
Risk Management Using Derivatives: Review of Literature

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Abstract

Changes in exchange rates, interest rates and stock prices of different financial markets have increased the financial risk to the corporate world. This has increased the core value of risk management & developed it as a specialized field. Derivatives served a useful purpose in fulfilling risk management objectives.

Purpose-This paper aims at determining the utilization and significance of Derivatives in Risk Management practices around the world.

Design-This paper is a summary and analysis of previous studies related to the use of derivatives in five different fields of risk management- Financial Risk, Corporate Risk, Currency Risk, Interest Rate Risk and Weather Risk.

Findings-Numerous researches related to the use of derivatives by companies in many countries have general conclusion that most of the companies are dependent on financial derivatives in their risk management strategies and the use of derivatives by institutional investors is widespread, covering all investor categories and sizes.

Originality/Value- This paper fulfils an identified need to study how derivatives served a useful purpose in fulfilling risk management objectives.

Key words: Risk, Derivatives, Exchange Rate, Corporate Strategies.

1. Introduction

Risk and Return are two sides of a coin, without assuming risk we can't receive returns. Risk taking is the core competence of entrepreneurial spirit, without embracing risks business can't reap rewards. Fund managers, merchant bankers, brokers and portfolio managers, all are exposed to various kinds of risk in day-to-day business. Changes in exchange rates, interest rates and stock prices of different financial markets have increased the financial risk to the corporate world. Adverse changes in the macroeconomic factors have even threatened the very survival of business world. This has increased the core value of risk management & developed it as a specialized field.

Risk Management is not about the elimination of risk; it is about the management of risk; selectively choosing those risk which are comfortable for the organization and minimizing those that it does not want. Financial Derivatives served a useful purpose in fulfilling risk management objectives. Through derivatives, risks from traditional instruments can be efficiently unbundled and managed independently. Used correctly, derivatives can save costs and increase returns. The objective of Derivatives instruments is to provide commitments to prices for future dates for giving protection against adverse movements in future prices, in order to reduce the extent of financial risks.

The last three decades have witnessed many-fold increase in the volume of international trade and business due to the wave of globalization and liberalization sweeping across the world. This has led to rapid and unpredictable variations in financial assets prices, interest rates and exchange rates, and subsequently expose the corporate world to an unwieldy financial risk. In the present highly uncertain business scenario, the importance of risk management is much greater than ever before. The emergence of derivatives market is an ingenious feat of financial engineering that provides an effective and less costly solution to the problem of risk that is embedded in the price unpredictability of the underlying asset.

This paper aims at determining the utilization and significance of Derivatives in Risk Management practices around the world. This paper is a summary and analysis of previous studies related to use of derivatives in managing Financial Risk, Corporate Risk, Currency Risk, Interest Rate Risk and Weather Risk. The study is organized into three sections. Section I deals with the concept, definition, features and types of risk management and derivatives. Section II has been devoted to analysis of previous studies in five different fields of risk management and the last section specifies summary and concluding remarks.

1.1 Risk Management

Risk management is the process of identifying, assessing and controlling threats to an organization's capital and earnings. These threats, or risks, could stem from a wide variety of sources, including financial uncertainty, legal liabilities, strategic management errors, accidents and natural disasters.

Every business and organization face the risk of unexpected, harmful events that can cost the company money or cause it to permanently close. Risk management allows organizations to attempt and prepare for the unexpected by minimizing risks and extra costs before they happen.

1.1.1 What is Risk?

A distinctive feature of modern societies is their ability to understand and control risks (**Bernstein, 1996**)¹. Progress, however, does not necessarily eliminate risk exposure. As argued by **Arrow (1965)**², “nothing is more obvious than the universality of risks in the economic system.” Economic development has, nonetheless, eased the process of shifting or trading risks.

Risk can be defined as a variability of actual return from the expected return. Standard deviation is a common tool for measuring risk. Risk and return are two sides of a coin; the more the risk, the more is the return.

1.1.2 Why Risk Management?

Important benefits of risk management include:

- Creates a safe and secure work environment for all staff and customers.
- Increases the stability of business operations while also decreasing legal liability.
- Provides protection from events that are detrimental to both the company and the environment.
- Protects all involved people and assets from potential harm.
- Helps establish the organization's insurance needs in order to save on unnecessary premiums.

