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Does derivative usage boost firm value in an economy with controls? Evidence from India

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Abstract
The role of derivatives on firm valuation has recently become a subject of intense debate for emerging markets where there is greater asset price volatility, illiquidity, and the absence of common regulations and accounting standards. Given the lack of data availability, disclosure inconsistency and distinctive regulatory requirements for Indian firms, we assess the impact of corporate hedging via derivative use on the performance of BSE-100 non-financial firms over the period 2010–2017. Our results from keywords-based hand-collected derivative usage data show that all types of derivatives, except rate derivatives, have a significant and positive impact on firm value through channels of reduced earnings volatility and increased leverage with tax benefits. Firms with greater leverage tend to benefit from the use of rate derivatives. Still, among those highly leveraged firms, the ones who experience high earnings volatility are unable to benefit from rate derivatives. Besides, hedge accounting benefits firms in dealing with earnings volatility when they have higher derivatives exposure. As capital controls on international flows can limit the use of derivatives, we show that firms with currency risk exposure in terms of long-term foreign currency debt do benefit from rate derivatives. Our results are also robust with a matched sample for derivative users and non-users. Overall, we conclude that easing regulatory controls on derivatives dealings can be beneficial for firms in growing emerging economies.

Keywords Risk management · Hedging · Firm value · FX hedging · Rates hedging · Commodities hedging

JEL Classification C31 · F31 · G32

1 Introduction

Since the introduction of derivatives in financial markets in the 1980s, the value of corporate hedging has been keenly contested by academics over the last three decades. On the one hand, the theoretical framework by Modigliani and Miller (1958) and an empirical

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study by Adam et al. (2017) argue that the usage of derivatives does not add any value to firms, whereas on the other hand, the theoretical studies by Smith and Stulz (1985), Leland (1998) and empirical evidence from Bartram et al. (2011), and Allayannis et al. (2012) demonstrate a positive contribution to a firm as a result of the usage of derivatives. More recently, Lin et al. (2017) show that firms with sophisticated and comprehensive derivatives usage policies display lower levels of uncertainty about future cash flows, volatility of future income and sales growth, and equity mispricing than those that do not use derivatives. Furthermore, Bachiller et al. (2021) and Biguri et al. (2022) show that derivatives-based hedging presents an economic advantage for all firms, and reduces idiosyncratic variance of stock returns.

However, previous studies that evaluated the significance of corporate hedging, were mainly confined to developed economies due to the easier data availability (e.g. Ahmed et al. 2020; Bartram et al. 2011; Gilje and Taillard 2017). In emerging markets, where derivative markets are yet to fully develop, we use data from Indian non-financial firms to examine the impact of corporate hedging via derivative usage on their performance. The gap in the literature in the context of emerging markets necessitates this study, and in the absence of readily available data on derivatives, we use a keywords-based search to hand-collect derivative usage data from annual reports to undertake this study.

Our focus on India is based on several reasons. India is the second-biggest emerging market and the fifth-largest economy in the world.[1] However, the issues pertaining to the financial market development are significantly under-researched, mainly due to the lack of data availability in derivative markets. The Indian economy has evolved significantly over the last three decades since the economic liberalisation in 1991. As a result, the country experienced phenomenal economic growth in the previous three decades. India's share of the world GDP and market cap of listed companies in the world has doubled over the last 15 years (see Table 14 and Fig. 6 in Appendix 1). Firms in a growing economy with increased international linkages have exposure to increased market risks. Additionally, specific local regulations and market structure make the need to manage those risks more pronounced. This has significantly increased hedging activities through derivatives for Indian firms (see Fig. 1).

At the same time, the financial sector became more advanced, albeit highly regulated. The Indian stock market, the oldest in Asia, banned the usage of derivatives for three decades until the end of the second millennium.[2] However, the stock market facilitated a system of 'carry forward trades' (also known as 'Badla'), which incorporated the attributes of 'limited forward trading'. Although this was banned by the SEBI, the Indian capital market regulator (akin to the SEC in the United States), in 1993, it was re-introduced in its alternative form in 1996. Thereafter, the introduction of computerized trading and settlement of derivatives, reinstatement of 'Badla', and the introduction of index futures, amongst many other things, facilitated a further increase in derivatives trading since 1998.

Indeed, economic liberalisation called for the complete overhaul of the trade-policy regime towards 'greater openness and to reap the full benefits of international trade' (Government of India, 1992, Eighth Five-Year Plan: 84). The unprecedented growth in international trade since 2000 resulted in firms facing greater challenges to manage their foreign exchange risks.

As we can see in Fig. 1, over half of the average daily turnover in the OTC derivatives in India were in FX swaps and outright forwards. We also see that the derivatives trading

[1] World Development Indicators database, World Bank, 1 July 2020.

[2] The Bombay Stock Exchange (BSE) was established in 1875 in Mumbai.

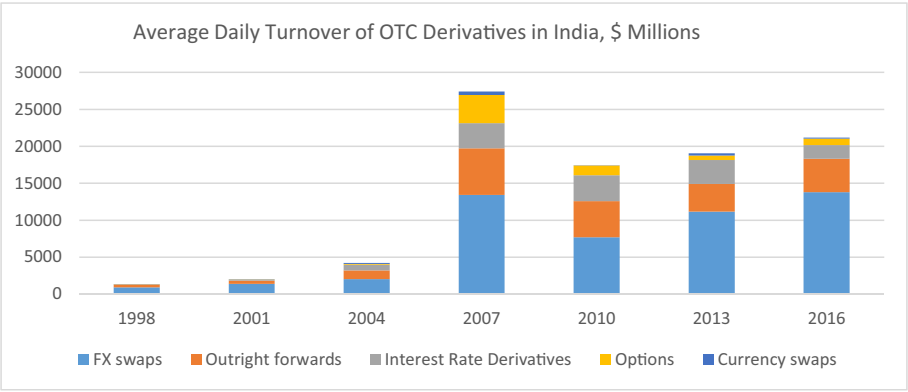


Fig. 1 India derivatives usage over the years. The above figure shows the average daily turnover of Indian derivatives as reported by the BIS triennial survey. FX spot volumes have been removed and each of the other derivative instruments has been shown in different colours in bar charts

volume witnessed explosive growth from 2004 to 2007, growing by more than 90% per annum. Although the number of the BSE-100 non-financial firms using derivatives has increased marginally over the last decade, the volume of derivatives used by these firms has increased tremendously (see Fig. 2). This significant growth can be attributed to some regulatory relaxations by the Reserve Bank of India, which allowed various rupee-based derivatives to be traded onshore for the first time, as well as speculative activities by some corporates using derivatives.[3] The financial crisis of 2008 resulted in significant losses for many corporates due to some of these speculative derivative positions. The subsequent regulatory framework by the Reserve Bank of India (RBI) ensured that the derivative transactions undertaken by the Indian firms are limited to hedging activities only. With the introduction of the new regulation in 2007 and the elimination of the effect of the financial crisis, it, therefore, becomes plausible to assess the significance of the derivatives usage by Indian firms for the post-financial crisis period. For the same reason, it is not possible to compare the derivative dealings of Indian corporations before the 2008 financial crisis with the period after it.

An additional motivation for undertaking this study for the case of India is that, being an emerging economy, it inherently has a very different financial system compared to advanced economies. Most emerging market economies (EMEs), including India, have varying degrees of capital controls that restrict the free movement of funds. Their exchange rates are either pegged to US dollars, or a form of dirty float, with moderate to high intervention from their central banks. The domestic interest rate benchmark-based derivative trades in emerging markets is either non-existent or highly illiquid. Furthermore, the regulatory framework in the EMEs may limit firms' freedom to engage in only specific types of derivative transactions. Due to these differences between advanced economies and EMEs, the results obtained for advanced economies may not be relevant to emerging markets. Therefore, the findings of this empirical study on the Indian market will address this gap in the literature. The Indian market is highly representative of other emerging markets where the currency is managed float and is not fully convertible. Therefore, we believe our results

[3] For Example, Permission on MIFOR swaps by DBOD Circular No. DBOD.BP.BC. 53/ 21.04.157/ 2005-06 dated December 28, 2005.

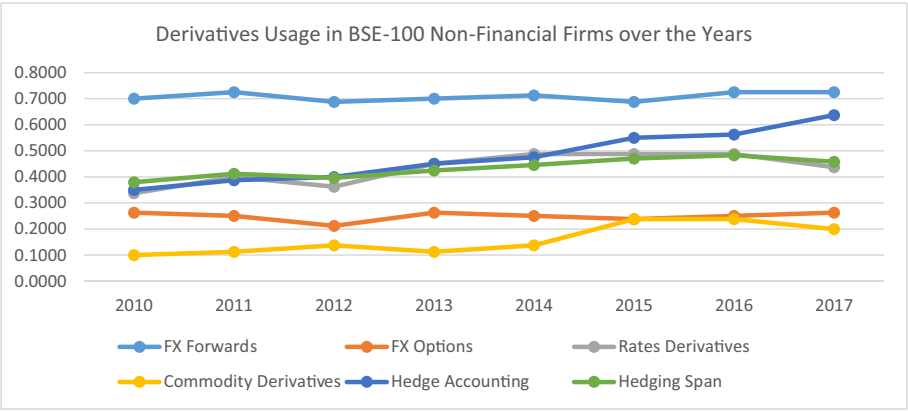


Fig. 2 Derivatives Usage in BSE-100 Non-Financial Firms over the Years. The above figure presents the results of year-wise derivatives usage by Indian companies for various types of derivatives (Table 2). The data has been hand collected using annual reports of all companies for all years, using key-word searches

can be generalized for other emerging market economies with capital and currency controls on international financial transactions.

Furthermore, it is worth mentioning that the findings of previous studies on the benefits of corporate hedging are mixed. For instance, Allayannis and Weston (2001) and Bartram et al. (2011) find that the usage of foreign exchange, interest rates, and commodity derivatives significantly lowers cash-flow volatility, total risk, and market risk. Perez-Gonzalez and Yun (2013) show that the use of weather derivatives by US firms results in higher valuations, investments and leverage. Although these empirical studies confirmed the positive effect of derivatives usage on firm value, some studies did not support this hypothesis. For instance, Jin and Jorion (2006) evaluate the hedging activities of 119 US oil and gas producers and find the relationship between hedgers' versus non-hedgers' firm value to be mildly negative and not significant. Khediri (2010) analyze the valuation effect of derivative usage by 250 non-financial French firms and find that the usage of the derivative is negatively correlated with firm value. Chen and King (2014) examine the usage of derivatives in the case of large US firms and find strong evidence that hedging is associated with a lower cost of debt.[4] Although these empirical studies highlight the benefits of derivative usage, very few studies provide evidence of the channels through which the benefits accrue to a firm by using these innovative financial instruments. For instance, studies have identified taxes (Graham and Rogers 2002), information asymmetry (Brown 2001; and He and Ren 2023) and competition (Haushalter et al. 2007; and Adam et al. 2007) as additional channels through which hedging affects firm value. More recently, Gilje and Taillard (2017) provide evidence that reducing financial distress and underinvestment risk are the first-order channels through which hedging affects the value of firms within the oil and gas industry. Against this backdrop, we explore the significance of hedging in affecting firm value through the channels of reduced earnings volatility and increased leverage. Since the derivatives data for Indian firms are not readily available, our research would provide

[4] For the UK non-financial firms, Panaretou (2013) find that the hedging premium is statistically and economically significant for foreign currency derivative users. However, the author find a weak evidence that interest rate hedging increases firm value.

new insights into this unchartered area and fill an important gap in the literature, including whether derivatives can mitigate the risk exposure of foreign-currency debt.

We observed that during the 2008 financial crisis, Indian regulators came up with strict guidelines to regulate the corporate derivatives market to ensure their use for risk management purposes only.[5] This further narrowed our focus to the post-financial crisis period, as data from the pre-financial crisis would not be relevant in light of new regulations. As Parnell et al. (2012) note that, managers should enhance risk management practices to improve performance in a highly uncertain environment; we are motivated to undertake this study to guide corporations and regulators alike toward the framing of sound risk management policies and regulations. Besides, India is a major market where the domestic currency, the Indian Rupee (INR) exchange rate, has been allowed to be determined by the market only since 1993. Furthermore, the convertibility of the Indian rupee (INR) by the central bank, which intervenes sporadically to smoothen out sharp currency movements, has been limited to the current account activities only, and the nature of FX movement is a managed float. This may, therefore, require firms to alter their risk management strategy, which is highly dependent on their characteristics.

