levelofsignificance(probability value greater than0.05).Thisindicates that there is no"More riskmore reward" relationship in the return series analysed for theperiod selected for the presentstudy.CoefficientofC inmeanreturnindicatestheaveragereturn.

Ifweobservethiscoefficient,itisnotsignificantforanyofthereturnseriesanalysed,itindicatesthatretur nforall the series is not significantly different from zero and it can be said that the stocks and ITIndex studied behaved efficiently during the period of study. Coefficient of RESID(-1)^2, i.e.informationfor volatility during previous period,indicates about the spikesinthe seriesandin the present study, it is significant (P value around 0) forall the return seriesanalysed.Highest spikes are observed in case ofWipro Ltd. followed by TCS Ltd. and Infosys Ltd. andleast spikes are observed in case of IT Index. Coefficient of GARCH(-1) indicates about thepersistenceofvolatilityandinthepresentstudy,it issignificantforallthereturnseriesanalysed.ItishighestforITIndex,followedbyInfosysLtd.,TCSLtd. andWiproLtd.



Q2FY23 NUMBERS AT A GLANCE

	TCS	Infosys	Wipro	HCLTech
Revenue	$6.87 billion	$4.5 billion	$2.8 billion	$3.08 billion
QoQ USD Revenue Growth	1.20%	3%	2.30%	1.90%
Operating Margins	24%	21.50%	15.10%	18%
Total Contract Value	$8.1 billion	$2.7 billion	$725 million	$2.38 billion
Net addition	9,840	10,032	605	8,359
Fresher addition	20,000	NA	4,000	10,339
Attrition rate (LTM)	21.50%	27.10%	23%	23.80%

Conclusion:

Onthebasisofdataanalysed,itcanbeconcludedthatthoughthestocksandIndexanalysedin the study behaved efficiently during the period of study, investors are not rewarded forassumingextrarisk.Spikesintheseriesare alsoobservedandthevolatilityispersistent.Noparticular pattern could be observed in the volatility of the return series analysed. The majorfour information technology businesses in India, Tata Consultancy Services (TCS), Infosys, Wipro,and HCLTech, all reported results that ranged from positive to mixed for the second quarter, whichcametoacloseonSeptember30.Inspiteofconcernsoveranimminentrecession,inflation,difficulties in obtaining US H-1B visas, a toughening climate in key markets such as north America,the United Kingdom, and Europe, and delays in employing freshers, the information technologyindustryshownresilienceduringthisquarterasdemandremainedconstant.Onlyafewlocalizeda reashave been seeing a slowdown, according to the commentary provided by corporate management, butoverall, demand is still quite high. Executives from the corporation, on the other hand, have advisedcautionandstressedthattheyarecontinuingtomonitorthesituationclosely.

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