By implementing a risk management plan and considering the various potential risks or events before they occur, an organization can save money and protect their future. This is because a robust risk management plan will help

¹ Bernstein, Peter L. (1996) *Against the Gods: The Remarkable Story of Risk*, John Wiley & Sons, New York.

² Arrow, Kenneth J. (1965) ‘Insurance Risk and Resource Allocation,’ in Kenneth J. Arrow, *Aspects of the Theory of Risk Bearing*, Helsinki: Helsinki, Yrjo Jahnsson Lectures.

a company establish procedures to avoid potential threats, minimize their impact should they occur and cope with the results.

Section II Literature Review

2.1 Financial Risk Management & Derivative Instruments

There is a growing need among companies which operate in very turbulent business environments to make the use of financial derivative instruments when hedging different types of financial risks. For the past three decades financial instruments have been used with more or less success by companies in developed countries for hedging purposes of their day-to-day business operations. Numerous researches related to the use of derivatives by companies in many countries have already been conducted, with general conclusion that most of the companies are dependent on financial derivatives in their risk management strategies.

The first evidence of derivatives use by non-financial firms is presented during 1995, in a survey undertaken by **Phillips (1995)**³ in a sample of 415 U.S. firms, 63.2% of the respondent informed that they used derivatives to hedge financial risk, 90.4% of them faced interest rate risk, 75.4% faced currency risk, while commodity risk was faced by just 36.6% of users. During the same year, the first of the three successive surveys of Wharton School conducted by **Bodnar et al. (1995)**⁴ was published.

In addition, the evidence verifies that derivatives are not used for speculation against market movements, but mainly for hedging anticipated transactions and firm's commitments. According to the second of the series survey the fraction of derivatives users reached 41%, despite the extensive losses that many firms suffered during fiscal year 1995 because of derivatives and which received great attention by the press and approached 50% in the 1998 survey. In this last and more specialized research undertaken by Bodnar and Marston [**Bodnar, Marston, 1998**]⁵ the issue that concerned derivative users the most is the accounting treatment of the contracts. For 67% users, the main objective of the hedging strategy is to reduce the cashflow volatility while 76% of users, report a documented policy concerning derivatives use.

Henk Berkman et.al (1997)⁶ made an International Comparison of Derivatives Uses between USA and New Zealand firms. NZ firms were more active derivatives users (relative to their size) and had more extensive reporting systems than USA firms. Then even, the motives of financial risk management were quite similar for firms in both countries. Transaction costs for most NZ dollar financial products were substantially higher than similar US dollar products. However, firms in a small open economy such as New Zealand's were more likely to be more exposed to currency movements than were US firms. Therefore, the use of derivatives seems to be the result of the need to manage risks rather than their availability as low-cost financial instruments.

³ Phillips A. (1995). Derivatives Practices and Instruments Surveys, *Financial Management*, 24(2), 115-125.

⁴ Bodnar G., Hayt G., Marston R. and Smithson C. (1995). 1994 Wharton Survey of Derivatives Usage by US Non-Financial Firms, *Financial Management, Contemporary Issues*, 24(2), 104-114.

⁵ Bodnar G., Hayt G. and Marston R. (1998). 1998 Wharton Survey of Financial Risk Management by U.S. Non-Financial Firms, *Financial Management*, 27(4), 70-91.

⁶ Henk Berkman, Michael E. Bradbury and Stephen Magan (1997). An International Comparison of Derivatives Use, *Financial Management*, 26(4), 69-73.

Khim and Liang (1997)⁷ asserted that Singaporean enterprises in various industries with varying turnover, ownership, involvement in foreign business, and listing status used financial derivative instruments differently and had distinct effects on company risk management. They discovered that enterprises in Singapore have been impacted differently by the volatility and uncertainty in the global financial markets. Between 1994 and 1995, **Grant and Marshall (1997)**⁸ conducted a survey of the biggest UK corporations (FTSE 250). The findings demonstrated that speculating on market movements with derivatives was uncommon. Derivatives were in fact most frequently utilized, according to the report, to lessen the volatility of firms' cash flows. The findings also showed that swaps, futures, and options were frequently employed to control interest rate and foreign exchange risks.

