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Stock Returns and Volatility in India : An Empirical Puzzle ?

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The behaviour of equity premiums in India shows that long term investors do get compensated for the systematic risk they bear by holding equities. In the short to medium run, however, both the direct and the indirect test suggested by French, Schewart and Stambaugh (1987) fail to establish the expected risk-return relationship for Indian equities. Dominance of short horizon players in the market and the associated avoidable volatility in the equity market obscures the implications of monetary policy for the equity cost of capital in India.

Introduction

In the financial economics literature, it is generally assumed that risk-averse investors expect higher returns for investing in relatively riskier assets and therefore, the risk premium represents the compensation to the investor for assuming risk. The non-zero risk premiums are not only directly unobservable but also vary substantially over time. Apart from the 'animal spirits' driving investor exuberance, short-term volatility in risk premiums could result from shifts in inflation expectations, monetary policy shocks, changes in market perceptions relating to the underlying 'fundamentals', all of which cause frequent corrections in expectations about future cash flows.

The relationship between premiums or excess returns, representing the excess of expected returns over risk free returns and risk, measured by the volatility of market prices of assets is an intensely debated theme in the literature. In particular, the focus of empirical investigation has been on the dynamics of the risk-return relationship in equity markets. The residual nature of returns to

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equity makes it the costliest form of capital. The equity cost of capital covers both the time value of money and a compensation for risk – a combination of 'term premium' and 'risk premium' – which are difficult to disentangle. Nevertheless, assuming the characteristics of a 'rational' market, a positive relationship is expected to emerge between excess returns on equities and volatility in equity returns.

This paper undertakes an empirical verification of the rational markets hypothesis of a positive relationship between excess return and volatility in the context of equity markets in India. In view of the growing debate surrounding the adequacy of the standard Capital Asset Pricing Model (CAPM) in providing empirically testable formulations of the hypothesis and the handicaps faced by alternative cross-sectional approaches, the paper adopts the time-series methodology first employed by French, *et al* (1987) in the context of US equity markets. In essence, volatility of returns is decomposed into an 'expected' component and an 'unexpected' component on the premise that even if the expected relationship between excess returns and realised volatility fails to be established, validation of a positive relationship between excess returns and expected or *ex ante* volatility and a negative relationship between excess returns and unanticipated volatility by means of the indirect test proposed by French, *et al* would provide corroboration to the rational market hypothesis. Section I encapsulates the debate on the observed behaviour of equity premiums and on the alternatives to empirical verification. Section II presents the stylized facts characterising returns in the Indian stock market. Section III sets out the methodology adopted in this paper, *a la* French, *et al*. Empirical findings are examined in Section IV and Section V concludes the paper by summarizing the major findings.

Section-I

The Debate Encapsulated

In the second half of the nineties, equity premiums appear to be going through a secular decline in most of the developed financial markets. During 1800-1850, the equity premium in the USA was close to zero due to high real rates on bonds. The premium remained mostly stable at around 4 per cent during the period 1850-1950. Since then, the equity premium declined from a peak of 10 per cent in the early 1950s to about 2-3 per cent in the 1990s (Blanchard, 1993). The phenomenon has been attributed to the gradual increase in the real returns on bonds. On a fundamental level, the 'vanishing equity premium' is viewed as the result of the prolonged experience of generalised low and stable inflation which has brought about a downward shift in the risk perception of investors (Modigliani and Cohn, 1979; Blanchard, *op.cit.*). The decline in equity premiums is also attributed to change in the degree of risk aversion *i.e.*, possible decline in the degree of risk aversion over time, global financial integration - allowing the diversification of ideo-syncratic risks on a global level, demographic changes - tilting the composition of the population in favour of younger/older and therefore risk loving/ averse age groups, and financial liberalization – lowering illiquidity risk and reducing transaction costs.

At an empirical level, testing for the risk-return relationship in financial markets has typically involved the application of the capital asset pricing model (CAPM), either in its standard form or variants. In the CAPM framework investors have to be compensated only for bearing systematic risks, since unsystematic risks can be managed through diversification. Since the mid-1980s and particularly in the 1990s, an intense debate has dominated the empirical literature on the adequacy of the CAPM in testing for the risk return relationship. Drawing from the seminal critique by Roll (1977), the debate has centred around whether "beta is dead" or whether "beta is alive and well" (Jagannathan, *et.al.*, 1993). This has motivated a search for alternative tests to explain the behaviour of the risk return relationship in the genre of cross sectional approaches. Factors such as price-earning ratios (Basu, 1977), firm size (Banz, 1981), book-to-market (Fama and French, 1992) and country ratings (Erb, et.al., 1996; Qin and Pattanaik, 2000) have been used as alternatives to CAPM *beta*.

Empirical failure of cross section approaches, despite powerful theoretical validity, has provoked attempts to empirically investigate the risk-return relationship in equity markets through time series type approaches among which French, *et.al*. can be regarded as seminal. French *et.al.* conducted empirical test using the Standard and Poor (S&P) composite index over the period 1928 to 1984. Volatility was decomposed into anticipated or *ex ante* component and unexpected volatility. Anticipated volatility was estimated using Auto Regressive Integrated Moving Average (ARIMA) and Generalised Auto Regressive Conditional Heteroscedasticity (GARCH) techniques. Instead of the direct test of the relationship between excess returns and contemporaneous estimates of *ex-post* volatility, French e*t.al*. proposed an indirect test through a positive relationship between excess returns and *ex ante* volatility and a negative relationship between excess returns and unanticipated volatility to validate the rational market hypothesis.