In this paper, we determine whether the users of derivatives are different from non-users in their key characteristics like size, leverage, liquidity, industry, ownership, profitability, growth opportunities and key performance measures. The derivative instruments we include in our study are FX forwards, FX options, interest rate derivatives (interest rate swaps and cross-currency swaps) and commodity derivatives. In the context of India, we also introduce one additional variable: hedge accounting. Hedge accounting allows firms to reduce earning volatility by giving them a choice to record their derivative usage either in P&L or balance sheet, depending on the type of exposure (long-term or short-term). To the best of our knowledge, this variable has not been studied before, and it has the potential to signify long-term usage of derivatives by a firm. The introduction of this new variable in the Indian context is another novel addition to our research. Finally, we introduce a new variable, hedging span, which has also not been studied in the previous literature. We define 'hedging span' as the arithmetic mean of binary variables representing FX, rates and commodity hedging by firms; hence, it can take four distinct values of 0, 0.33, 0.67 and 1.0. This variable would measure the span of derivatives used by firms in their hedging process, although we do acknowledge that some firms may not need to use all types of hedging if they do not have underlying exposures to those risks. As data for derivative usage is not readily available in any database, our derivative usage data is hand-collected from annual reports of our chosen firms, which is another novelty of our paper. Although there are over 5,500 listed companies in India, our sample of 80 companies represents more than 52% of the market cap and 71% of the derivative activities of all listed non-financial companies. To ensure that our sample is representative of Indian market conditions, we obtained derivative usage data of the remaining non-financial firms in BSE-250 (117 more firms), hand-collected from their annual reports for the year 2023. We found that derivative usage dropped significantly with size (see Appendix Table 15), Furthermore, we believe the results we obtained from BSE-100 firms are representative of the Indian market..

Our findings suggest that the usage of all types of derivatives studied, except rate derivatives, has a significant positive impact on firm value through channels of reduced earnings volatility and increased tax shields. The corporate usage of rate derivatives

[5] Reserve Bank of India issued comprehensive guidelines on derivatives via Circular DBOD No.BP.BC.86/21.04.157/2006–07 dated April 20, 2007. These were later updated by circular DBOD.No.BP.BC.27/21.04.157/2010–11 dated August 2, 2011.

turned positively significant only when we consider firms' usage of derivatives alongside their level of leverage, suggesting that the usage of rate derivatives adds value only for highly leveraged firms. Additionally, we also observe that firms with a higher level of earnings volatility are able to enhance their value when they use hedge accounting. This is a novel result of our research, as the variable 'hedge accounting' has not been studied in any significant detail in the current hedging literature. By undertaking a 'like-for-like' comparison in a propensity score matching framework, we further validate that the derivatives-user firms tend to have higher firm value than similar matched companies without using derivatives to manage risk. Moreover, our results also suggest that this effect is particularly stronger for highly leveraged firms. Capital account controls on the convertibility of the Indian rupee prohibit its free conversion to other currencies and place restrictions on cross-border lending/borrowing transactions. This results in the unavailability of many sophisticated hedging products, especially local currency derivatives, and reduces the propensity of firms to hedge. This can potentially impact firms from hedging, as firms may not wish to, or may not be able to hedge their exact risk and may have to rely on proxy hedges, thereby reducing the effectiveness and value of these hedges. Bose et al. (2020) show the positive impact of capital account liberalization on firm productivity and exports in Indian conditions. Taking a cue from them, we have performed an additional analysis wherein we include long-term foreign currency debt (LTFD) as an additional mechanism.

This paper contributes to the existing literature in the following areas. First, given the lack of data availability, disclosure inconsistency, and distinctive regulatory requirements, an observation that can also apply to other emerging markets, we assess the role of derivative usage on firm valuation. We show that all types of derivatives, except rate derivatives, have a significant and positive impact on firm value through the channels of reduced earnings volatility and increased leverage with tax benefits. In the context of India, the foreign exchange management act (FEMA) restricts firms to access funds from abroad. Bose et al. (2020) showed that Indian companies were restricted to have access to foreign-currency funding, and the liberalization during the 2000s enabled better firm performance through the easing of those controls. We, therefore, explore whether greater access to trade financing by firms in countries like India with capital account restrictions can make a difference to their risk management strategy; thus firms would require derivatives usage to manage their foreign-currency risk exposure in terms of higher long-term foreign currency borrowing. Such regulatory controls can be reflected through firm-level foreign currency debt along with their derivatives use, which can impact firm value. We thus suggest that easing regulatory controls on derivatives dealings can bring benefits to firms in emerging markets wherein they are restricted from having foreign currency exposure.

Secondly, we assess the significance of 'hedge accounting' and 'hedging span', in addition to the standard derivatives measures. To our knowledge, neither of these measures had been studied in detail before. Hedge accounting measure is based on whether firms take mark-to-market of hedges to their balance sheet or income statement, and 'hedging span' measure reflects the span of derivatives used by firms in their hedging process.

The paper is structured as follows. We discuss the literature and hypothesis development in Section 2 and present our empirical framework and data selection in Section 3. Section 4 presents the empirical findings and further analysis using propensity score matching (PSM), and Section 5 concludes.

2 Literature overview and hypothesis development

The literature on risk management, the firm's use of derivatives and their impact on firm value, is rich and diversified. The limitation, however, is related to the time period and geographical diversity of the same. Derivatives markets started developing since the 1980s and meaningful research on the topic started soon afterwards. In addition, due to market liquidity, regulatory framework, disclosure norms and data availability issues, previous studies including Allayannis and Weston (2001), Geczy et al. (1997), Guay and Kothari (2003) etc. have focused on advanced economies. As noted earlier, there is no notable study on the significance of derivatives usage by Indian non-financial firms. To understand the significance of hedging, we discuss the theoretical and empirical studies in the following section.

2.1 Why do firms hedge

In their landmark paper, Modigliani and Miller (1958) argued that in perfect markets, hedging financial risks should not add value to the firm because shareholders can hedge by themselves. Their analysis showed that the average cost of capital is constant for all firms, irrespective of their financial structure, in the absence of external frictions like taxes, contracting costs, etc. This idea of a flat, straight line was challenged subsequently, leading to the prevailing view of a U-shaped cost of the capital curve with higher leverage. They examined three main aspects that govern firms' hedging decisions: taxes, contracting costs, and the impact of hedging policy on the firms' investment decisions. Their analysis determined the reasons for the firms that hedged versus those that did not hedge, the firms that hedged some risks while leaving other risks unhedged, and the firms that hedged their accounting risk while others hedged their economic value. With regard to taxes, they demonstrated that if effective marginal tax rates are an increasing function of a corporate's pre-tax value, then by reducing the variability of the pre-tax return value; hedging could reduce expected corporate tax liability and increase the expected post-tax value of the firm, as long as hedging costs are not too high. Subsequently, they argued that transaction costs and bankruptcy could be added motivations for firms to hedge, as hedging may reduce the variability of the firm's future value, thereby reducing the probability of incurring bankruptcy costs.

Froot et al. (1993) attempted to develop a general framework for the analysis of corporate risk management policies. They hypothesized that if external sources of finance were much costlier than internal sources, then hedging would add value to ensure internal finances' availability and take advantage of the available attractive investment opportunities. Given external borrowings can be costly, and reduced investments may mean a lower average value for the firm, hedging is desirable if it reduces variability in cash flows. Furthermore, Leland (1998) examined the joint determination of capital structure and investment risks, which challenged the irrelevance of the financing policy hypothesis by noting that the equity holders potentially increase the risk in a firm, and thus extract value from bondholders after the debt has been obtained. The study focused on ex-post flexibility in choosing risk and its effect on capital structure and demonstrated how a firm's ex-post choice of risk is distorted by the presence of debt in its capital structure, thus it tried to ascertain the size of agency costs at the optimum level of capital structure and risk choices. The study, therefore, found that hedging reduces the volatility of earnings, which increases the firm's borrowing capacity while increasing its tax benefit on interest cost.

Against this theoretical backdrop, several empirical studies have attempted to determine the reasons for the hedging decisions of firms. For instance, Mian (1996) empirically examines the determinants of corporate hedging decisions with respect to different models of hedging and finds that the evidence needs to be consistent with financial distress cost models and mixed with respect to contracting costs, tax-based models and capital market imperfections. Geczy et al. (1997) examine the use of currency derivatives to differentiate among existing theories of hedging behaviour. They examine 372 Fortune 500 non-financial firms in 1990 that had significant foreign exchange exposure due to foreign operations, a high component of foreign currency debt or a significant presence of foreign competitors in their industry. They find that 41% of these firms use FX derivatives to manage risks. Furthermore, they find that firms with higher growth opportunities and tighter financial constraints are more likely to use derivatives to manage volatility in their cash flows. Glaum (2002) examined the concept of selective hedging, where firms follow profit-oriented, forecast-based hedging strategies, and found selective hedging to be negatively correlated with profits.

Guay and Kothari (2003) attempt to identify the size of the derivative portfolio of active derivative users and the impact on their derivative book in case of a three-standard deviation in the underlying market variables. They find that derivative portfolios of large firms are relatively small and they cover only between 3 to 6 per cent of their aggregated currency and interest rate exposures. Kim et al. (2006) went on to examine the use of operational hedges by firms and find that firms that have effective operational hedges need few financial hedges to manage risks. Based on these findings, they conclude that multinational corporations (MNCs) use very little financial hedges to manage their FX exposure despite having large FX positions. Purnanandam (2008) tried to develop a corporate risk management theory in the presence of financial distress deadweight losses, and made a distinction between financial distress and insolvency, stating that financially distressed firms were more likely to violate their debt commitments without being insolvent, thus incurring deadweight losses in the form of financial penalties among others. The author also noted that the propensity to hedge increased with leverage, but for an extremely high level of leverage, the value of hedging disappeared. More recently, Bartram (2019) demonstrated, using 47 countries' analysis, that firms use derivatives to reduce risk, and not for speculation purposes. Jeong-Bon et al. 2022 tried to explain the reduced stock price crash risks for corporations using derivatives.

Summarising the benefits of derivatives-based hedging by corporates over various studies (see Appendix Table 16), we see that the range of hedging benefits is between 1 to 5% in most cases, with a confidence interval ranging around 95%. In nearly all studies, FX derivatives add more value with a higher degree of certainty. Using a meta-analysis of 51 studies that includes nearly 15,000 firms in 18 countries for a sample of over 30 years, Bachiller et al. (2021) conclude that after controlling for publication bias and endogeneity, derivative usage increases firm value. The results have a stronger degree of confidence for FX derivatives (99%) than for other derivatives (95%). In another meta-study of 71 papers between 1995 and 2016, Geyer-Klingeberg et al. (2021) found that the effect on firm value is + 1.8%, -0.8% and -0.6% for FX, rates, and commodity derivatives, respectively.

2.2 Relationship between hedging and firm value: Hypothesis development

The literature review in Section 2.1 leads us to believe that the majority of firms undertake derivative activities to enhance firm value, which provides our core hypothesis:

Hypothesis 1: The usage of derivatives is positively associated with firm value.

In the following sub-sections, we investigate this hypothesis in detail and try to analyse various constituents of derivatives usage in detail.

2.2.1 FX hedging strategy and firm value

Bessembinder (1991) conducted an early study on this issue and argued that hedging with the forward contracts increased firm value as it reduced the incentives for equity holders to underinvest, mainly by reducing the sensitivity of senior claims to incremental cash-flows. The author stated that hedges could increase firm value by reducing agency costs and by improving contracting terms. As most of the above studies used forward contract as a measure of derivatives usage, we examine whether the usage of FX forwards impacts firm value, especially as Indian regulations only allow usage of FX forward to hedge genuine exposure for which firms have to provide documentary evidence to hedging banks. This leads us to develop our first sub-hypothesis as follows:

H1A: The usage of FX Forwards has a positive impact on firm value.

Allayannis and Weston (2001) examine the impact of foreign currency derivative usage, including FX options, on firm value for 720 US non-financial firms over 6 years during 1990–95. They find that the premium on firm value of hedgers versus non-hedgers was 4.87%. In a subsequent study for French companies, Clark and Mefteh (2010) investigate the relationship between foreign currency derivative usage, including FX Options, and firm value on a sample of 176 non-financial firms based on 2004 annual reports. The authors find that value creation is more significant for larger firms with higher FX exposure and is asymmetric to long and short euro exposures. In another cross-country study, Allayannis et al. (2012) examine the impact of the usage of currency derivatives of various kinds on firm value from a sample of 39 countries. In their analysis, the authors assumed that investors have means at their disposal to influence firm-level and county-level corporate governance to control the usage of derivatives for hedging purposes only, instead of speculation or serving managerial self-interest. The authors find that on average the usage of foreign currency derivatives by firms is valuable across countries. Governance as a reason behind the usage of these derivatives is important as the findings suggested a significant premium in market value for foreign currency derivatives using firms that have strong internal and external governance compared to those that have weak governance.[6]

The above studies expanded the definition of FX derivatives to include the use of FX options, but the usage of FX options in India is fundamentally different to developed economies as the Indian rupee options market is heavily regulated and illiquid. As most FX options traded in India are amongst G7 currencies, we would wish to examine whether FX options usage in non-home currency has any impact on firm value. This leads us to develop our second sub-hypothesis as follows:

H1B: The usage of FX options has a positive impact on firm value.