The New York University Stern School of Business, CIBC World Markets and KPMG Investment Consulting Group undertook a survey of derivatives usage and risk management practices among U.S. institutional investors. The sample included pension plan sponsors, college and university endowments, and private foundations. To our knowledge, this was the first survey to cover these three classes of primary fiduciaries in the United States. The target population consisted of 12,000 foundations, 1,000 pension plan sponsors and 500 university endowments. The survey suggested that the use of derivatives by institutional investors is widespread, covering all investor categories and sizes. Although derivative use was widespread, the intensity of use was not that high. Derivatives were most frequently used in the management of foreign bond, foreign equity and foreign exchange risks, and derivative positions were greater for foreign bonds and foreign exchange than other underlying assets. (**Richard M. Levich, 1998**)⁹

The research of Bodnar and Gebhardt (**Bodnar, Gebhardt, 1999**)¹⁰ which took place in Germany, when compared to the 1998 Wharton Survey in the United States, revealed more extensive use of derivatives in Germany with 78% of German firms using derivatives compared to 57% of US firms and outstanding differences in the hedging strategies among firms of the two countries. German non- financial firms seem to consider it more important to hedge their accounting earnings relative to their corporate cashflows.

The Survey by **S K Kapitsinas (2008)**¹¹ about the use of derivative contracts in the risk management process by Greek non-financial firms revealed that the use of derivatives in risk management is not wide spread among domestic firms, while it is observed that large firms are more likely to use derivatives contrary to the small-size ones. Firms use derivatives mainly to manage their interest rate risk and secondary their foreign exchange risk, though no firm seems to manage its equity risk. The major sources of concern for derivatives users are the

7 Khim E.M. and Liang D.L. (1997). The use of derivative financial instruments in company financial risk management: the Singapore experience, *Singapore Management Review*, 19(2), 17-44.

8 Grant K. and Marshall A.P. (1997). Large UK companies and derivatives, *European Financial Management*, 3(2), 191-208.

⁹ Richard M. Levich, 1998. *International Financial Markets : Prices and Policies*, McGraw-Hill, ISBN: 0256130116.

¹⁰ Bodnar G. and Gebhart G. (1998). Derivative Usage in Risk Management by U.S. and German Non-Financial Firms: A Comparative Survey, *Journal of International Financial Management and Accounting*, 10(3), 153-187.

¹¹ Kapitsinas S. (2008). Derivatives Usage in Risk Management by Non-Financial Firms: Evidence from Greece, MPRA Paper 10945, University Library of Munich, Germany.

accounting treatment of derivatives and the requirement to disclose their use. Very interesting is the conclusion that most firms develop an internal risk management department to which they appeal for the evaluation of their derivative position, as well as that the evaluation of the effectiveness of risk management is more profit based than risk reduction based.

Selvi & Turel (2010)¹² Compared the derivative uses by Turkish non-financial firms and bank. The results of their studies indicate that banks and the non-financial companies listed in the ISE-100 Indices, which represent 86 % of the market capitalization, use derivatives mainly for hedging purposes. However, the evidence that they usually prefer reporting their gains/losses arising from these transactions as “held for trading” instead of applying “hedge accounting”, since they could not meet the compulsory criteria described in the IAS 39 (Financial Instruments: Realization and Measurement).

Tai-Yuen Hon (2012)¹³ identified the methods used by the Hong Kong companies in the Hang Seng Index Constituent Stocks to manage their financial risks with derivatives. Among the 46 companies under study, 38 of them (or 82.6%) reported that they used at least one derivative if and when the need arises. In view of the global financial crisis, the Hong Kong companies have been concerned about interest rate risk and foreign exchange risk. The companies preferred to use interest rate swaps to hedge interest rate risk and forward contracts to hedge foreign exchange risk.

Kozarevic et.al (2012)¹⁴ found that the Slovenian and Croatian companies use derivatives in bigger extent than Bosnia and Herzegovina companies. As for the types of derivatives being used, companies from those countries predominantly use OTC derivatives, which are more expensive than exchanged-traded derivatives, due to the fact that there is no regional market for derivatives available for exchange-traded derivatives. Also concluded that major rationales for a low use of derivative instruments are due to lack of information about procedures of derivatives use and lack of knowledge about potential benefits of these instruments in the domain of risk management. This applies not only to company employees, but to bank employees too.