Emerging market returns in general are more predictable than developed market returns, the higher degree of predictability stemming from lack of market efficiency (Bekaert *et.al.*, 1998). Emerging markets are usually characterised by high degree of volatility persistence, showing the presence of conditional heteroscedasticity and considerable momentum, indicating path dependence with autocorrelations. Non-normal distribution of the returns is another typical feature of emerging market returns, with fat distribution tails indicating the presence of volatility clustering (Jacobson, 1997). The predictability of returns, which is taken as an invalidation of the random walk process, is no longer viewed as rejection of market efficiency. Recent econometric advances and empirical evidence suggests that financial asset returns are indeed predictable. "Thirty years ago this would have been tantamount to an outright rejection of market efficiency. However, modern financial economics teaches us that other, perfectly rational factors may account for such predictability" (Campbell, *et.al*. 1997). In fact, it is argued that as compared with returns, the volatility of stock returns could be predicted with greater certainty (Pagan and Schwert, 1990). It may be useful, therefore, to estimate predictable volatility and study how predictable volatility influences investor behaviour, as highlighted in French, *et.al.*

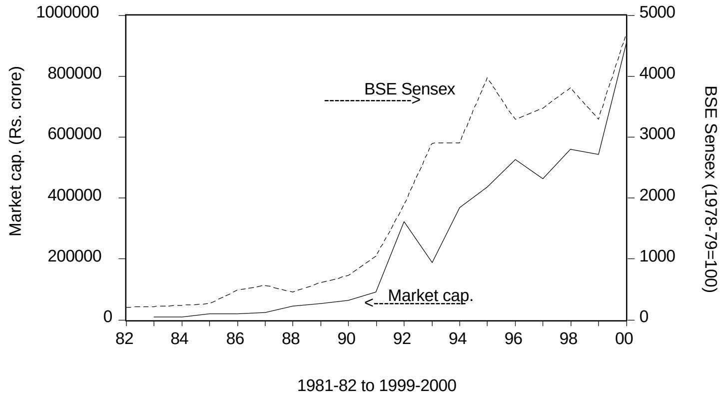
Section – III

Stock Retuns in India : The Stylised Facts

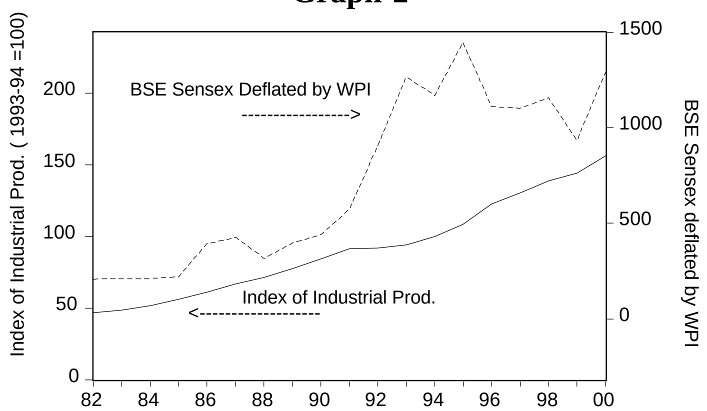
Indian capital market has acquired considerable depth over the past years and benefited from significant transformations brought about by the introduction of new institutions, infrastructure, technology and innovative instruments. (See Misra, 1997 for a comprehensive review.) The growing importance of capital market as an alternative to banks for intermediating the country's saving is exhibited from the fact that total annual mobilisation of resources through the primary market as a percentage of annual incremental aggregate deposits of scheduled commercial banks has increased from a low of 3.4 per cent in the seventies to about 70 per cent in 1999-2000. In the secondary market, market capitalisation as a percentage of GDP also rose from less than 7 per cent in the seventies to about 47 per cent in 1999-2000. Growth in market capitalisation is a combined effect of growth in new additions to equity and the increase in stock prices. (Graph-1 plots the behaviour of market capitalisation *vis-à-vis* stock price movements during the eighties and the nineties.) In terms of fundamental analysis, stock prices as reflected in a market index is expected to converge to a path justified by a nominal growth rate of equity return that is equal to the expected rate of real GDP (or IIP) growth plus the rate of inflation. Return on individual stocks may be more or less than the long run nominal growth rate of GDP/IIP, but for the market as a whole the convergence is expected to hold in the long run. Graph-2, which plots the Index of Industrial Production against the BSE sensex deflated by WPI shows that the real value of stock prices in India deviated considerably from the actual IIP. Since stock prices should reflect expected future real activity, a contemporaneous relationship as shown in Graph-2 may not be valid.