[6] Also see Huang et al. (2018) who provide evidence that the firm's monitoring environment influences both the interest rate and currency derivative usage.

2.2.2 Interest rate hedging effect

Graham and Rogers (2002) evaluate the relationship between hedging and tax incentives; and in doing so, they hypothesise the following: First, firms hedge to increase debt capacity and therefore, increase tax deductions, and second, firms hedge to reduce expected tax liability if the tax function is convex. They find that hedging increases the median firm's debt ratio by 3%. Furthermore, they also find the median tax benefits of increased debt capacity to be 1.1% of the firm value. Using a sample of 250 non-financial firms for three years (2000–2002), Khediri (2010) examine the valuation effect of derivative usage in the French market and find that the usage of FX and interest rate derivatives was negatively correlated with firm value, which was in stark contrast with results from the US that showed a positive correlation. They explain their results by two possible theoretical factors. Firstly, high ownership concentration among French companies might have implied derivative usage by the controlling party towards their benefit to the detriment of the minority shareholder. Secondly, weaker investor protection might have meant investors not linking derivative usage with value-enhancing activities. To study the implications of hedging for corporate financing and investments, Campello et al. (2011) use private credit agreements in the syndicated loan market. Their findings suggest that hedging reduces the cost of external financing and eases the firm's investment process. Furthermore, they also find proof of increased investment spending with higher hedging intensity. Their findings further confirmed the widely held academic belief that hedging reduces borrowing costs, and increases documentary flexibility on loan agreements and investment spending.

All of the above studies expanded the range of underlying asset classes of derivatives to include not only FX derivatives but also interest rate derivatives. In India, rates derivatives markets mainly comprise rupee interest rates derivatives for liability duration management, G7 interest rates derivatives to hedge interest rate risk on foreign currency borrowings and cross-currency swaps to hedge external commercial borrowings. We examine whether the combination of types of rates derivatives used by Indian corporates has any impact on firm value, which leads us to develop our next sub-hypothesis as follows:

H1C: The usage of interest rate derivatives has a positive impact on firm value.

2.2.3 Commodity hedging effect

To assess the impact of hedging activity on firm value and a possibility of a differential effect of hedging based on industry characteristics, Jin and Jorion (2006) examine the hedging activities of 119 US oil and gas producers from 1998 to 2001. Using a multivariate regression framework the results were found to be mildly negative and not significant which negated the hypothesis that hedgers have a higher Tobin's Q compared to non-hedgers for the oil and gas industry. Mackay and Moeller (2007) attempt to derive and estimate a model of the value of corporate risk management. They show that hedging could add value if revenues are concave in product prices or costs are convex in factor prices. As per the model developed by the authors for a sample of the US oil refiners, the value of hedging concave revenues and not hedging concave costs represented about 4 per cent each of the firm value. They find stronger evidence of the same for the bigger firm, an explanation of which can be reduced hedging cost for them compared to smaller firms due to economies of scale. In a multi-country analysis, Bartram et al. (2011) examine the effect of derivative usage on the firm's risk measures and value over a sample of around 7000 firms from 47

countries. The authors took into account the usage of foreign exchange, interest rates and commodity derivatives, and their impact on cash-flow volatilities, the standard deviation of stock returns, market betas and market values. Their findings indicate that derivative users had significantly lower cash-flow volatility, total risk as well as market risk. In a multivariate analysis, results showed that derivative usage significantly reduced cash flow and stock return volatility. Perez-Gonzalez and Yun (2013) examine the impact of financial innovation and the use of weather derivatives on firm value, investment, and financing decisions. As weather derivatives became available in 1997, the authors attempted to determine whether the introduction of these derivatives had any impact on firm value, investments and capital structure decisions. They found that the firms exposed to weather were two to three times more likely to use weather derivatives. Furthermore, they find a significant and positive increase in market value for weather derivative users. Chen and King (2014) demonstrate that hedging using FX, interest rate and commodity derivatives reduces the cost of debt for the firm, thereby increasing firm value. The benefits in cost of debt of a hedger to a non-hedger were found to be 19.2 basis points (bps) and 45.2 bps respectively for investment-grade and speculative-grade issuers. Adam et al. (2017) note that corporations do selective hedging in commodity markets despite there being no theoretical rationale to do so for enhancing firm value. The belief that information advantage drives this selective hedging behaviour was found to be empirically incorrect and they found a better relation between selective hedging and financial constraints instead. Ding et al. (2019) show that artificial intelligence (AI) techniques can be used to model the volatility of commodity prices, and note that its model can be used to develop optimal hedging strategies to deal with fluctuating commodity prices. More recently, studying commodity hedging among US oil and gas producers, Hong et al. (2020) show hedging profits are positively related to commodity hedging intensity, but more positively related to the market timing aspect of hedging. The above studies, therefore, introduced another asset class of commodity in derivative usage, which is used by a few Indian firms exposed to commodity risks. We assess whether the usage of these commodity derivatives by Indian firms adds value to them, further expanding our hypothesis as follows:

H1D: The usage of commodity derivatives has a positive impact on firm value.

2.2.4 Market specific effect

Studying the significance of the types of derivative instruments in the Indian context alerted us to an incremental variable, specifically applicable to the Indian economy. Arising out of Indian accounting norms, a new variable called "Use of hedge accounting" was identified. Indian accounting standards allow companies to take year-end marked-to-market (MTM) valuation of a derivative position to either a P&L statement or as a "hedging reserve" on their balance sheet. Companies that use derivatives for managing their short-term exposures, normally do not use hedge accounting and reflect derivatives year end MTMs in their yearly P&L accounts. However, firms that use longer term derivatives to hedge longer term underlying risks, do not wish to create unnecessary volatility in their P&L on account of derivative MTMs, thus they can partially insulate intermediate years' P&L by using hedge accounting. If the firms decide to take derivative MTMs to their balance sheet as hedging reserves, theoretically it reduces volatility in earnings; but additional work needs to be done to establish the hedge effectiveness of underlying derivatives. We observe that correlation coefficients

of all four individual hedging variables with hedge accounting variables are positive and more than 0.4, thus implying that heavy users of derivatives were mostly using hedge accounting compared to non-heavy users. As this accounting treatment is specific to the Indian market and may affect the willingness of Indian firms to continue using derivatives for a longer period, we attempt to determine its significance in affecting firm value. This leads us to our new sub-hypothesis.

H1E: Hedge accounting variable positively influences firm value.

2.2.5 Hedging span effect

Finally, we wanted to check whether the firm's broader risk-management activities across all its market risks have any impact on its value. To this purpose, we introduce a new concept called 'hedging span', which is an indicator of types of asset classes where the firm was using derivatives to manage its risks. To measure the hedging span, we use a simple digital variable that is the arithmetic mean of the three binary variables describing three types of derivatives (FX, interest rate and commodity) that the firm transacts. Thus, this hedging span variable can have four unique values of 0, 0.33, 0.66 and 1.0. We acknowledge that hedging span would not give an ideal indication of hedging intensity, as firms may not be exposed to all types of risks, but our idea was to see whether there is any monotonic relationship between asset classes of derivatives used and firm value. This leads us to our final sub-hypothesis:

H1F: Hedging span variable positively influences firm value.

3 Empirical framework and data selection

To assess the significance of the derivatives instruments in firm valuation, we adopt a standard multivariate panel regression model with fixed effects (Allayannis and Weston 2001):

$$Firm\ Value_{i,t} = \alpha_0 + \beta_1 Derivative\ usage_{i,t} + \beta_i X_{i,t} + \alpha_i + \alpha_t + u_{i,t} \quad (1)$$

where, $i = 1, 2, \ldots, N$ cross-section units (firms in this case) at time t. $Firm\ Value_{i,t}$ is the dependent variable of interest, which is the performance of firm i in Year t. α_0 is intercept, β_1 is the coefficient of derivative usage on firm value, α_i, and α_t are firm and time fixed effects, respectively. X is the vector of control variables at the firm level, and $u_{\rangle,\sqcup}$ are the disturbance terms.

As explained earlier, the reasons for studying India as a major emerging market over the 2010–2017 period are primarily due to the introduction of new regulations by the Reserve Bank of India in 2007 and the financial crisis of 2008–2009. Due to the declining usage of derivatives since the 2008 financial crisis, and considering data availability limitations, we have restricted our study to the top 100 publicly listed companies in India, covered by BSE-100. Going through the list of these 100 companies, we found 20 of them to be banks, non-banking financial companies or companies involved primarily in financing activities. Due to the nature of their work, some of them enter derivatives for trading purposes and not necessarily for risk management purposes only. Hence, these twenty firms were excluded from our study and, therefore, 80 firms form part of our sample. A list of these firms is given in Appendix Table 17.

For these 80 companies, financial data for all eight years (2010–2017) were sourced from Thomson Eikon. Some of these companies started operations midway through the period, merged, or did not report for some periods, hence we have some missing financial data in our analysis and have 425 company-year combinations. The information on hedging activity for these 80 firms was hand-collected from the annual reports using a keywords search. The company's annual reports were obtained from the Bombay Stock Exchange.[7] As a measure of firm performance, we include Tobin's Q (e.g. include some studies) and include a range of derivative measures (as discussed earlier) as an independent variable alternatively. We also control for observed heterogeneity by including firm-specific variables of size, profitability, leverage, investment growth opportunity, liquidity and industry as used in studies by Clark and Mefteh (2010) and Bartram et al. (2011). Previous studies including Jin and Jorion (2006), Khediri (2010), and Allayannis et al. (2012) have used Tobin's Q as it represents a true estimate of firm value. Tobin's Q is defined as the book value of total assets minus the book value of equity plus the market value of equity, divided by the book value of assets. In this study, Tobin's Q (also referred to as "Q") is approximated by the ratio of price to tangible book value. As the distribution of Tobin's Q was skewed, i.e. mean differing significantly from the median, we used the natural logarithm of Tobin's Q as the dependent variable in our study.

It was difficult to find the variable that defined the firm's usage of derivatives. This information was not available in any dataset; therefore, we hand-collected this information by individually studying the annual reports of these 80 companies for the period 2010–2017. In doing so, we looked for eleven keywords in the order mentioned, along with their rationale reported in Appendix Table 18. Once we found a "hit" on any of the keywords, we further explored the relevant section of the annual report to collect information about the five dummy variables of interest. Finally, using the first four dummy variables, we created the sixth dummy variable of "hedging span" using the formula given in Appendix Table 19. As the disclosed information on annual reports was not consistent and of high quality across firms, we use dummy variables defining derivative usage, instead of continuous variables based on derivative contracts outstanding as a proportion of sales.

Following the existing literature including Allayannis and Weston (2001) and Khediri (2010), among others, we expect variables of size, profitability, leverage, investment growth opportunity, liquidity, and industry to affect Tobin's Q. Therefore, we have included these measures as our control variables. As larger firms are more likely to have a derivative usage strategy due to the high fixed cost of setting it up, we control this by including a size measure. The impact of size on firm value is more likely to be negative due to the lack of sufficient opportunities at higher sizes; hence, we expect the sign of this coefficient to be negative. The proxy for size was taken as the natural logarithm of the net asset value of the firm. We use return on assets (ROA) as a proxy for profitability. As the distribution of the ROAs was positively skewed (Table 3), we have taken the natural logarithm of the same. The expectation is ROA to be positively related to Tobin's Q. Leverage is defined in the literature as total long-term debt divided by the market value of total shareholders' equity. Although leverage gives additional tax shields to companies, Allayannis and Weston (2001) found evidence of a negative relation between leverage and Tobin's Q as higher leverage means a higher probability of default and higher risk; thus, we expect Tobin's Q to be negatively related to leverage. The investment growth opportunity was measured by taking the natural logarithm of actual capital expenditure (Capex). On the one hand, high capital expenditure means high investment opportunities, and hence a positive impact on Tobin's Q, but on the other hand, this may deteriorate

[7] www.bseindia.com

Table 1 Explanatory variables and expected signs on the coefficients

Variables	Type of the Variable	Description of the variables	Predicted Sign
ln(firm value)	Dependent	Natural logarithm of Tobin's Q	
derivative usage	Independent	Digital variable	(+)
ln(size)	Explanatory	Natural logarithm of net asset value	(-)
ln(profitability)	Explanatory	Natural logarithm of return on assets	(+)
Leverage	Explanatory	Total long term debt / market value	(-)
ln(investment growth opportunity)	Explanatory	Natural logarithm of actual capex	No Prior Expectation
Liquidity	Explanatory	Quick Ratio {(cash + short term marketable securities) / short term liabilities}	(-)
service/ manufacturing	Explanatory	Dummy with value 1 for manufacturing and 0 for services	No Prior Expectation

The above table lists and defines the nature of various variables used in the analysis and includes the expected signs of the coefficients of the explanatory variables. The first column indicates the type of the explanatory variable, followed by a description of the variables, while the last column indicates the predicted sign between the dependent

Table 2 Derivatives Usage in India over the Years

	FX forwards	FX options	Rates derivatives	Commodity derivatives	Hedge accounting	Hedging span
2010	0.7368	0.2763	0.3553	0.1053	0.3684	0.3789
2011	0.7436	0.2564	0.4103	0.1154	0.3974	0.4122
2012	0.7534	0.2329	0.3973	0.1507	0.4384	0.3955
2013	0.7089	0.2658	0.4557	0.1139	0.4557	0.4250
2014	0.7308	0.2564	0.5000	0.1410	0.4872	0.4458
2015	0.7143	0.2467	0.5065	0.2467	0.5714	0.4706
2016	0.7250	0.2500	0.4875	0.2375	0.5625	0.4833
2017	0.7250	0.2625	0.4375	0.2000	0.6375	0.4583
Average	0.7295	0.2560	0.4444	0.1643	0.4911	0.4336

The above table reports results of year-wise derivatives usage by Indian companies for various types of derivatives. The data has been hand collected using annual reports of all companies for all years, using keyword searches

the firm's cash-flow situation and leverage and thus can negatively affect Tobin's Q. We have no prior expectation of this relationship. The 'quick ratio' was arrived at by dividing cash and short-term marketable securities by short-term liabilities and used as a measure of a firm's liquidity. Angelo and Johnston (2023) demonstrate that more liquid firms earn significantly higher levels of returns over subsequent period, thus, we expect a negative relationship between the quick ratio and Tobin's Q. Finally, to account for the value effects of conditions of services versus the manufacturing industry, we create a binary variable that takes values 1 for manufacturing and 0 for services. All the explanatory variables, their types, descriptions and predicted signs are detailed in Table 1.