Živanović et.al (2017)¹⁵ analyzed the research results regarding derivative usage in Serbian, Croatian and Slovenian companies. The results of the conducted surveys show that 65.9 per cent of Slovenian companies covered by the sample employ financial derivatives, v/s 43 per cent in Croatia. As indicated by financial managers from Slovenia and Croatia, there are high costs of introducing and implementing risk management programs that surpass the benefits. In respect of the derivatives use, currency forwards and swaps and interest rate swaps are certainly the most significant instruments in Serbia while Croatian and Slovenian non-financial companies resort to forwards and swaps which are doubtless the most significant instruments in these two countries. The comprehensive analysis of the derivative usage in Serbia has demonstrated clear evidence that a more substantial use of hedging instruments brings numerous benefits.

Chang-Mo Kang and Donghyun Kim (2022)¹⁶ examined the optimal design of managerial compensation in a setting where a manager must be induced to maximize shareholder value while managing the firm's cash flow

¹² Selvi Y. and Turel A. (2010). Derivatives Usage in Risk Management by Turkish Non-Financial Firms and Banks: A Comparative Study, *OECONOMICA*, 12(2), 662-671.

¹³ Hon Tai-Yuen (2012). The behavior of small investors in the Hong Kong derivatives markets: A factor analysis, *Journal of Risk and Financial Management*, 5, 59-77.

¹⁴ Kozarevic E., Kestovic I., Kokorovic-Jukan M. and Civic B. (2012). The Usage of Derivatives in Financial Risk Management by Companies in Bosnia and Herzegovina, *Economic Review - Journal of Economics and Business*, 10(2), 59-72.

¹⁵ Zivanovic B. and Mina K. (2017). The Usage of Financial Derivatives in Financial Risk Management by Non-Financial Companies in Serbia, *Industrija*, 45(3), 65-82.

¹⁶ Chang-Mo Kang and Donghyun Kim (2022). Risk management transparency and compensation, *Journal of Corporate Finance*, Vol. 75, August 2022, 102245.

risks. The study's model shows that, while high-powered incentive pay (e.g., options) induces the manager to increase shareholder value, it also provides incentives to engage in unproductive risk-seeking activities. The trade-off suggests that shareholders' monitoring of risk management practices facilitates the awarding of high-powered managerial compensation. This study empirically tests this prediction using a regulatory shock, namely, the issuance of Statement of Financial Accounting Standards No. 133 (FAS 133). The new standard enhances the stringency of hedge accounting treatments, thereby improving shareholders' monitoring of firms' speculative use of derivatives. The study found that FAS 133 enhances the awarding of convex compensation to financial officers who manage and oversee corporate derivative programs. However, the new standard does not affect compensation for their peer executives. Findings of this study support the optimal contracting hypothesis.

2.2 Foreign Exchange Risk Management & Derivative Instruments

Geczy et.al (1997)¹⁷ examined the determinants of corporate use of currency derivatives from the perspectives of managers, debtholders and equity-holders. The results of univariate and multivariate tests of the differences between currency derivatives users and non-users indicate that firms with a combination of high growth opportunities but low accessibility to internal and external financing are most likely to use currency derivatives. This result is consistent with the hypothesis that hedging can reduce underinvestment costs associated with investment opportunities in the presence of financial constraints. Currency derivatives user firms, which are generally larger than non-users, are further characterized by greater analyst following and institutional ownership, and greater managerial option holdings. These two groups of firms are similar in their tax positions and in managerial share ownership.

The primary goal of hedging is the determination of a hedge rate that is used for budgeting, pricing, and ex post evaluation of foreign operations and managers. (Gregory W. Brown, 1999)¹⁸ In the study of HDG Inc's foreign exchange risk management program he found that many commonly cited reasons (such as minimizing expected taxes, avoiding costs of financial distress, managerial risk aversion, and coordination of cash flows and investment) for corporate hedging are not the primary motivation for why HDG undertakes a risk management program. Instead, informational asymmetries, facilitation of internal contracting and competitive pricing concerns motivate hedging.

The management of exchange rate risk at ABC plc UK multinational company when compared with academic theory, showed interesting results (A. Dhanani, 2003)¹⁹. As per theory three commonly identified forms of exchange rate risk are: translation risk, transaction risk & economic exchange rate risk. The company refrained from managing the translation-based effects of movements in exchange rate on financial performance, because they did not have implications for the market value of the firm. Its primary objective was to manage the long-term effects of exchange rates, i.e. economic risk, which had been identified as the most important form of risk in the literature. Finally, the firm managed its transaction risk, which was also a cash flow risk with implications for the overall corporate value.