As per the standard valuation of stock prices in terms of expected discounted future earnings, however, using the P/E ratio one could assess to some extent the possible deviations from the fundamental values of stocks. In India, the P/E ratio has exhibited large fluctuations over time, quite unrelated to fundamentals. As estimated by Gupta, Jain and Gupta (1998), the P/E jumped from about 15 in January 1991 to almost 40 by April 1992, fell by almost half in the next one year and touched 43 in April 1994 before falling to 10.5 in December 1996. (Graph-3) Studying the behaviour of P/E from early eighties, they classified the market valuation of stocks into four categories: dangerously high (for more than 21), high (18 to 20), reasonable (13 to 17) and too low (12 or below). If one uses the P/E on IFC global Index (which is available for the whole of 1990s), during 1991-94 the market was dangerously overvalued and since then it has been either high or reasonable. The inverse of the P/E ratio is also known as the earnings yield – indicating corporate profitability in relation to the market value of corporate equity. For an end March 2000 P/E of 19.76, one obtains an earnings yield of about 5 per cent. If one assumes the market to remain either high or reasonable, then the associated earnings yield would range in between 7.7 per cent to 5 per cent. Such estimates are, however, point estimates and could vary significantly over time since P/E ratio itself is a function of the risk free rate, the risk premium, and expectations of growth, each of which could be time varying.[1] It may be noted that compared with the US market (i.e. S&P 500) which has yielded an averge earnings yield of close to 7 per cent during 1950-99[2], earnings yield on Indian stocks in the 1990s do not seem to be attractive. For such comparisons, however, the holding period is important. For a five year holding period with terminal years in 1992, 1993, 1994 and 1995 returns on BSE Sensex were high in the range of 30 to 40 per cent because the P/E showed the sharpest rise during this period. (Gupta, 2000)[3]. For a ten year holding period, the average rate of return remained above 10 per cent throughout the nineties.

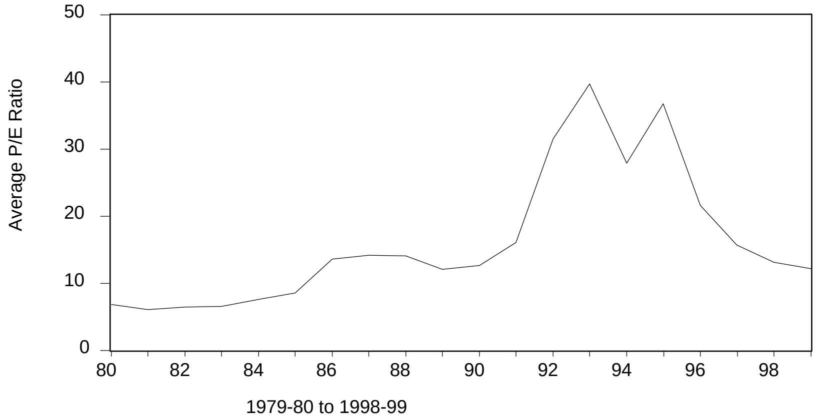
Graph-1



Graph-2



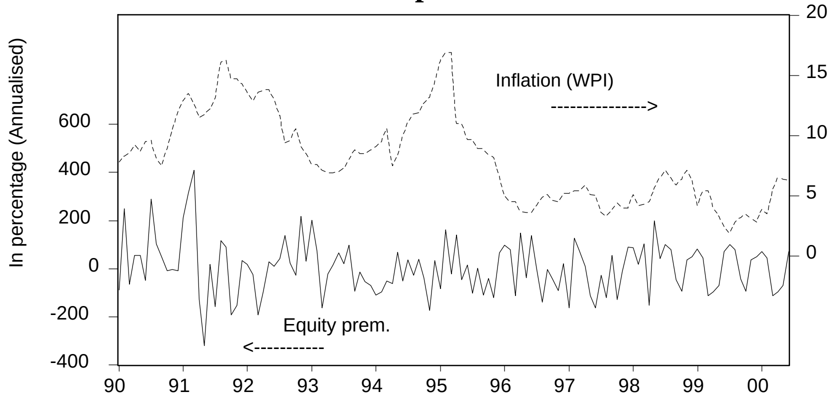
Graph-3



Source : Gupta (2000)

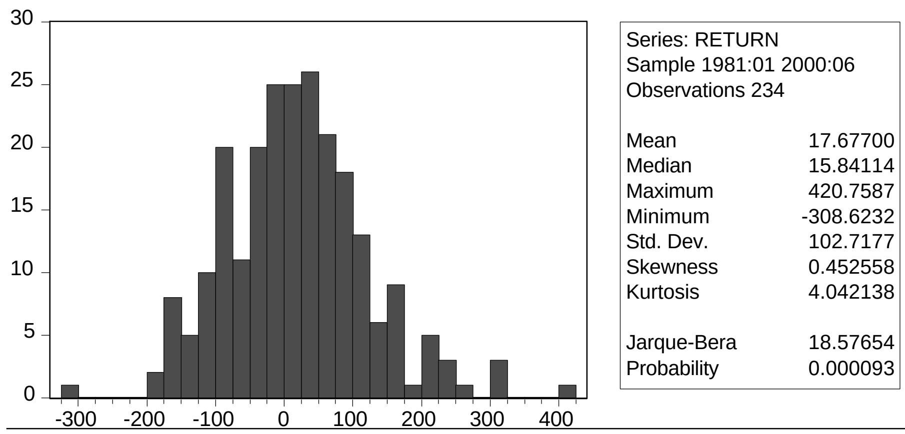
Shah (1999) presented a comprehensive assessment of the impact of reform measures introduced in the Indian capital market in the nineties and concluded that developments like sharp reduction in transaction costs, enhanced liquidity, reduced leverage and evidence of superior information processing by the market agents contributed to greater efficiency in the market. Against these developments, the empirical validity of the indirect test suggested by French *et.al.* could also help in assessing the potency of monetary policy in reducing the equity cost of capital in India. In Graph-4, however, the behaviours of equity premium and inflation do not seem to exhibit any particular relationship between the two. The return on equity could be decomposed in to risk free rate (r_f), risk premium (r_p), bubble premium (b_p) and unanticipated shocks to stock returns (ε_t). Inflation and financial instability represent systematic risks and monetary authority could limit the exposure of the economic system to systematic risk by ensuring financial stability and a low inflation environment. When monetary policy proves effective in containing the equity market bubbles and in avoiding hard landings, the return on equity demanded by the investors could also be influenced. In a market when prices do not yield returns consistent with the systematic risks, evaluating the implications of monetary policy for the equity cost of capital could be difficult.