4 Empirical findings

4.1 Descriptive analysis

Using the annual reports of 80 non-financial publicly listed firms for the period 2010–2017, we found that FX hedging is most common among Indian firms, with FX forwards being used 73% of the time. Respective numbers for FX options, rates derivatives, commodity derivatives, hedge accounting and hedging span were respectively 26%, 44%, 16%, 49% and 43% when averaged over the period (see Table 2). It is difficult to directly compare the size of the derivatives outstanding of Indian companies with advanced economies due to non-standard disclosures of Indian companies, which is the main reason we had to settle for a binary independent variable for our analysis. However, in general, the usage of derivatives by large companies in India is slightly lower than that of developed economies, especially when it comes to rate derivatives. This can largely be attributed to regulatory controls in India that allow derivative usage only for hedging purposes and capital account controls that do not allow the free flow of foreign currency borrowings, thereby hindering the development of Indian rupee derivative markets.

Table 3 Key Firm Characteristics split by hedging behaviour

	Overall	FX forwards		FX options		Rates derivatives		Commodity derivatives		Hedge accounting		Standard	Skewness
	Average	Hedgers	Non-hedgers	Hedgers	Non-hedgers	Hedgers	Non-hedgers	Hedgers	Non-hedgers	Users	Non-users	deviation	
Tobin's Q	1.5531	1.6105	1.3988	1.5590	1.5494	1.2719	1.7622	1.2851	1.6024	1.5566	1.5472	0.9101	0.3861
Return on assets	2.1471	2.0814	2.3234	2.1072	2.1578	1.7014	2.5081	1.5124	2.2815	2.0333	2.2646	0.9082	0.8249
Leverage	0.2013	0.2380	0.1023	0.4091	0.1259	0.3432	0.0639	0.3003	0.1858	0.1913	0.2186	0.5603	0.3140
Quick Ratio	1.3853	1.1799	1.9605	1.3983	1.3885	0.9893	1.7124	0.8189	1.5035	1.1851	1.5898	1.4667	5.1138
Net asset value	25.2710	25.2954	25.2033	25.7701	25.0938	25.5923	25.0049	25.9602	25.1234	25.4802	25.0534	1.2873	0.0905
Market cap	27.1008	27.2001	26.8720	27.4437	26.9969	27.1310	27.0956	27.3939	27.0558	27.2380	26.9891	0.8161	0.6228
EBITDA	24.1272	24.1788	24.0008	24.7459	23.9202	24.4296	23.8902	24.6610	24.0186	24.3005	23.9556	1.2249	0.2571
Capex	23.1301	23.1912	22.9775	23.6493	22.9559	23.7374	22.6394	24.0333	22.9399	23.3889	22.8585	1.5853	0.3837
Industry	0.7625	0.7792	0.7143	0.5597	0.8312	0.7174	0.7971	0.9216	0.7303	0.7410	0.7816	0.4259	-1.2337
Ownership	0.8250	0.9205	0.5595	0.9434	0.7814	0.8188	0.8261	0.8137	0.8247	0.9213	0.7278	0.3803	-1.7107

The above table gives summary statistics of independent and dependent variables broken for hedgers and non-hedgers for each derivative type in the sample

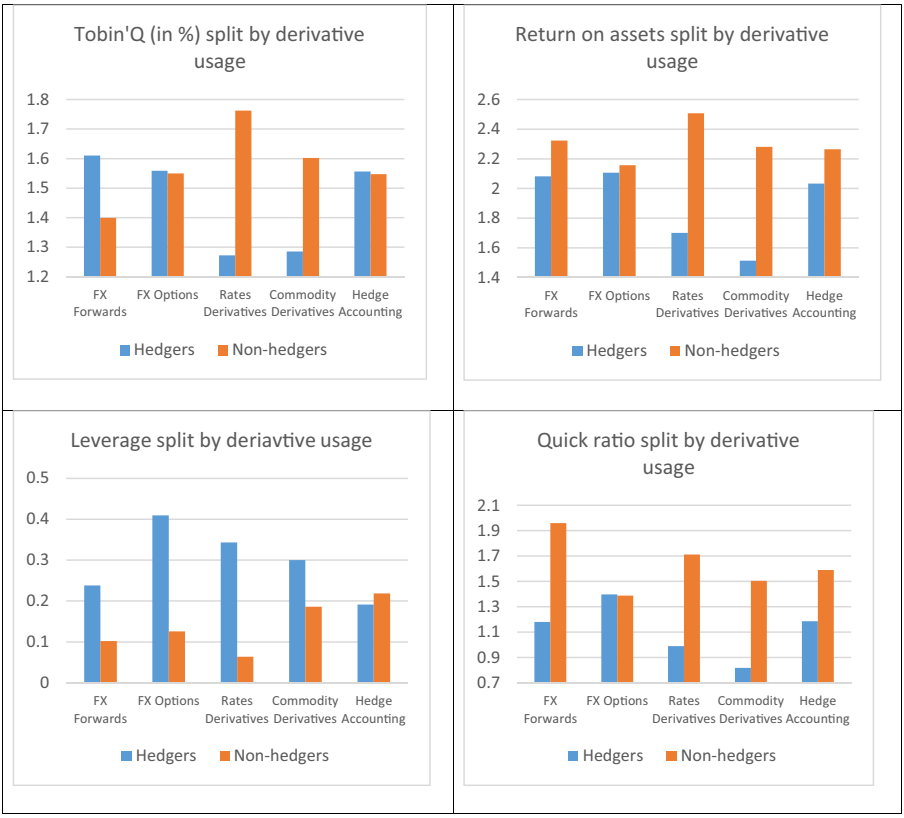


Fig. 3 Tobin's Q, ROA, Leverage, and Quick Ratio Split by Derivative Usage. The above figures present results of Tobin's Q, return on assets, leverage and quick ratio, split by groups of derivatives users and non-users

There are no significant observable temporal variations except for hedge accounting, whose use has consistently been increasing over the years. This is a possible sign of the growing maturity of corporate derivative users in India, who increasingly use derivatives to hedge their longer-term exposures, thereby necessitating hedge accounting to reduce earnings volatility. The descriptive statistics of derivative usage of all firms are reported in Table 3. The graphical representations of variables of Tobin's Q, return on assets, leverage, quick ratio, net asset value, market cap, EBITDA, capex, industry and ownership segregated for hedgers and non-hedgers are shown in Figs. 3 and 4. We discuss these variables in the next section in detail.

4.2 Hedging firm characteristics

From the analysis presented earlier, it emerges clearly that size and derivative usage are positively correlated. For all four measures of size: net asset value, market cap, EBITDA, and capex, all six types of derivatives users are significantly above non-users. Therefore, it can be safely confirmed that bigger firms are more likely to have derivative-based hedging than smaller firms. Reasons for the same can be attributed to a high fixed cost

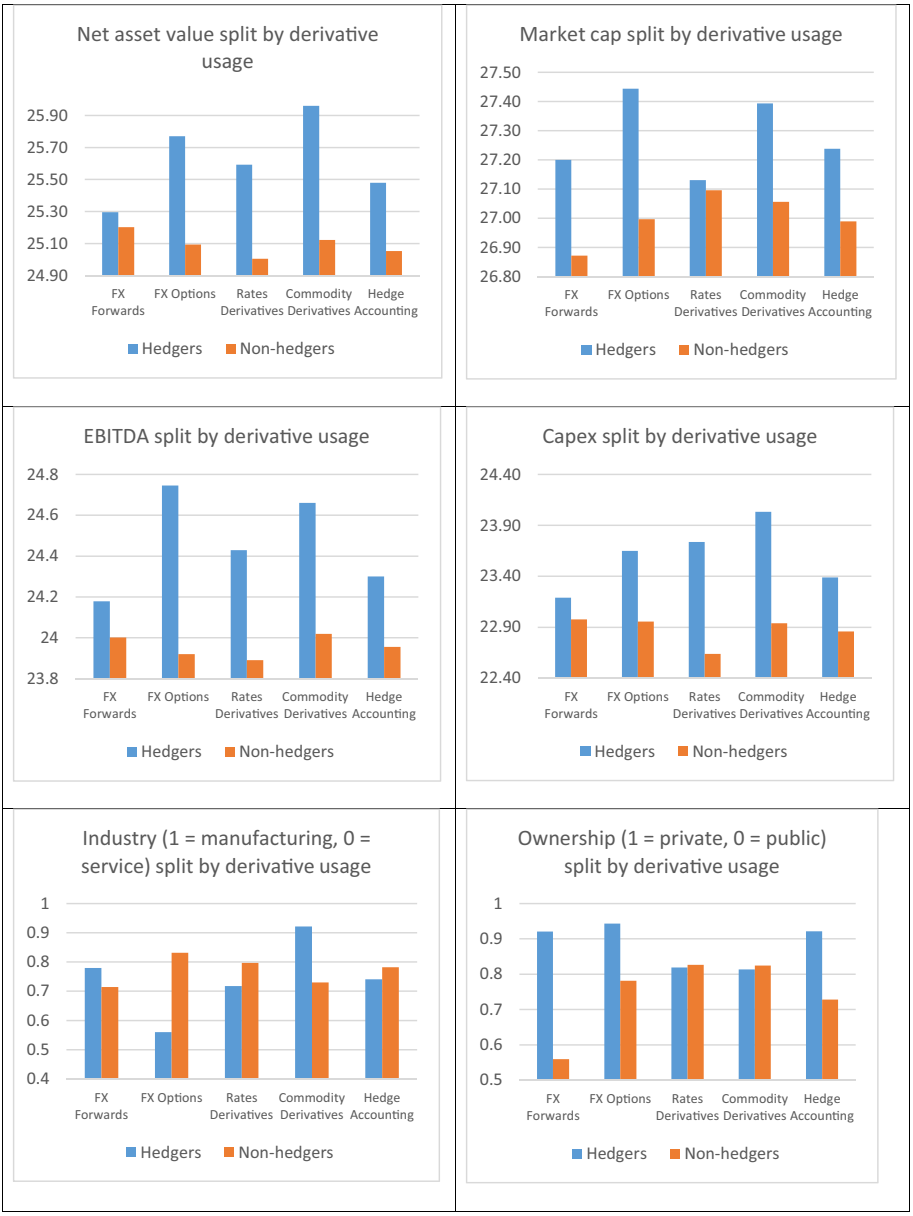


Fig. 4 NAV, Market Cap, EBITDA, CAPEX, Industry and Ownership Split by Derivative Usage. The above figures present results of net asset value, market cap, EBITDA, CAPEX, industry classification and ownership, split by groups of derivatives users and non-users

of setting up, running and monitoring a derivative portfolio as also found by Allayannis and Weston (2001) and Khediri (2010). Univariate analysis of Tobin's Q with independent variables does not show any secular trend. The relationship is positive and significant for FX forward, negative and significant for interest rates and commodity derivatives, and