Survey by Bengt Pramborg (2004)²⁰ added to existing research by analyzing country differences in foreign exchange risk-management practices between Swedish and Korean firms. Korea and Sweden are both export-oriented countries, heavily dependent on foreign trade, suggesting that their markets would be suitable for this

¹⁷ Geczy C., Minton A. and Schrand C. (1997). Why Firms Use Currency Derivatives, *The Journal of Finance*, 52(4), 1323-1354.

¹⁸ Brown G.W. (1999). Managing Foreign Exchange Risk with Derivatives, *Jurnal of Financial Economics*, 60(2), 401-448.

¹⁹ Dhanani A. (2003), Foreign Exchange Risk Management: A Case in the Mining Industries, *The British Accounting Review*, 35, 35-63.

²⁰ Pramborg B. (2004). Derivatives Hedging, Geographical Diversification and Firm Market Value, *Journal of Multinational Financial Management*, 14(2), 117-133.

type of study. The countries' markets differ in other ways, such as their stage of economic and financial development. While Swedish derivatives markets are well developed, comparable Korean markets have been heavily regulated. Firms in both countries were equally likely to decide to hedge foreign exchange exposure, this decision being dependent of level of exposure and firm size. However, the aim of hedging activities differed. Korean firms were more likely to focus on minimizing fluctuations of cash flow rather than accounting earnings, while Swedish firms were more likely to focus on accounting numbers.

Managerial compensation and ownership are important factors in the hedging decisions of banking firms (**Adkins et.al, 2006**)²¹. They examined the effect of managerial incentives on the use of foreign-exchange derivatives by U.S. bank holding companies using data from 1996-2000. The results suggest that greater equity holdings by managers are associated with a greater probability of hedging, and given the decision to hedge, a greater level of derivatives usage. Managers who receive larger option awards are less likely to hedge using derivatives. These results offer powerful evidence of the importance of appropriate managerial contracts to ensure the proper incentives are in place to prevent unwarranted risk-taking by bank managers.

Afza & Alam (2011)²² explored about the usage of derivatives to hedge foreign exchange and interest rate risk in by taking 105 non-financial firms listed in Karachi stock exchange as a sample. The bottom line of this study reveals that the firms having higher exposure of foreign exchange are more convergent towards hedging.

According to **Xiangchao Hao, Qinru Sun and Fang Xie (2022)**²³, banks are the most important users in the foreign exchange (FX) derivatives market, while the effect of FX derivatives usage on bank capital buffer is hitherto under-explored. This study constructs an international sample consisting of non-US banks from 59 economies, and examine the relationship between them. It was found that banks with more FX derivatives have lower capital buffers, suggesting that FX derivatives usage is a substitute for capital buffer, and banks use FX derivatives largely for risk management purpose. The substitution effect is more significant for non-dealer banks, banks with high capital buffers, and banks in economies with floating currency system. It is also more significant when the FX rate and stock market are volatile. Findings of the study support policymakers, especially in developing economies, in promoting the development of FX derivatives market to facilitate the risk management of banks.

2.3 Interest Rate Risk Management & Derivative Instruments

The banking system's net position is somewhat interest-rate sensitive. Relatively small increases in interest rates can cause fairly large decline in the value of swaps held by banks. Interest-rate risk exists because changes in interest rates affect the value of a swap. Also, credit risk exists because a counter- party may default. A swap is a zero-sum transaction. While the initial value of a swap is zero, over the life of the swap interest rates may change, causing the swap to become an asset to one party (the fixed-rate payer if rates rise) or a liability (for the fixed-rate payer if rates fall); clearly, one party's gain is the other's loss.

Assessing risk requires information. There is very little publicly available information on the swap positions of banks. This means that it is very difficult to estimate the exposure of banks to interest-rate movements (**Gorton & Rosen, 1995**)²⁴. In banking, the relationship between risk and derivatives is more important because banks dominate most derivatives markets and derivative holdings are concentrated at a few large banks. Difficulty in

²¹ Adkins L., Carter D. and Simpson W. (2006). Managerial Incentives and The Use of Foreign Exchange Derivatives by Bank, *The Journal of Financial Research*, 30(3), 399-413.

²² Afza T. and Alam A. (2011). Corporate derivatives and foreign exchange risk management: A case study of non-financial firms of Pakistan, *Journal of Risk Finance*, 12(5), 409-420.

²³ Xiangchao Hao, Qinru Sun and Fang Xie (2022). International evidence for the substitution effect of FX derivatives usage on bank capital buffer, *Research in International Business and Finance*, Vol.62, December 2022, 101687.