Graph-4

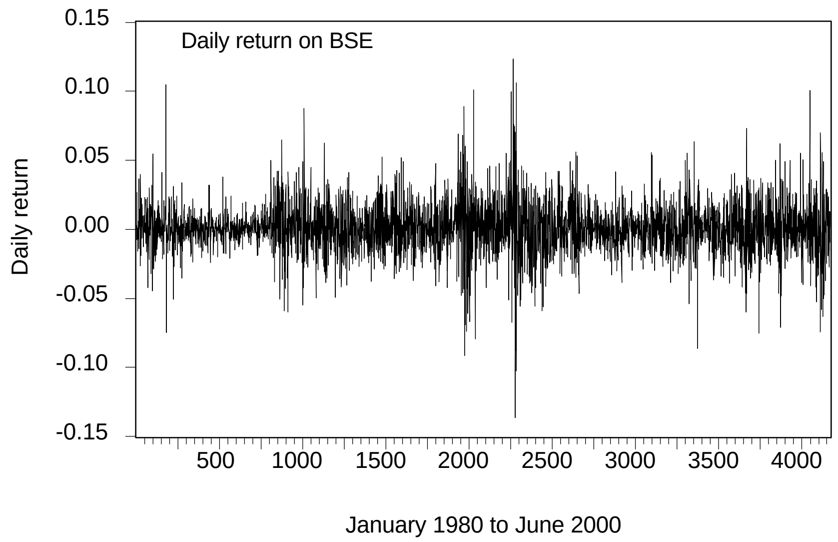


As could be seen from Graph-5, the distribution of monthly (annualised) returns[4] on BSE sensex (January 1981 to June 2000) is symmetric. But the Skewness, Kurtosis and Jarque-Bera test statistics reject the null of normality, indicating the presence of fatter tails. The first order autocorrelation coefficient (estimated as the slope of the regression of monthly return on one period lagged return) at 13.13107 (with standard error = 0.049648) indicates the returns to be autocorrelated, and therefore time dependent. Graph-6 also shows the presence of volatility clustering. The distribution characteristics of BSE stock returns are, therefore, typical of most emerging market economies. Irrespective of these characteristics, every rational market should show a positive relationship between equity premiums and the volatility of returns. When the direct test of this relationship fails, one could use the indirect test suggested by French *et.al*. to validate the relationship.

Graph - 5



Graph – 6



Section-IV

The Methodology

The conventional approach to study the relationship between "expected return" and "*ex-ante* volatility" is through the simple regression equation:

Risk premia (*i.e.* market return – risk free rate) = $\alpha + \beta$ (*ex-ante* variance or standard deviation of the market portfolio). In actual empirical analyses, realised volatility rather than *ex-ante* volatility is considered and, as a result, the underlying market behaviour is not explained properly. Realised volatility represents a combination of ex-*ante* or expected volatility and un-*expected* volatility. While risk premiums may exhibit a positive relationship with *ex-ante* volatility, their relationship with the unanticipated volatility could be negative.[5] Since the relative importance of *ex-ante* volatility and unexpected volatility could vary over time, one may get an obscured relationship between risk premium and observed *ex-post* volatility.

French *et.al.* applied ARIMA and GARCH techniques for estimating *ex-ante* volatility from *ex-post* volatility. Following French *et. al.* monthly standard deviations are computed from daily stock returns on the composite BSE. The standard deviation of monthly returns is tested for stationarity and after identifying the appropriate orders of AR and MA process embodied in the stationarised series, ARIMA based conditional forecasts of the standard deviations are generated to see whether the predicted SDs track the actual SDs closely. The forecasts are then assumed to represent the "predictable volatility", and "unpredictable volatility" is derived as the difference between realised volatility and the predicted volatility. Prior to running regressions of excess holding period returns (as proxy of risk premiums) on ARIMA generated forecasts of volatility, two further adjustments as suggested by French *et.al.* are made: (a) each observation of the relevant variables is weighted by the predicted standard deviation (*i.e.* the use of weighted least squares to correct for possible presence of heteroscedasticity), and (b) White's consistent correction for heteroscedasticity to the regression at (a) is employed.

Following French *et. al. ex ante* measures of volatility using ARCH and GARCH are estimated and the relationship between equity premium and volatility for the composite BSE sensex is empirically tested. When variance of the error term varies directly with one or more independent variables in the regression equation, use of weighted least squares technique could transform errors into a homoscedastic process and thereby Ordinary Least Squares (OLS) could still provide efficient parameter estimates. An alternative is to use White's correction for heteroscedasticity. When the error term is not a function of one or more independent variables in the regression equation but instead varies over time in a manner that large errors are followed by large errors and small errors are followed by small errors (i.e. current errors depend on how large or small were the past errors), it becomes useful to apply ARCH and GARCH techniques. The variance of the error term is explained through the volatility observed in the past and instead of OLS, maximum likelihood estimation procedure is used.