Table 4 Baseline Results: Effect of derivatives usage on Tobin's Q

		FX forwards	FX options	Rates derivatives	Commodity derivatives	Hedge accounting	Hedging span
Independent Variables	FX forwards	0.2823***					
		(0.0691)					
	FX options		0.2303***				
			(0.0701)				
	Rates derivatives			0.0257			
				(0.0670)			
	Commodity derivatives				0.2692***		
					(0.0891)		
	Hedge accounting					0.2183***	
						(0.0593)	
	Hedging span						0.3655***
							(0.1054)
Control Variables	Net asset value	-0.2413***	-0.2469***	-0.2287***	-0.2528***	-0.2370***	-0.2518***
		(0.0442)	(0.0447)	(0.0449)	(0.0451)	(0.0443)	(0.0448)
	Return on assets	0.4979***	0.4746***	0.5030***	0.5254***	0.5025***	0.5234***
		(0.0415)	(0.0424)	(0.0436)	(0.0428)	(0.0416)	(0.0431)
	Leverage	-0.1504**	-0.1668**	-0.1397*	-0.1331*	-0.1311*	-0.1479**
		(0.0736)	(0.0746)	(0.0751)	(0.0742)	(0.0738)	(0.0750)
	Capex	-0.0365	-0.0451	-0.0474	-0.0484	-0.0497	-0.0476
		(0.0349)	(0.0351)	(0.0356)	(0.0351)	(0.0350)	(0.0353)
	Quick ratio	-0.1116***	-0.1395***	-0.1401***	-0.1320***	-0.1420***	-0.1096**
		(0.0431)	(0.0428)	(0.0436)	(0.0430)	(0.0426)	(0.0437)
	Industry	-0.1727**	-0.1041	-0.1449*	-0.1959**	-0.1388*	-0.1770**
		(0.0780)	(0.0793)	(0.0793)	(0.0802)	(0.0780)	(0.0795)
	Constant	7.4855***	8.0109***	7.6159***	8.1998***	7.7736***	7.9967***
		(0.6887)	(0.7033)	(0.7016)	(0.7209)	(0.6919)	(0.7020)

Table 4 (continued)

	FX forwards	FX options	Rates derivatives	Commodity derivatives	Hedge accounting	Hedging span
N	425	425	425	425	425	425
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Overall	0.5636	0.5576	0.5463	0.5558	0.5604	0.5511

The above table lists the results of six independent regressions that demonstrates the relationship of Tobin's Q with those individual variables. ***, **, and * indicates statistically significant levels of 1%, 5% and 10%, respectively. Values in brackets () below are standard errors

insignificant for others on a standalone basis. The relationship of the ROA with derivatives usage is negative and significant for all cases except FX options where it is negative but not significant. Possible reasons for it could be that firms that have lower ROAs are using derivatives to increase them, or that firms with higher inherent ROA do not have any added motivations to use derivatives. Leverage is significantly positively related to derivatives usage of all kinds, except hedge accounting. The reasons could be that derivatives users can afford higher leverage due to lower volatility in their incomes and that firms that have higher inherent leverage have less latitude to suffer volatility; so they use derivatives to hedge. The literature also talks about derivative usage giving firms the capacity to increase their leverage, which could also be a reason for this observation. Liquidity, defined by quick ratio, is normally negatively associated with derivative usage. The reasons for the same could be that firms that have ample liquidity available do not see the need for using hedging to manage cash-flows as they have to buffer to withstand volatility in operational cash-flows. On the other hand, less liquid firms would want more certainty in their cash-flows; so they use more hedging.

The results indicate that manufacturing firms are more likely to do hedging activities compared to service firms. Some activities such as FX forwards and commodity hedging are done more by manufacturing companies, while FX options and rates hedging are done more by services companies. Lastly, private firms are more likely to use derivatives as their managerial motivation and remuneration might be better aligned to risk management activities. These results are supported by the analysis.

4.3 Derivative usage and firm value

Table 4 reports the estimation results of the baseline model wherein Tobin's Q is regressed on all six variables representing derivative usage, running six different regressions to study the impact of each on firm value.

From this table, we see that the firm value is positively and significantly (with a 99% confidence interval in all cases) related to the use of FX forwards, FX options, commodity derivatives, hedge accounting and hedging span. This is broadly in line with the study of Allayannis and Weston (2001), stating that firms use hedging to reduce risk and volatility in their cash flows, and investors reward them with better market value for doing so.

The results for the relationship between firm value and rates hedging are positive but not significant (Table 4). This may be due to the lack of granularity of data that does not allow us to differentiate between pure interest rate hedging and long-dated cross-currency hedging. It may also be that rates hedging firms in India are doing so to express their view on rates and the yield curve, instead of hedging, as explained by Faulkender (2005). It may also be due to the peculiarities of the Indian market where most rate hedging is done mainly on the back of floating foreign currency borrowings to convert them to a fixed rate, which may not be perceived positively by investors. We have done further analysis on this to uncover a channel by including an interaction variable in Section 4.4.3.

The results of the control variables are similar to the findings of the previous studies (e.g. Allayannis and Weston (2001) and Khediri (2010)). Specifically, we observe the impact of size is negative and significant in all six regressions indicating that large firms have lower firm value. This is explained in the existing literature by large firms not having enough positive NPV projects available to them to be able to make a difference in Tobin's Q. Smaller firms, on the other hand, have more projects available compared to their size, from which they can choose and this choice creates a positive impact on Tobin's Q. Profitability has

a positive relationship with Tobin's Q as per the literature and it was amply demonstrated with the Z statistics of ROA above 10 in all regressions. More profitable firms are likely to have higher Tobin's Q as per Allayannis and Weston (2001) which is corroborated here. Existing literature is divided on the effect of leverage on firm value. For instance, Titman and Wessels (1988) show a negative sign for the same due to the increased risk that comes with leverage. Some studies like Modigliani and Miller (1963), and Myers (1977), however, show that increased leverage increases the tax shield available to firms, which in turn shall result in a positive Tobin's Q. Overall; the accepted relationship of leverage with Tobin's Q is negative. This was demonstrated in our regressions where half of our regressions showed a negative sign at a 5% significance level and the other half showed a 10% significance of a negative relationship of leverage with firm value in line with Allayannis and Weston (2001). However, as in Allayannis and Weston (2001), we did not find any significant relationship between Capex and firm value. With regard to the relationship with liquidity, it turned out to be negative and significant in all regressions, as expected. The reasons for this are that cash-constrained firms are likely to invest only in high NPV projects thus making their Tobin's Q higher compared to non-cash-constrained firms. Due to the nature of the Indian market, where the services industry has overall lower levels of debt compared to manufacturing, which is more capital intensive, we expected a higher Tobin's Q for the services industry compared to manufacturing. This was confirmed in all regressions where the relationship of Tobin's Q was found to be negative with the industry dummy, and it was significant for all except FX options.

4.4 Exploring channels through which derivative usage impacts firm value

Hedging impacts firm value through two main channels. The first could be increased leverage (Smith and Stulz 1985) as it increases the available tax shields to the firm. This was also empirically demonstrated by Hang et al. (2021) who show that for electric utility firms, hedging increases debt capacities and the availability of internal funds. he second channel could be reduced cash-flow/income volatility (Froot et al. 1993), as it increases the chances of a firm entering into the highest positive NPV projects available to them. The above two channels also reduce firm risk, allowing them to reduce borrowing costs, probability of financial distress and bankruptcy costs. We attempt to test the significance of both these channels.

4.4.1 Increased leverage

In Section 4.1, we mentioned graphically (Table 3, Fig. 3) that in our sample, the leverage of hedgers was significantly higher than that of non-hedgers. To identify the channels, we introduce an interaction term between leverage and derivative usage in our baseline model. The resultant estimable model can be specified as follows:

$$\begin{aligned} Firm\ Value_{i,t} = {} & \beta_0 + \beta_1 Derivative\ usage_{i,t} + \beta_2 Leverage_{i,t} \\ & + \beta_3 Derivative\ usage_{i,t} \times Leverage_{i,t} + \beta_i X_{i,t} + \alpha_i + \alpha_t + u_{i,t} \end{aligned} \tag{2}$$

The results of the above model are reported in Table 5. Our results show that for all cases firm value is positively related to derivative usage (except rates derivatives) and negatively related to leverage. However, the interaction of leverage with hedging variables is insignificant for all others, except rates derivatives and hedge accounting, where

Table 5 Effect of derivatives usage on Tobin's Q, including leverage as a channel

		FX forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Hedging Span
Independent Variables	FX Forwards	0.2974***					
		(0.0784)					
	Leverage	-0.0343					
		(0.2952)					
	FX Forwards * Leverage	-0.1203					
		(0.2961)					
	FX Options		0.1971**				
			(0.0784)				
	Leverage		-0.3344*				
			(0.1917)				
	FX Options * Leverage		0.1859				
			(0.1959)				
	Rates Derivatives			-0.0673			
				(0.0773)			
	Leverage			-0.8229***			
				(0.2972)			
	Rates Derivatives * Leverage			0.7008**			
				(0.2951)			

Table 5 (continued)

		FX forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Hedging Span
	Commodity Derivatives				0.1658		
					(0.1115)		
	Leverage				-0.1636**		
					(0.0767)		
	Commodity Derivatives * Leverage				0.3849		
					(0.2502)		
	Hedge Accounting					0.1500**	
						(0.0654)	
	Leverage					-0.2014**	
						(0.0790)	
	Hedge Accounting * Leverage					0.4162**	
						(0.1728)	
	Hedging Span						0.2585**
							(0.1262)
	Leverage						-0.5488**
							(0.2719)
	Hedging Span * Leverage						0.5987
							(0.3903)
Control Variables	Net Asset Value	-0.2402***	-0.2454***	-0.2357***	-0.2471***	-0.2162***	-0.2545***

Table 5 (continued)

	FX forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Hedging Span
	(0.0443)	(0.0447)	(0.0448)	(0.0452)	(0.0449)	(0.0448)
Return on Assets	0.4962***	0.4665***	0.4841***	0.5344***	0.5381***	0.5257***
	(0.0417)	(0.0433)	(0.0441)	(0.0431)	(0.0440)	(0.0430)
Capex	-0.0396	-0.0386	-0.0304	-0.0552	-0.0742**	-0.0408
	(0.0357)	(0.0357)	(0.0362)	(0.0353)	(0.0362)	(0.0355)
Quick Ratio	-0.1079**	-0.1425***	-0.1614***	-0.1424***	-0.1497***	-0.1281***
	(0.0441)	(0.0429)	(0.0443)	(0.0434)	(0.0425)	(0.0453)
Industry	-0.1627**	-0.1168	-0.2037**	-0.2171***	-0.1531**	-0.2231***
	(0.0820)	(0.0804)	(0.0826)	(0.0813)	(0.0778)	(0.0849)
Constant	7.5060***	7.8771***	7.5786***	8.2259***	7.7669***	8.0107***
	(0.6912)	(0.7174)	(0.6979)	(0.7199)	(0.6880)	(0.7009)
N	425	425	425	425	425	425
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Overall	0.5638	0.5585	0.5523	0.5584	0.5664	0.5536

The above table lists results of six independent regressions that demonstrates the relationship of Tobin's Q with those individual variables including the effect of leverage and its interaction variable with the independent variable. ***, **, and * indicates statistically significant levels of 1%, 5% and 10%, respectively. Values in brackets () below are standard errors

Table 6 Effect of derivatives usage on Tobin's Q, including earnings volatility as a channel

		FX Forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Hedging Span
Independent Variables	FX Forwards	0.1849*					
		(0.1007)					
	Earnings Volatility	-0.0043					
		(0.0059)					
	FX Forwards * Earning Volatility	0.0103					
		(0.0083)					
	FX Options		0.2212**				
			(0.1003)				
	Earnings Volatility		0.0005				
			(0.0050)				
	FX Options * Earning Volatility		-0.0017				
			(0.0093)				
	Rates Derivatives			0.0365			
				(0.0997)			
	Earnings Volatility			0.0004			
				(0.0051)			
	Rates Derivatives * Earning Volatility			-0.0005			
				(0.0099)			
	Commodity Derivatives				0.4092***		

Table 6 (continued)

		FX Forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Hedging Span
					(0.1280)		
	Earnings Volatility				0.0022		
					(0.0046)		
	Commodity Derivatives * Earning Volatility				-0.0296		
					(0.0180)		
	Hedge Accounting					0.0470	
						(0.0904)	
	Earnings Volatility					-0.0054	
						(0.0053)	
	Hedge Accounting * Earning Volatility					0.0183**	
						(0.0087)	
	Hedging Span						0.2721*
							(0.1433)
	Earnings Volatility						-0.0061
							(0.0051)
	Hedging Span * Earning Volatility						0.0124
							(0.0129)
Control Variables	Net Asset Value	-0.2712***	-0.2783***	-0.2573***	-0.2880***	-0.2694***	-0.2743***
		(0.0516)	(0.0530)	(0.0532)	(0.0525)	(0.0517)	(0.0526)

Table 6 (continued)

	FX Forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Hedging Span
Return on Assets	0.5246***	0.5249***	0.5543***	0.5702***	0.5305***	0.5633***
	(0.0526)	(0.0532)	(0.0536)	(0.0510)	(0.0500)	(0.0535)
Leverage	-0.1758	-0.1168	-0.1002	-0.1212	-0.0422	-0.1337
	(0.1164)	(0.1276)	(0.1335)	(0.1082)	(0.1116)	(0.1231)
Capex	-0.0330	-0.0417	-0.0466	-0.0424	-0.0451	-0.0518
	(0.0422)	(0.0431)	(0.0450)	(0.0422)	(0.0422)	(0.0433)
Quick Ratio	-0.1345***	-0.1629***	-0.1692***	-0.1707***	-0.1589***	-0.1294***
	(0.0498)	(0.0494)	(0.0501)	(0.0490)	(0.0490)	(0.0498)
Industry	-0.1736*	-0.1239	-0.1555*	-0.2077**	-0.1263	-0.1807**
	(0.0889)	(0.0903)	(0.0903)	(0.0906)	(0.0894)	(0.0904)
Constant	8.1679***	8.6412***	8.2270***	8.8783***	8.4717***	8.6377***
	(0.7941)	(0.8145)	(0.8056)	(0.8197)	(0.7970)	(0.8043)
N	323	323	323	323	323	323
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2 Overall	0.6088	0.6024	0.5939	0.6068	0.6075	0.5966

The above table lists results of six independent regressions that demonstrates the relationship of Tobin's Q with those individual variables including the effect of earnings volatility and its interaction variable with the independent variable. ***, **, and * indicates statistically significant levels of 1%, 5% and 10%, respectively. Values in brackets () below are standard errors

it is positive and significant. This demonstrates that while the hedging value in other asset classes may not be linked with the leverage of users, for rates hedging the value is created by only those with higher leverage. Additionally, hedge accounting is useful for all firms but is more important for those with high leverage.