²⁴ Gorton G. and Rosen R.J. (1995). Corporate control, portfolio choice, and the decline of banking, *Working Paper*, University of Pennsylvania.

monitoring risk is especially important when the party entering into a derivative transaction such as a swap is an agent managing money for outside principals. Whenever outside principals cannot fully monitor, an agent may find it optimal to speculate (**Dow and Gorton, 1994**)²⁵

S. Ahmed et.al (1997)²⁶ used a sample of 152 large bank holding companies to study the Interest Rate Risk (IRR) management activities of commercial banks including their use of derivatives. They discovered that the interest rate sensitivity of net income, as opposed to the interest rate sensitivity of stock returns, was the main focus of IRR management. Liquidity directly affects the level of net accounting exposure, while managerial competence and bank size have an adverse effect. Users of derivatives as a whole experience lower mean and median exposure than non-users, and for the vast majority of users, exposure is decreased by the use of derivatives.

The duration targeting by dealers has adverse price effects due to capital constraints as predicted by **Froot and Stein (1998)**²⁷. Government bond market dealers engage in duration targeting, behaving as if they have a comparative advantage in bearing interest rate risk (Naik & Yadav, 2001). They actively use futures to hedge changes in the spot exposure. They hedge changes in their spot exposure more when the potential costs of regulatory distress are high, when the cost of such hedging is low, and during periods of greater uncertainty.

Traditional ways to measure and manage interest rate risk include gap analysis, duration analysis, simulation and scenario analysis. Banks participate in derivative markets specially because their traditional lending and borrowing activities expose them to financial market risk and doing so can help them to hedge or reduce risk and to achieve acceptable financial performance (**Brewer & Moser, 2001**)²⁸. Interest rate risk can be controlled optimally by using derivatives along with traditional methods, in order for banks to experience less interest rate uncertainty, and to increase their lending activities, which can result in greater returns and higher overall profitability (**Soretha Beets, 2004**)²⁹.

Interest rate risk management decisions of non-financial firms are determined by both hedging and speculative motivations (**Chernenko & Faulkender, 2008**)³⁰. Hedging of interest rate risk is concentrated among high investment firms, consistent with the presence of costly external finance while firms appear to use interest rate swaps to speculate when their executive compensation contracts are more performance sensitive and to manage earnings.

Thomasvan, Lech and Cornelis (2022)³¹ observed that in March 2020, the world was thrown into financial distress. This manifested itself in increased uncertainty in the financial markets. Many interest rates collapsed,

²⁵ Dow J. and Gorton G. (1994). Noise trading, delegated portfolio management, and economic welfare, Working Paper No. 4858, *National Bureau of Economic Research*.

²⁶ Ahmed S., Beatty A. and Takeda C. (1997). Evidence on Interest Rate Risk Management and Derivatives Usage by Commercial Banks, *SSRN Electronic Journal*.

²⁷ Froot K. and Stein J. (1998). Risk Management, Capital Budgeting and Capital Structure Policy for Financial Institutions: An Integrated Approach, *Journal of Financial Economics*, 47, 55-82.

²⁸ Brewer E.J., Jackson W.E. and Moser J.T. (2001). The value of using interest rate derivatives to manage risk at U.S. banking organizations, *Economic Perspectives*, 25(3), 49-55.

²⁹ Beets S. (2004). The Use of Derivatives to Manage Interest Rate Risk in Commercial Banks, *Investment Management and Financial Innovations*, 2, 60-74.

³⁰ Chernenko S. and Faulkender M. (2008). The Two Sides of Derivatives Usage: Hedging and Speculating with Interest Rate Swaps, *Journal of Financial and Quantitative Analysis*, 46(6), 1727-1754.

³¹ Thomasvan der Zwaard, Lech A. Grzelak and Cornelis W. Oosterlee (2022). Relevance of Wrong-Way Risk in Funding Valuation Adjustments, *Finance Research Letters*, Vol. 49, October 2022, 103091.

and funding spreads surged significantly, which increased due to the market turmoil. In light of these events, it is essential to understand and model Wrong-Way Risk (WWR) in a Funding Valuation Adjustment context. WWR may currently be absent from calculations in banks' Valuation Adjustment engines. However, in this letter, authors demonstrated that WWR effects are non-negligible in modelling from a risk-management perspective. The study looks at the impact of various modelling choices, such as including the default times of the relevant parties, as well as stochastic and deterministic funding spreads. A case study is presented for interest rate derivatives.