Section-V

Empirical Test Using Monthly Return on BSE Sensex

For generating ARIMA based forecasts of return volatility, monthly standard deviations of return series is tested for stationarity and both the plot of the correlogram and ADF test statistics (reported in Table 1) validate the series to be stationary. The ACFs and PACFs presented in Statement-1 for the full sample and two sub-samples do not seem to change significantly. The stability of the ACFs and PACFs across sub-samples suggests that the parameters of the ARIMA equation can be assumed to be known and stable, and accordingly, as suggested by French *et.al*. the fitted values could be used as the predictable volatility. The moving average specification of the model that statistically approximates the data is as follows[6]:

$$\underset{}{SDReturn} = \underset{(16.88)}{0.02} + \underset{(9.41)}{0.58}\ MA(1) + \underset{(6.10)}{0.41}\ MA(2) + \underset{(4.25)}{0.27}\ MA(3) \quad \bar{R}^2 = 0.41$$

As could be seen from the plot of the residuals (Graph-8), there is evidence of volatility persistence and, therefore, the error term is conditionally heteroscedastic. ARCH (1)[7] test for conditional heteroscedasticity (with chi-square = 21.99 and F= 24.08) also support the need for representing the errors through ARCH/GARCH specification. Following Lee (1991)[8], the errors are captured through a GARCH (1,1) in mean specification, yielding the following results :

$$SDReturn = \underset{(5.67)}{0.01} + \underset{(5.83)}{0.50}\ MA(1) + \underset{(4.83)}{0.37}\ MA(2)$$

$$+ \underset{(4.55)}{0.29}\ MA(3) + \underset{(1.90)}{0.83}\ GARCH\ (SD) \quad \bar{R}^2 = 0.42$$

$$Error\ variance = \underset{(2.57)}{0.006} + \underset{(3.84)}{0.183}\ ARCH(1) + \underset{(5.87)}{0.623}\ GARCH(1)$$

The sum of the ARCH and GARCH coefficients is less than one, signifying the volatility process to be stationary. Graph-9 plots the fitted values (proxy for *ex-ante* volatility) against the original volatility series (representing *ex-post* volatility). The difference between the *ex-post* volatility and *ex-ante* volatility for every month is assumed to represent the unanticipated volatility for that month. Graph-10 plots both expected and unanticipated volatility against the equity premiums. In order to explain whether equity premiums[9] exhibit any relationship with the estimated measures of volatility, the following regression equations were run:

Full sample (January 1981 to June 2000)[10]

1) Equity premium = 20.49 – 802.58* (*ex-post* SDs)
(1.41) (-1.01)

2) Weighted Least Square (with predictable SDs used as weights)

Equity premium = 120.57 – 5404.88* (predictable SDs)
(5.95) (-6.67)

-650.53* (unpredictable SDs)
(-0.74)

Sub-sample (January 1995 to June 2000)

2) Weighted Least Square (with predictable SDs used as weights)

Equity premium = -68.92 + 2429.09* (predictable SDs)
(-1.11) (-0.83)

– 4196.77* (unpredictable SDs)
(-2.22)

(All the relevant variables in the above equations are stationary as per the ADF and PP test statistics reported in Table-1. Figures in the parentheses are the respective t values.)

For the full sample, the relationship between equity premium and original volatility turns out to be negative. Furthermore, the t-statistic corresponding to the estimated coefficient signifies that the coefficient is not different from zero. When the alternative test suggested by French *et.al.* is considered through regression equation (2), the coefficients of both predictable and unpredictable volatility appear to be negative with the coefficient for predictable volatility alone turning out to be statistically significant. This is appearently puzzling, because if the predictable volatility is expected to increase, then the investors should actually demand a higher return. The negative relationship could be interpreted, in a sense, as a case of market dominance by investors who mostly speculate on factors unrelated to fundamentals and keep changing their positions with the objective of increasing returns in the short-run. As a result, when the market goes bearish, selling pressure mounts, the BSE sensex declines and monthly returns turn negative, thus showing a negative relationship with volatility. On the other hand, when the market turns bullish, buying pressures lead to rally in BSE sensex and monthly returns become positive, showing a positive relationship with volatility. Over any period of time, therefore, the net impact of volatility on return could depend on both (a) the number of bull/bear phases during that period, and (b) the degree and speed of market response during alternating phases of markets. If the market reacts in the majority of outcomes to bearish conditions than to bull runs and if the bearish phase remains more prolonged than bull phases, then one could get a negative relationship between return and volatility. Such a result, however, hints at the absence of adequate number of genuine long term investors in the market who generally avoid the bandwagon of alternating phases in the stock markets but ensure a long-run return on equity that compensates them appropriately for the time value of money as well as the greater level of risk associated with equity.