4.4.2 Reduced earnings volatility

To test the relationship of firm value with earnings volatility, we calculated a three-year rolling EBITDA standard deviation for each firm. Based on the eight-year data available, we managed to get six earnings volatility estimates for each firm. In addition to finding the standalone effect of earnings volatility on firm value, we were also keen to establish the joint effect of derivative usage and earnings volatility on firm value. Therefore, we introduced an interaction variable: 'derivative usage*earnings volatility and the resultant estimable model can be specified as follows:

$$\begin{aligned} Firm\ Value_{i,t} = {} & \beta_0 + \beta_1 Derivative\ usage_{i,t} + \beta_2 Earnings\ Vol_{i,t} \\ & + \beta_3 Derivative\ usage_{i,t} \times Earnings\ Vol_{i,t} + \beta_i X_{i,t} + \alpha_i + \alpha_t + u_{i,t} \end{aligned} \tag{3}$$

Based on the above, we conducted individual regressions for all six hedging variables, the results of which are presented in Table 6. Our results highlight that for all cases, firm value is not significantly impacted by earning volatility on its own. However, the interaction of earnings volatility with hedging variables has a positive and significant effect on firm value. This demonstrates that firms with higher earnings volatility add to their value significantly when they use hedge accounting. This is a novel and useful result from our research which confirms our initial understanding that firms are using hedge accounting to add value by reducing earnings volatility.

4.4.3 Joint interaction of leverage, earnings volatility with hedging variables

In Sections 4.4.1 and 4.4.2, we talked about the interaction of hedging variables with leverage and earnings volatility individually. As a final step in our analysis, we wanted to establish if there is any cross-interaction among these three variables to understand whether any relationship exists between our hedging variables, leverage and earnings volatility, we introduce the triple interaction term in our baseline model. The estimation model is specified below:

$$\begin{aligned} Firm\ Value_{i,t} = {} & \beta_0 + \beta_1 Derivative\ usage_{i,t} + \beta_2 Leverage_{i,t} + \beta_3 Earnings\ vol_{i,t} \\ & + \beta_4 Derivative\ usage_{i,t} \times Leverage_{i,t} \\ & + \beta_5 Derivative\ usage_{i,t} \times Earnings\ vol_{i,t} \\ & + \beta_6 Derivative\ usage_{i,t} \times Leverage_{i,t} \times Earnings\ vol_{i,t} \\ & + \beta_i X_{i,t} + \alpha_i + \alpha_t + u_{i,t} \end{aligned} \tag{4}$$

Based on the above, we conducted individual regressions for all six hedging variables, the results of which are presented in Tables 7 and 8. The results show the positive effect of double interaction terms on firm value; however, the triple interaction term was negative in all cases (and significant in four out of six cases). This suggests that Indian firms that have either high leverage or high earning volatility, are positively impacted by derivative usage but if they have both, they are unable to benefit from derivative use, given the negative relation.

Table 7 Combined role of leverage and earning volatility towards effect of derivatives usage on Tobin's Q

		FX Forwards	FX Options	Rates Derivatives
Independent Variables	FX Forwards	0.1206		
		(0.1192)		
	Leverage	0.0561		
		(0.3749)		
	Earnings Volatility	-0.0045		
		(0.0060)		
	FX Forwards * Leverage	0.1347		
		(0.3769)		
	FX Forwards * Earning Volatility	0.0170*		
		(0.0090)		
	FX Forwards * Leverage * Earnings Volatility	-0.0067**		
		(0.0030)		
	FX Options		-0.0159	
			(0.1300)	
	Leverage		-0.1445	
			(0.2273)	
	Earnings Volatility		-0.0010	
			(0.0050)	
	FX Options * Leverage		0.6864**	

Table 7 (continued)

		FX Forwards	FX Options	Rates Derivatives
			(0.2938)	
	FX Options * Earnings Volatility		0.0151	
			(0.0111)	
	FX Options * Leverage * Earnings Volatility		-0.0113***	
			(0.0041)	
	Rates Derivatives			-0.1761
				(0.1212)
	Leverage			-0.6445*
				(0.3868)
	Earnings Volatility			-0.0017
				(0.0052)
	Rates Derivatives * Leverage			0.9302**
				(0.3731)
	Rates Derivatives * Earnings Volatility			0.0174
				(0.0116)
	Rates Derivatives * Leverage * Earnings Volatility			-0.0084**
				(0.0033)
Control Variables	Net Asset Value	-0.2544***	-0.2434***	-0.2453***
		(0.0519)	(0.0539)	(0.0527)
	Return on Assets	0.5577***	0.5575***	0.5660***

Table 7 (continued)

	FX Forwards	FX Options	Rates Derivatives
	(0.0549)	(0.0544)	(0.0553)
Capex	-0.0584	-0.0652	-0.0528
	(0.0439)	(0.0439)	(0.0453)
Quick Ratio	-0.1364***	-0.1665***	-0.1921***
	(0.0511)	(0.0490)	(0.0509)
Industry	-0.1431	-0.0944	-0.2119**
	(0.0937)	(0.0916)	(0.0962)
Constant	8.2151***	8.2338***	8.1750***
	(0.7924)	(0.8312)	(0.7958)
N	323	323	323
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2 Overall	0.6150	0.6127	0.6065

The above table lists results of three independent regressions that demonstrates the relationship of Tobin's Q with those individual variables including effects of leverage, earnings volatility, their interactions with independent variables and a triple interaction variable too. ***, **, and * indicates statistically significant levels of 1%, 5% and 10%, respectively. Values in brackets () below are standard errors

Table 8 Combined role of leverage and earning volatility towards the effect of derivatives usage on Tobin's Q

		Commodity Derivatives	Hedge Accounting	Hedging Span
Independent Variables	Commodity Derivatives	0.3765**		
		(0.1598)		
	Leverage	-0.1310		
		(0.1141)		
	Earnings Volatility	0.0023		
		(0.0046)		
	Commodity Derivatives * Leverage	0.1352		
		(0.3701)		
	Commodity Derivatives * Earning Volatility	-0.0257		
		(0.0222)		
	Commodity Derivatives * Leverage * Earnings Volatility	-0.0232		
		(0.0921)		
	Hedge Accounting		-0.0363	
			(0.0965)	
	Leverage		-0.1528	
			(0.1240)	
	Earnings Volatility		-0.0036	
			(0.0053)	
	Hedge Accounting * Leverage		0.6284**	

Table 8 (continued)

		Commodity Derivatives	Hedge Accounting	Hedging Span
			(0.2440)	
	Hedge Accounting * Earning Volatility		0.0226**	
			(0.0090)	
	Hedge Accounting * Leverage * Earnings Volatility		-0.0902	
			(0.0563)	
	Hedging Span			0.1040
				(0.1780)
	Leverage			-0.1689
				(0.3968)
	Earnings Volatility			-0.0072
				(0.0051)
	Hedging Span * Leverage			0.5226
				(0.4803)
	Hedging Span * Earnings Volatility			0.0280*
				(0.0143)
	Hedging Span * Leverage * Earnings Volatility			-0.0098**
				(0.0046)
Control Variables	Net Asset Value	-0.2862***	-0.2540***	-0.2599***
		(0.0529)	(0.0521)	(0.0528)
	Return on Assets	0.5713***	0.5558***	0.5917***

Table 8 (continued)

	Commodity Derivatives	Hedge Accounting	Hedging Span
	(0.0512)	(0.0514)	(0.0551)
Capex	-0.0430	-0.0569	-0.0691
	(0.0425)	(0.0431)	(0.0447)
Quick Ratio	-0.1727***	-0.1738***	-0.1410***
	(0.0499)	(0.0492)	(0.0522)
Industry	-0.2109**	-0.1293	-0.1873*
	(0.0925)	(0.0905)	(0.0994)
Constant	8.8477***	8.3258***	8.6434***
	(0.8309)	(0.7946)	(0.7996)
N	323	323	323
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
R^2 Overall	0.6069	0.6158	0.6039

The above table reports the results of three independent regressions that demonstrates the relationship of Tobin's Q with those individual variables including effects of leverage, earnings volatility, their interactions with independent variables and a triple interaction variable too. ***, **, and * indicates statistically significant levels of 1%, 5% and 10%, respectively. Values in brackets () below are standard errors

Table 9 Propensity Score Matching: Distribution of sample between treated and untreated groups

			Off Support	On Support	Total
FX forwards	Pseudo R^2 0.0533	Untreated	0	107	107
		Treated	10	308	318
		Total	**10**	**415**	**425**
FX options	Pseudo R^2 0.0926	Untreated	0	313	313
		Treated	5	107	112
		Total	**5**	**420**	**42**
Interest rate derivatives	Pseudo R^2 0.1782	Untreated	0	219	219
		Treated	14	192	206
		Total	**14**	**411**	**425**
Commodity derivatives	Pseudo R^2 0.2960	Untreated	0	351	351
		Treated	1	73	74
		Total	**1**	**424**	**425**
Hedge accounting	Pseudo R^2 0.0180	Untreated	0	192	192
		Treated	5	228	233
		Total	**5**	**420**	**425**
Hedging Span	Pseudo R^2 0.0609	Untreated	0	362	362
		Treated	0	62	62
		Total	**0**	**425**	**425**

The above table demonstrates the distribution of treated and untreated with "off support" and "on support" group in our PSM exercise for all hedging variables. Pseudo R^2 is also given in each analysis to estimate the goodness of match

Table 10 Causal identification using Propensity Score Matching

	Tobin's Q of Treated Firms	Tobin's Q of Control Firms	Difference between Treated and Control	T-Statistics
FX forwards	1.55906	1.28487	0.27419	2.54**
			(0.10778)	
FX options	1.55185	1.27794	0.27391	2.60**
			(0.10521)	
Rates derivatives	1.28247	1.16244	0.12003	1.10
			(0.10913)	
Commodity derivatives	1.05615	0.75759	0.29857	1.91*
			(0.15647)	
Hedge accounting	1.51671	1.28860	0.22810	2.47**
			(0.09221)	
Hedging span	1.07915	0.97294	0.10622	0.80
			(0.13230)	

The above table demonstrates the ATT on Tobin's Q of the treatment group versus the control group for all types of derivatives usage. **, and * indicates statistically significant levels of 5% and 10%, respectively

Table 11 Quality of matching between treatment and control firm Variables in propensity score matching