In the last equation that relates to the more recent period (i.e. January 1995 to June 2000), the indirect test suggested by French *et.al.* seems to work for the Indian equity market. Predictable volatility shows a positive relationship but in terms of statistical significance, it does not seem to be very different from zero. Unpredictable volatility, on the other hand, not only shows the expected negative relationship but also turns out to be statistically significant. High negative and statistically significant coefficient for "unpredictable volatility" indirectly explains the positive relationship between expected risk premia and *ex ante* volatility. Since investors want to be compensated for higher risks through higher return, increased "unpredictable volatility" at time (t) would make the investors demand higher risk premia at time (t+1), causing the stock prices to fall so as to offer higher returns. The unobserved positive relationship between equity premium and "predictable volatility" could, therefore, be implicit in the negative relationship between unpredictable volatility and equity premiums.

An alternative to the indirect test could be an ARCH in Mean (ARCH-M) or GARCH in Mean (GARCH-M) specification to directly estimate the relationship between return and risk in an intertemporal capital asset pricing model framework. In this approach, the mean of a sequence (say return or equity premium) is generally seen to depend on its own conditional variance. Following Engle, Lilien and Robins (1987), the equity premium (EP) can be written in a functional form as:

$$EP = \mu_t + \varepsilon_t$$

where μ_t is the risk premium necessary to induce an investor to hold equities as opposed to other risk free instruments, and ε_t is the unanticipated shock (or deviation from μ_t) to the equity premium. In the long run, the expected excess return on equity should approximate μ_t; i.e. E (EP) = μ_t. It is possible that the risk premium μ_t could be an increasing function of the conditional variance of ε_t, so that the expected compensation μ_t increases with the increase in the conditional variance of ε_t. μ_t could then be written as:

$$\mu_t = \alpha + \beta h_t, \text{ for } \beta > 0$$

where h_t is the ARCH (q) process : $h_t = \gamma_0 + \sum_{j=1}^{q} \gamma_j \varepsilon_{t-j}^2$

The conditional mean return (or mean equity premium) thus depends on the conditional variance h_t. When this relationship holds, it becomes equivalent of the indirect test of French *et.al.* The negative relationship of French *et.al.* between unexpected volatility and risk premium as an indirect test of the risk return relationship also explains what an ARCH-M or GARCH-M process can do. In the former case, an increase in unexpected volatility would increase the next - period expected volatility and the expected return accordingly. In the latter case, the mean return (or equity premium) would increase as the conditional variance of the unexpected shock to equity premium (*i.e.* the errors) increases.

For the ARCH-M test, daily equity premium series for the period January 1981 to June 2000 are used. The series turns out to be stationary as per ADF and PP tests (Table-1). The estimated mean specification of the equity premium series appears to be:

$$\underset{(2.02)}{EP = 0.000562} + \varepsilon_t ,$$

with 0.000562 representing the simple average of EP over the period. ARCH-LM tests for the errors ε_t of the above equation show evidence of strong heteroscedasticity (with chi-square = -59.03919 and F = -12.1878). The following ARCH-M specification with a statistically significant ARCH(3) process is estimated to study the return risk relationship :

$$EP = \underset{(-5.56)}{-0.003602} + \underset{(6.73)}{0.257796} * h_t + \varepsilon_t$$

$$h_t = \underset{(34.00)}{0.000152} + \underset{(13.21)}{0.235358} * \varepsilon^2_{t-1} + \underset{(9.79)}{0.178742} * \varepsilon^2_{t-2} + \underset{(9.82)}{0.148929} * \varepsilon^2_{t-3}$$

All three ARCH coefficients appear to be statistically significant as also the ARCH-M coefficient in the mean equation. The statistically significant positive relationship between h_t and EP indicate that the indirect relationship between equity premium and predictable volatility may also hold for the Indian data.

Section - V

Conclusions

Equity premiums in India do not seem to exhibit a pattern that could be explained by return volatilities. The absence of the basic relationship between risk and return that characterises many rational equity markets, throws up a puzzle. Unlike the puzzle highlighted by Blanchard - the vanishing equity premiums alongside increasing returns on bonds - the puzzle in the Indian equity market represents a violation of a basic characteristic of equity markets. The inflation environment in India does not seem to be a factor in influencing the risk premiums on equities, significantly limiting thereby the efficacy of monetary policy in lowering the equity cost of capital through a low and stable inflation environment. The empirically observed negative relationship with *ex-ante* volatility and statistically insignificant relationship with the unpredictable component of return volatility also indicate that even the indirect tests of the return-risk relationship do not hold in India. The negative return-risk relationship could be explained to some extent by the nature of investors operating in the markets as well as their asymmetrical response to bearish and bullish phases of the market. As could be seen from Graph-5, the equity market in India could have given an annualised return of 17.7 per cent to a long-term investor over January 1981 to June 2000, implying a return in excess of risk free alternatives as a compensation for risk. But the empirical relationship suggests that investors who tend to optimise return in the short-run dominate the equity market. As a result, they not only add avoidable volatility to the stock market and increase the amplitudes of the BSE sensex but also give rise to alternating short phases of bull runs and bear hugs.