	Control Variable	Mean		% Bias	T-Test	
		Treated	Control		T	p>|t|
FX forwards	Net asset value	25.3600	25.4650	-8.1	-0.98	0.327
	Return on assets	2.1052	2.1764	-8.5	-1.06	0.291
	Leverage	0.1453	0.1440	0.3	0.07	0.948
	Capex	23.3010	23.3170	-1.0	-0.12	0.905
	Quick ratio	1.1101	1.1373	-2.8	-0.48	0.634
	Industry	0.8084	0.7742	7.8	1.04	0.297
FX options	Net asset value	25.7520	25.7880	-2.9	-0.21	0.838
	Return on assets	2.1638	2.0851	8.5	0.66	0.510
	Leverage	0.1936	0.2334	-6.7	-0.92	0.360
	Capex	23.6810	23.7910	-6.9	-0.47	0.638
	Quick ratio	1.2815	1.2345	5.5	0.42	0.675
	Industry	0.6542	0.6650	-2.5	-0.17	0.868
Rates derivatives	Net asset value	25.6680	25.6400	2.3	0.23	0.821
	Return on assets	1.8833	1.8241	7.2	0.79	0.429
	Leverage	0.2195	0.1656	11.8	1.42	0.156
	Capex	23.7420	23.6090	8.8	0.82	0.414
	Quick ratio	0.9994	1.0031	-0.5	-0.07	0.946
	Industry	0.7604	0.7408	4.7	0.44	0.657
Commodity derivatives	Net asset value	26.3620	26.3400	1.8	0.12	0.908
	Return on assets	1.4330	1.3582	9.5	0.46	0.650
	Leverage	0.3044	0.3057	-0.3	-0.02	0.982
	Capex	24.4960	24.6140	-7.8	-0.46	0.646
	Quick ratio	0.7983	0.7942	0.6	0.07	0.947
	Industry	0.8904	0.8756	3.9	0.28	0.783
Hedge accounting	Net asset value	25.4860	25.4700	1.3	0.14	0.886
	Return on assets	2.0589	2.0458	1.5	0.15	0.877
	Leverage	0.1856	0.1525	6.9	0.94	0.347
	Capex	23.4110	23.4000	0.7	0.08	0.938
	Quick ratio	1.2312	1.2035	3.2	0.34	0.735
	Industry	0.7456	0.7641	-4.4	-0.46	0.647
Hedging span	Net asset value	26.4800	25.7890	59.4	3.30	0.001
	Return on assets	1.4436	1.5231	-10.1	-0.49	0.625
	Leverage	0.3326	0.3116	5.2	0.35	0.731
	Capex	24.6200	24.1880	29.3	1.58	0.117
	Quick ratio	0.8285	0.6555	25.5	3.16	0.002
	Industry	0.8710	0.7666	26.9	1.51	0.134

The above table demonstrates the performance of matching in PSM for control variables. It also lists down % bias and p-scores, to help decide the extent of matching for control variables

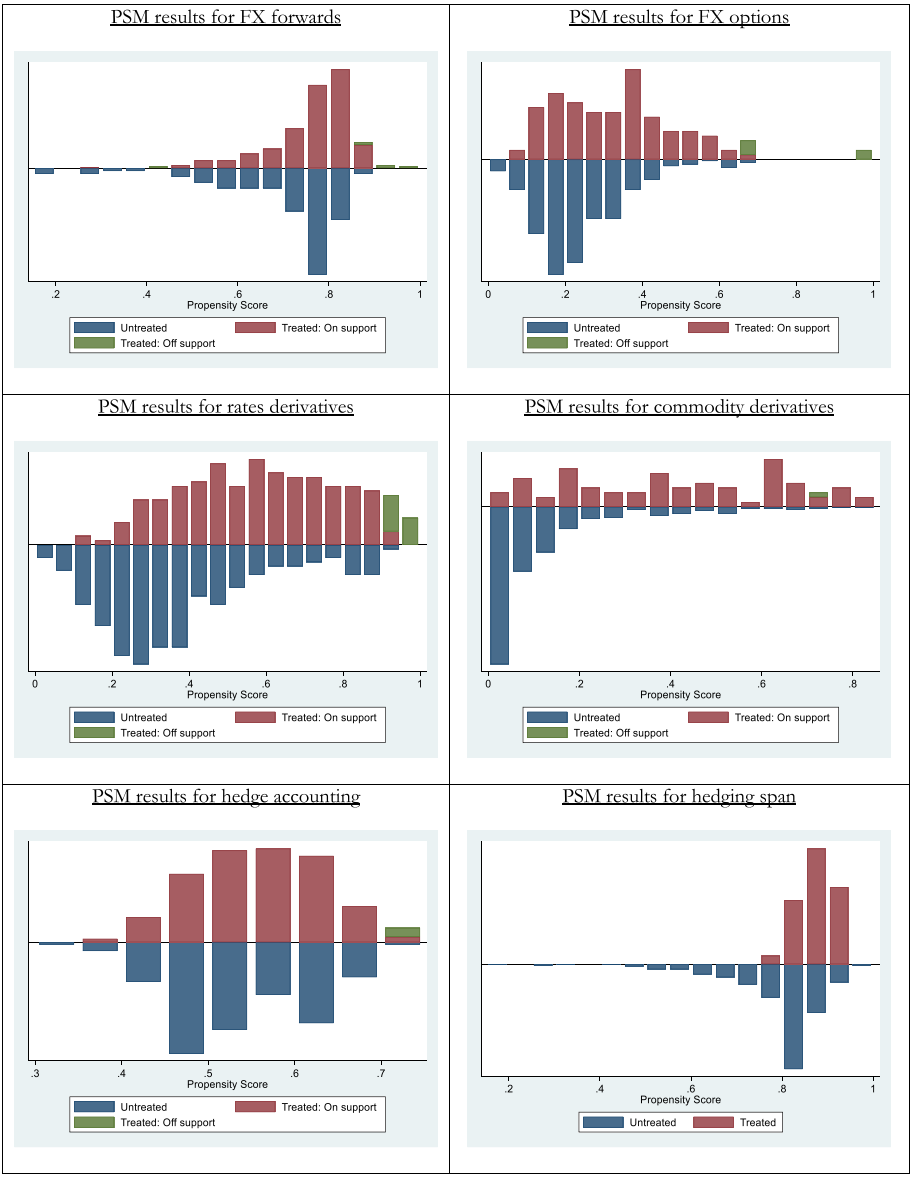


Fig. 5 PSM results for all six hypothesis. The above figures present results of propensity score matching for all six hypotheses

4.5 Further analysis using propensity score matching

To address the robustness of our results and to overcome the issue of non-random selection bias, we applied the Propensity Score Matching (PSM) approach to allow an adequate "like for like" comparison. We used the same six control variables (size, profitability, leverage,

investment growth opportunity, liquidity, and industry) as in our regressions to calculate propensity scores in the case of each of our six hypotheses from H1A to H1F. Once these scores were calculated, we used Kernel and Caliper methods for matching treatment groups with control groups. We found that nearly all observations could be defined as "On Support" for PSM exercise in all six hypotheses (Table 9). Pseudo R^2 was also low in all cases. Having categorised observations into treatment and control groups, based on matching, we can then derive the 'average treatment effect' (ATT) as follows:

$$\tau_{ATT} = E\left[Y_{it}|\rho, D = 1\right] - E\left[Y_{it}|\rho, D = 0\right] \tag{5}$$

The results of ATT on Tobin's Q of the treatment group versus the control group in all six hypotheses are given in Table 10. In all cases, the firm value of treated groups, i.e. firms using derivatives, is higher than control groups, i.e. firms not using derivatives. As expected, the significance is strong in all cases, except interest rate derivatives and due to its effect on the hedging span. The propensity score histogram of matched treated and control firms suggests a high rate of overlapped propensity scores between treated and untreated firms of above 0.6 for FX forwards and hedging span, although the match is occurring at the lowend for other types of derivatives. This suggests that the former two instruments are used by top-end firms where it is hard to find untreated/treated firms at low propensity scores. As most untreated firms with propensity scores below 0.6 are available to be matched with treated firms having similar propensity scores—in particular in the range of 0.1 to 0.4, the quality of matching in the histogram and Table 11 appear consistent.

Graphical results of PSM are shown for all six cases in Fig. 5. It is clear from tables and graphs that our main results are supported by the PSM technique too, as the mean difference in Tobin's Q of treated versus untreated group is significant and positive. We also tested for quality of matching by checking for percentage bias and p-scores of control variables in all six hypotheses. Results, presented in Table 11, clearly demonstrate excellent quality of matching based on low Percent bias and high p-scores in all cases, except for a few in the hedging span, thereby further corroborating our panel results.[8]

4.6 Additional robustness test for rates derivatives

In Section 4.3, we find that, contrary to the existing literature, the usage of rates derivatives per se did not add any firm value because of regulations and market structure. Following Bose et al. (2020), who show that Indian companies with access to foreign funding achieve better productivity and export performance, we explore the impact on valuation for firms with long-term foreign currency debt (LTFD) and that employ rates derivatives to manage currency risk exposure.

We hand-collect data on outstanding long-term foreign currency debt (External commercial borrowings, inter-company FCY loans, developmental institutions FCY loans and other long-term FCY bonds and loans) from the company's annual report. We find that 59% of companies in our sample had LTFD. The maximum LTFD was INR 308.44 billion while the average LTFD for all companies was INR 24.06 billion. The correlation matrix of various derivatives measure and LFTD is reported in Table 12. We observe that the

[8] Additionally, to test the possibility of derivative usage effect surfacing with a lag, we also ran all regressions with a lag of one and two years on dependent variables. Results were largely similar to our main analysis. For brevity, they are not shown here but are available upon request.

Table 12 Correlation matrix of various derivatives usage and LTFD

	FX Forwards	FX Options	Rates Derivatives	Commodity Derivatives	Hedge Accounting	Long-term foreign currency debt (LTFD)
FX Forwards	1.0000					
FX Options	0.3406	1.0000				
Rates Derivatives	0.2529	0.1733	1.0000			
Commodity Derivatives	0.2308	0.0586	0.2945	1.0000		
Hedge Accounting	0.4170	0.3979	0.4307	0.1904	1.0000	
LTFD	0.2040	0.1503	**0.6726**	0.2253	0.3624	1.0000

The above table shows the correlation matrix among various derivatives usage and long-term foreign currency debt usage

Table 13 Effect of rates derivatives usage on Tobin's Q, including LTFD as a channel

		Rates Derivatives	Long-term foreign currency debt (LTFD)	Rates Derivatives and LTFD
	Rates Derivatives	0.0257		-0.2598**
		(0.0670)		(0.1155)
	Long-term foreign currency debt (LTFD)		-0.0092	-0.0397***
			(0.0104)	(0.0135)
	Rates Derivatives * LTFD			0.0659***
				(0.0186)
Control Variables	Net Asset Value	-0.2287***	-0.2328***	-0.2386***
		(0.0449)	(0.0451)	(0.0446)
	Return on Assets	0.5030***	0.4875***	0.4858***
		(0.0436)	(0.0442)	-0.0440
	Leverage	-0.1397*	-0.1253*	-0.1504**
		(0.0751)	(0.0763)	(0.0756)
	Capex	-0.0474	-0.0367	-0.0316
		(0.0356)	(0.0370)	(0.0366)
	Quick Ratio	-0.1401***	-0.1504***	-0.1535***
		(0.0436)	(0.0443)	(0.0437)
	Industry	-0.1449*	-0.1542*	-0.1687**
		(0.0793)	(0.0799)	(0.0790)
	Constant	7.6159***	7.5735***	7.6741***
		(0.7016)	(0.7023)	(0.6937)
	N	425	425	425
	Firm FE	Yes	Yes	Yes
	Year FE	Yes	Yes	Yes
	R^2 Overall	0.6137	0.6123	0.6254

The above table lists the results of three independent regressions that demonstrates the relationship of Tobin's Q with those individual variables. ***, **, and * indicates statistically significant levels of 1%, 5% and 10%, respectively. Values in brackets () below are standard errors

correlation coefficient is highest between rates derivatives and LTFD, thereby strongly suggesting that firms who have LTFD on their balance sheet are most likely to use rates derivatives. Since we wanted to understand the linkages between LTFD and rates derivatives usage, we examine whether firms with LTFD benefit from employing rates derivatives. We use the below model to individually assess the impact on value of LTFD usage and the interaction of rates derivatives usage with LTFD.

$$\begin{aligned} Firm\ Value_{i,t} = \beta_0 + \beta_1 Rates\ derivative_{i,t} + \beta_2 LTFD_{i,t} \\ + \beta_3 Rates\ derivative_{i,t} \times LTFD_{i,t} + \beta_i X_{i,t} + \alpha_i + \alpha_t + u_{i,t} \end{aligned} \quad (6)$$

In our baseline regression, although there is no direct significant effect of LTFD on firm value, when we interact rates derivatives with LTFD, we find a positive and significant relationship, suggesting that firms with higher LTFD tend to benefit from the use of rates derivatives in boosting their firm value (see the results in Table 13).

The above results confirm our initial hypothesis that rate derivatives in Indian conditions may not add value to all firms, but when used by firms with LTFD, it adds significant value to those firms.

5 Conclusion

The risk management policy of the firm to hedge future financial risk matters significantly in improving firm performance (Ding et al. 2019). The usage of derivatives has become a widespread phenomenon in recent years in many emerging markets including India, particularly so for top Indian listed non-financial companies. This paper attempts to highlight the nature and key characteristics of companies that use various types of derivatives. Despite data limitations on hedging in the Indian context, we were able to undertake this study using hand-collected hedging data across firms along with the balance-sheet financial data on Indian companies to understand whether different types of hedging strategies by firms are beneficial in improving firm value. The key contribution of this paper is that it empirically establishes the positive impact of various types of derivative usage on firm value in the Indian context as a key emerging market where derivatives trading has been re-regulated post-global financial crisis. Introducing a new variable called 'hedging span'; we demonstrate a positive and significant relationship between hedging span and firm value.