The indirect test suggested by French *et.al.* holds for the Indian equity market for the period Jnauary 1995 to June 2000, signalling possible firming up of the basic risk-return relationship in the Indian equity market. The ARCH in Mean specification of daily equity premium also indicates the validity of the indirect test. The negative relationship with the unpredictable component of the return volatility, however, requires some rational economic analysis. One argument could be the effect of leverage; *i.e.* when stock prices decline, the debt to equity ratio (leverage) increases automatically and as the capital structure deteriorates (*i.e.* more debt and less equity), expected equity return increases which, in turn, imparts further volatility. The estimated positive relationship between expected return and predictable volatility, therefore, overestimates the CAPM relationship which is corrected to the true relationship by the negative relationship one finds between return and unpredictable volatility. In the Indian case, the estimated relationship between equity premiums and predictable volatility turns out to be negative and, therefore, even the leverage explanation may not be valid. Leverage, in any case, can not be the sole factor to explain the entire negative relationship. As in the cross sectional analysis of CAPM where one often questions the empirical validity of the CAPM in terms of the inability of *beta* to explain the risk premiums, in time series framework also one could argue that standard deviation or variance may not be adequate to capture the element of risk and one may have to identify a more appropriate measure of return volatility. In cross section analysis, Fama and French considered factors like size, P to E, price to book *etc.* to explain return behaviour and argued that these factors could better explain risk premia compared to *beta*. In the time series framework one may also have to identify some alternative measures of return volatility as opposed to conventionally used indicators like variance. Another common point made by the CAPM protagonists is that the market index used for CAPM testing may not be the right representative of market portfolio. Any index which is not the true indicator of market portfolio would contain both systematic and unsystematic risks, whereas the CAPM market portfolio should explain only systematic risks. In the time series test of CAPM conducted in this paper the BSE sensex may not be the true indicator of a market portfolio and hence, such indirect tests of CAPM may not yield the desired results.

Notes

1. According to the Gorden formula, price of an asset $P_t = D_t (1+g)/(i + \rho - g)$, where D_t, g, i and ρ stand for dividend paid, growth rate of dividend, risk free interest rate and the equity risk premium. With dividend being generally a δ percentage of the earnings (i.e. $D = \delta E$) - the above formula can be written as
$P_t/E_t = \delta (1+g)/(i + \rho - g)$. With information on P/E, g, i and δ, one could derive the equity premium ρ.

2. See World Economic Outlook, IMF, May 2000 for the details.

3. If the P/E ratio remains the same at the initial year and the terminal year for any investment, returns need not be zero since EPS growth could be positive. EPS could grow at a higher rate when lrge proportion of profits are ploughed back and invested productivitely. Technical progress, organizational improvements, scale and scope economies, takeovers/mergers that generate positive synergies, all of these could contribute to EPS growth. EPS and P often exhibit positive correlation since highr current earnings imply higher expected earnings in future.

4. Monthly returns are the sum of daily returns during the month. Daily return is calculated as $(\log P_t) - (\log P_{t-1})$. This is so because, $P_t = P_{t-1} * e^r$. In other words, $P_t / P_{t-1} = e^r$. Taking log on both sides, we get $(\log P_t) - (\log P_{t-1}) = r$. Total return should comprise of capital appreciation and dividend payment. For empirical testing, we need to use daily returns and, therefore, dividend payments are not considered. As pointed out by Gupta and Choudhury (2000), however, the share of dividend component in total return on BSE Sensex portfolio has declined from as low as 5.1 per cent during 1980-85 to just 1.6 per cent during 1992-97. As a result of the insignificant importance of dividend, our estimated average annual return at 17.7 per cent is close to their estimte at 18.8 per cent.

5. According to French *et.al.*, given a positive relationship between equity premium and *ex-ante* volatility, when the observed *ex-post* volatility increases, investors expectations about *ex-ante* volatility is revised upwards, giving rise to a higher risk premium. As a result, the discount rate increases, NPV declines (assuming unchanged cash flows) and current stock prices fall. Equity premium may, therefore, show a negative relationship with the unanticipted volatility. According to French *et.al.*, this negative relationship could be an indirect proof of a positive relationship between equity premium and *ex-ante* volatility.

6. Figures in the parentheses are respective t values.

7. ARCH(1) is Lagrange multiplier test for conditional heteroscedsticity with chi-squre distribution.

8. According to LEE(1991), LM test of the null of white noise against an ACRH(1) process is equivalent to an LM test of white noise against GARCH (1,1).

9. For generating the equity premium series, we deduct return on three year deposits (instead of short-term risk free rates) from the returns on equity. The reasons being : (a) the importance of bank deposits in the Indian financial system *vis-à-vis* other instruments of financial saving, and (b) the possibility of removing a great part of the term premium from the equity premium so that we can focus on explaining the risk premium on equity.

10. In these equations R^2 are generally low (as in French *et.al.*); the emphasis, therefore, is on the sign of the coefficient and the statistical significnce of the coefficients rather than the degree to which volatility could explain equity premium.

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Statement-1 : Correlogram of Monthly Volatility (SD of daily return)

Sample : 1981:01 to 2000:06

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*****	*****	1	0.652	0.652	100.73	0.000
****	*	2	0.471	0.080	153.57	0.000
***		3	0.346	0.020	182.20	0.000
**		4	0.230	-0.038	194.91	0.000
*		5	0.187	0.052	203.34	0.000
**	*	6	0.221	0.138	215.16	0.000

Sample : 1981:01 to 1991:12

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*****	*****	1	0.621	0.621	52.018	0.000
****	**	2	0.519	0.217	88.644	0.000
***		3	0.379	-0.014	108.32	0.000
**		4	0.314	0.036	121.95	0.000
**		5	0.268	0.045	131.95	0.000
**	*	6	0.278	0.102	142.80	0.000

Sample : 1991:12 to 2000:06

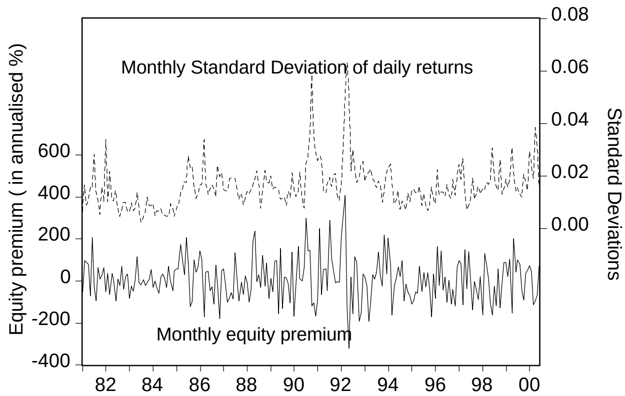
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*****	*****	1	0.656	0.656	45.676	0.000
***	*	2	0.388	-0.076	61.780	0.000
**	*	3	0.283	0.105	70.466	0.000
*	*	4	0.117	-0.172	71.960	0.000
*	*	5	0.072	0.112	72.538	0.000
*	*	6	0.120	0.082	74.145	0.000

Table-1 : Tests of Stationarity

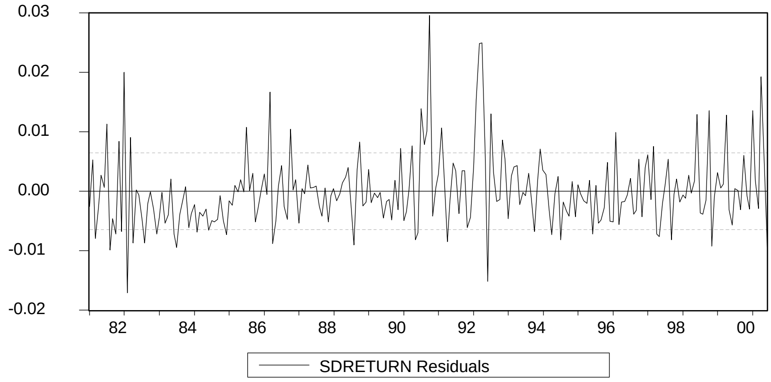
	ADF	PP
Monthly Equity Premiums	-5.386322	-13.95768
SD of Daily Return	-3.513992	-7.034327
SD of Predictable Return	-3.778759	-5.648865
SD of Unpredictable Return	-4.050140	-13.33402
Daily Equity Premiums	-12.18780	-59.03919

With constant in every ADF/PP equations and relate to AIC based lags.

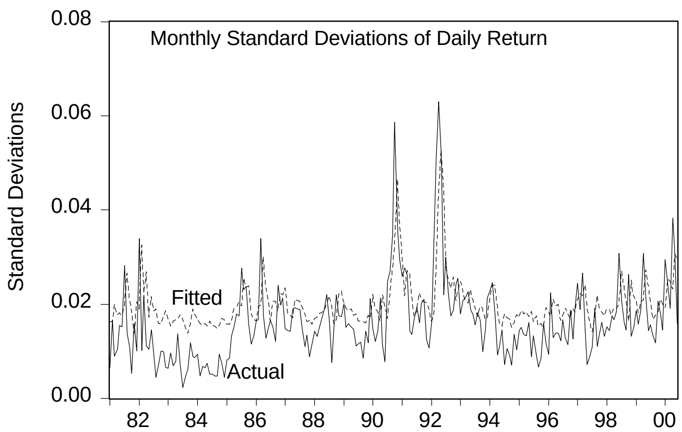
Graph-7



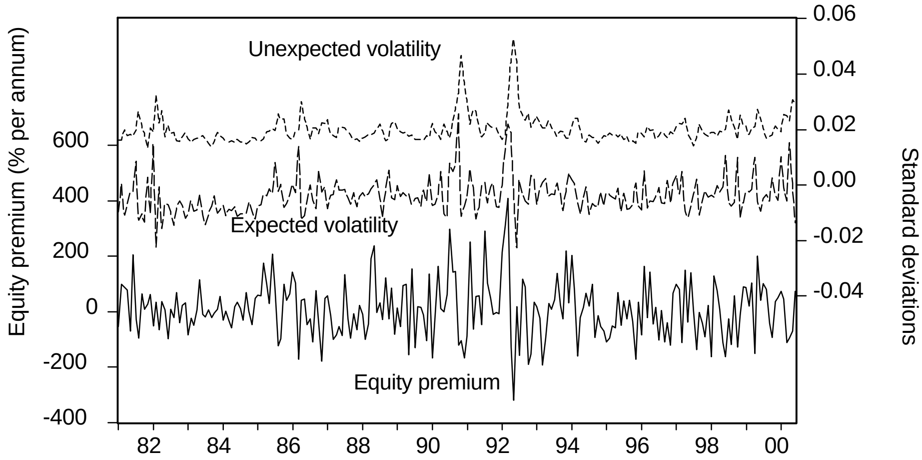
Graph-8



Graph-9



Graph-10


Unexpected volatility
Expected volatility
Equity premium
Equity premium (% per annum)
Standard deviations
600
400
200
0
-200
-400
0.06
0.04
0.02
0.00
-0.02
-0.04
82
84
86
88
90
92
94
96
98
00