The main emphasis of our empirical results is four-fold: First, all types of hedging, except rates hedging, directly add value to a firm through reduced earnings volatility and increased tax shields through greater leverage. Second, rates hedging per se does not increase firm value, but only benefits firms who are highly leveraged. Third, hedge accounting is an extremely useful tool to increase firm value for a firm with higher earnings volatility, as volatile derivative MTMs for compliant derivative positions can be kept on the balance sheet as hedging reserves instead of taking to P&L every year. Lastly, firms can add value by using derivatives if their leverage is high, or they have higher earnings volatility, but not both. The robustness of these results holds under the PSM-based comparison between derivative users and non-users. Comparing the results of other studies in Appendix Table 16 with our analysis of Indian firms, we find a similar pattern where FX and commodity derivatives have a strong and positive relationship (99% confidence) to firm value, but the direct effect of rates derivatives usage does not show any significant effect on firm value. It, therefore, seems for the case of India that the FX (and commodity) derivatives usage has a stronger (and weaker) relation to firm value when compared to average global markets. The additional analysis done for rate derivatives using the LTFD channel tells us that rate derivatives in Indian conditions may not add value to all firms on average, but when used by firms with LTFD, it adds significant value to those firms.

These results fill an important gap in the existing derivative literature for Indian and in the context of broader emerging markets. The results of this study can be used by Indian and emerging market corporates to formulate their risk management policy and use hedge accounting for longer-term compliant derivative positions. Regulators can use results from this study to streamline regulations to restrict the use of interest rate derivatives for highly leveraged firms only, even when they have exposure to foreign currency risk.

Appendix 1

Table 14 India's share in world GDP and market cap of listed companies

Year	GDP ($ Trillions)			Market Cap of Listed Companies ($ Trillions)		
	India	World	India as % of the world	India	World	India as % of the world
2008	1.20	64.12	1.87%	0.92	51.80	1.78%
2009	1.34	60.80	2.21%	0.70	35.90	1.95%
2010	1.68	66.61	2.52%	1.55	53.50	2.90%
2011	1.82	73.86	2.47%	1.31	54.10	2.42%
2012	1.83	75.50	2.42%	1.29	54.50	2.37%
2013	1.86	77.61	2.39%	1.28	63.60	2.01%
2014	2.04	79.73	2.56%	1.86	75.40	2.47%
2015	2.10	75.19	2.80%	1.66	66.40	2.50%
2016	2.29	76.47	3.00%	1.68	67.60	2.49%
2017	2.65	81.41	3.26%	2.24	84.00	2.67%
2018	2.70	86.47	3.13%	2.19	87.90	2.49%
2019	2.83	87.65	3.23%	2.29	89.70	2.55%
2020	2.67	85.12	3.13%	2.31	89.30	2.59%
2021	3.18	96.53	3.29%	3.43	102.50	3.35%

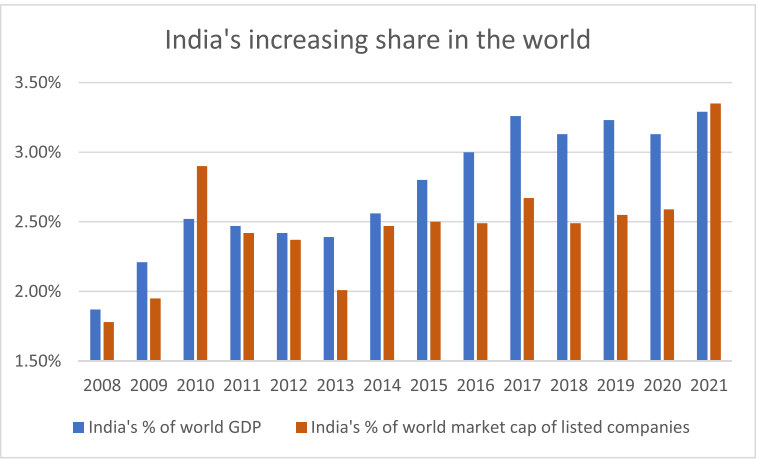


Fig. 6 The above table shows the GDP and market cap of listed companies for India and the world. It also shows India's share in both parameters since the global financial crisis. The chart below presents the same information in graphical format

Appendix 2

Table 15 Analysis of derivatives usage reduction with size

	BSE-100 Firms Average over Years 2010–2017	BSE-250 Firms (excluding BSE-100 firms) Year 2023
FX Forwards	0.7295	0.4957
FX Options	0.2560	0.1111
Rates Derivatives	0.4444	0.1197
Commodity Derivatives	0.1643	0.0256
Hedge Intensity	0.4300	0.2200
Sample size	80	117

The above table compares derivative usage in BSE-100 and remaining BSE-250 companies and shows derivatives usage drops significantly with size

Appendix 3

Table 16 Summary of benefits of hedging in various papers

Authors (Year)	Type of Derivatives	Countries	Time Period	Number of Firms	Benefit found	Confidence Interval
Allayannis and Weston (2001)	FX	US	1990–1995	720	Hedging premium of 4.87% of firm value	99%
Bachiller et al (2021)	All Derivatives	18	1985–2015	14,790	Meta-Analysis of 51 papers, Average hedging premium of ~ 4.5% of firm value	95%
Bartram et al (2011)	FX, IR, Commodities	47	2000–2001	6888	Hedging premium of 0.7%-6.9% of firm value	Weak
Campello et al (2011)	FX, IR	US	1996–2002	1185	29% reduction in borrowing costs	95%—99%
Chen and King (2014)	FX, IR, Commodities	US	1994–2009	2612	Borrowing cost reduction of 19.2 bps for investment grade and 45.2 bps for speculative-grade	99%
Geyer-Klingeberg et al. (2021)	All Derivatives	Global	1995–2016	1016	Meta-Analysis of 71 papers. Impact on firm value of + 1.8% for FXD, -0.8% for rates derivatives and -0.6% for commodity derivatives	95%
Graham and Rogers (2002)	FX, IR	US	1994–1995	855	Increased firm value of 1.1%	95%—99%
Mackay and Moeller (2007)	Commodities	US	1985–2002	34	Increased firm value of 1.31%—4.09%	95%
Perez-Gonzalez and Yun (2013)	Weather	US	1987–2008	203	Increased firm value of 5.2%	95%

The above table shows a summary of relevant findings from our literature review

Appendix 4

Table 17 List of companies in the sample set

S.N	NSE Trading Code	Company Common Name	S.N	NSE Trading Code	Company Common Name
1	ABB.NS	ABB India Ltd	41	IDEA.NS	Idea Cellular Ltd
2	ACC.NS	ACC Ltd	42	IOC.NS	Indian Oil Corpn Ltd
3	APSE.NS	Adani Ports and Special Economic Zone Ltd	43	INFY.NS	Infosys Ltd
4	ABUJ.NS	Ambuja Cements Ltd	44	ITC.NS	ITC Ltd
5	APLH.NS	Apollo Hospitals Enterprise Ltd	45	JSTL.NS	JSW Steel Ltd
6	ASOK.NS	Ashok Leyland Ltd	46	LART.NS	Larsen & Toubro Ltd
7	ASPN.NS	Asian Paints Ltd	47	LUPN.NS	Lupin Ltd
8	ARBN.NS	Aurobindo Pharma Ltd	48	MAHM.NS	Mahindra and Mahindra Ltd
9	BAJA.NS	Bajaj Auto Ltd	49	MRCO.NS	Marico Ltd
10	BAJE.NS	Bharat Electronics Ltd	50	MRTI.NS	Maruti Suzuki India Ltd
11	BFRG.NS	Bharat Forge Ltd	51	MOSS.NS	Motherson Sumi Systems Ltd
12	BHEL.NS	Bharat Heavy Electricals Ltd	52	MRF.NS	MRF Ltd
13	BPCL.NS	Bharat Petroleum Corporation Ltd	53	NEST.NS	Nestle India Ltd
14	BRTI.NS	Bharti Airtel Ltd	54	NMDC.NS	NMDC Ltd
15	BHRI.NS	Bharti Infratel Ltd	55	NTPC.NS	NTPC Ltd
16	BOSH.NS	Bosch Ltd	56	ONGC.NS	Oil and Natural Gas Corporation Ltd
17	BRIT.NS	Britannia Industries Ltd	57	PLNG.NS	Petronet LNG Ltd
18	CADI.NS	Cadila Healthcare Ltd	58	PIDI.NS	Pidilite Industries Ltd
19	CIPL.NS	Cipla Ltd	59	PIRA.NS	Piramal Enterprises Ltd
20	COAL.NS	Coal India Ltd	60	PGRD.NS	Power Grid Corporation of India Ltd
21	COLG.NS	Colgate-Palmolive (India) Ltd	61	RELI.NS	Reliance Industries Ltd
22	CCRI.NS	Container Corporation of India Ltd	62	RURL.NS	Rural Electrification Corp Ltd
23	CROP.NS	Crompton Greaves Consumer Electricals Ltd	63	SHCM.NS	Shree Cement Ltd

Table 17 (continued)

S.N	NSE Trading Code	Company Common Name	S.N	NSE Trading Code	Company Common Name
24	CUMM.NS	Cummins India Ltd	64	SIEM.NS	Siemens Ltd
25	DABU.NS	Dabur India Ltd	65	SUN.NS	Sun Pharmaceutical Industries Ltd
26	DIVI.NS	Divi's Laboratories Ltd	66	TTCH.NS	Tata Chemicals Ltd
27	DLF.NS	DLF Ltd	67	TCS.NS	Tata Consultancy Services Ltd
28	REDY.NS	Dr Reddy's Laboratories Ltd	68	TAGL.NS	Tata Global Beverages Ltd
29	EICH.NS	Eicher Motors Ltd	69	TAMO.NS	Tata Motors Ltd
30	EXID.NS	Exide Industries Ltd	70	TTPW.NS	Tata Power Company Ltd
31	GAIL.NS	GAIL (India) Ltd	71	TISC.NS	Tata Steel Ltd
32	GLEN.NS	Glenmark Pharmaceuticals Ltd	72	TEML.NS	Tech Mahindra Ltd
33	GOCP.NS	Godrej Consumer Products Ltd	73	TITN.NS	Titan Company Ltd
34	GRAS.NS	Grasim Industries Ltd	74	TVSM.NS	TVS Motor Company Ltd
35	HVEL.NS	Havells India Ltd	75	ULTC.NS	UltraTech Cement Ltd
36	HCLT.NS	HCL Technologies Ltd	76	UPLL.NS	UPL Ltd
37	HROM.NS	Hero MotoCorp Ltd	77	VAKR.NS	Vakrangee Ltd
38	HALC.NS	Hindalco Industries Ltd	78	VDAN.NS	Vedanta Ltd
39	HPCL.NS	Hindustan Petroleum Corp Ltd	79	WIPR.NS	Wipro Ltd
40	HLL.NS	Hindustan Unilever Ltd	80	ZEE.NS	Zee Entertainment Enterprises Ltd

The above table lists the non-financial companies of the BSE-100 index

Appendix 5

Table 18 List of keywords searched in Annual reports along with rationale

S.N	Keyword	Rationale
1	Hedg	Identifying words like "hedge", "hedging", "hedge accounting" etc
2	Deriv	Identifying usage of word "derivative"
3	Forwa	Identifying words like "forwards", "forward contract" etc
4	Swap	Identifying words like "swaps", "cross-currency swaps", "interest rate swaps" etc
5	Future	Identifying words like "futures", "commodity futures", "interest rate futures" etc
6	Fair V	Identifying usage of word "fair value"
7	Commod	Identifying words like "commodity", "commodity risk", "commodity hedging" etc
8	Option	Identifying words like "options", "fx options", "interest rate options" etc
9	Foreign	Identifying words like "foreign", "foreign exchange" etc
10	FX	Identifying usage of word "FX" as a short form of foreign exchange
11	to Market	Identifying usage of "mark to market"

The above table lists keywords that were searched in annual reports to establish the usage of a particular type of derivative

Appendix 6

Table 19 List and construct of independent dummy variables

S.N	Description of Dummy Variable	Variable Type	Variable Construct
1	Usage of FX forwards (A)	Binary	Binary value of 1 or 0
2	Usage of FX options (B)	Binary	Binary value of 1 or 0
3	Usage of interest rate derivatives (C)	Binary	Binary value of 1 or 0
4	Usage of commodity derivatives (D)	Binary	Binary value of 1 or 0
5	Usage of hedge accounting (E)	Binary	Binary value of 1 or 0
6	Hedging span	Digital	{Max (A, B) + C + D}/3 Hence, 4 distinct values [0,0.33,0.66, 1]

The above table lists the independent dummy variables, their type and construct

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