2.4 Weather Risk Management & Derivative Instruments

Weather derivatives differ from conventional derivatives in that there is no original, negotiable underlying or price of an underlying that normally forms the basis of any derivative. For example, financial derivatives are based on shares, share indexes, bonds or exchange rates or currencies which are in themselves negotiable objects, something that cannot be said of the weather in view of its numerous facets. The underlying of weather derivatives is based on data such as temperature, which influence the trading volume of other goods. This in turn means that the objective of weather derivatives cannot be to hedge the price of the underlying, as it is impossible to put a monetary value (price) on the various facets of the weather. Consequently, weather derivatives are suitable for other objectives, e.g. for hedging other risks on which the weather has a major influence, such as the risk of declining sales in the energy and power sector as a result of a change in the weather and the price changes possibly resulting therefrom. The clear focus in dealing with weather derivatives is in the field of options designed to afford protection against fluctuating temperatures. Degree Day Options are based on so-called Cooling Degree Days (CDD- days above 65°F, an indication of electricity demand for air conditioning) and Heating Degree Days (HDD- days below 65°F, an indication of electricity, oil, and gas demand required for heating). These indices represent the average temperature for a given period of time (Muller & Grandi, 2000)³².

Calum G. Turvey (2001)³³ examined the economics and pricing of weather derivatives in Ontario and argued that weather derivatives and weather insurance can be used as a form of Agri-cultural insurance. Daily rainfall and temperature data from 1935 to 1996 at Woodstock, Ontario, was examined. Cumulative rainfall and cumulative degree-days above 50°F were correlated with average county yields. Using a Cobb–Douglas production function, it was shown that corn and soybeans were more sensitive to low temperatures, while hay was more sensitive to low rainfall. The results indicated that specific-event weather conditions can contribute significantly to crop yield risk and thus weather insurance/derivatives can have a significant role to play in managing agricultural production risks.

Weather has a huge impact on businesses' profits, costs, or both across the globe. According to Auer J. (2003)³⁴, the weather affects 4/5 of the global economy either directly or indirectly. The term "sensitivity" or "exposure to weather" refers to the degree to which sales, production, or costs are affected by weather-related factors including temperature, sunshine, rainfall, snowfall, wind, etc. A sector is said to be weather sensitive if output volatility in that sector is influenced by variations in the weather. There are differences in weather sensitivity between different geographic regions and economic sectors, although all economic sectors are weather sensitive to some degree.

³² Müller A. and Grandi M. (2000). Weather derivatives for protection against weather risks: Speculation tool or integral element of the risk management tools of weather-sensitive industries? Geneva Papers on Risk and Insurance: Issues and Practice, 25, 273--87, http://www.munichre.com/publications/art_weather_derivates_en.pdf [as of 2009-06-15].

³³ Calum G. Turvey (2001). Weather Derivatives for Specific Event Risks in Agriculture, *Review of Agricultural Economics*, Agricultural and Applied Economics Association, 23(2), 333-351.

³⁴ Auer J. (2003). Weather Derivatives Heading for Sunny Times, Available online: <http://www.dbresearch.com/PROD/999/PROD0000000000052399.pdf> (accessed on 9 July 2020).

Brockett, Wang, and Yang (2003)³⁵ adopted an incomplete market pricing model, the indifference valuation approach to analyze the valuation of weather derivatives. The indifference valuation approach stems from the economic principle of certainty equivalent, but was modified and extended to accommodate partial hedging in the financial market. The relationship between the indifference prices of weather derivatives and the transaction volume was investigated in a mean variance framework, and a number of criteria were attained where the actuarial price was not a suitable valuation for weather derivatives. By comparing the buyers' and sellers' indifference prices, the authors also examined the conditions for the viability of the weather derivatives market. In addition, by examining explicitly the distributional impacts of all the stochastic variables involved, Brockett, Wang, and Yang investigated the impacts of partial hedging, natural hedges, basis risk, quantity risk, and price risk on the investors' indifference prices.

The paper by **Cao & Wei, (2004)**³⁶ proposed a valuation framework for temperature derivatives and studied the market price of weather risk therein. The framework was the generalized Lucas's model of 1978. The underlying variables in the economy were the aggregate dividend and the weather uncertainty, and the two were allowed to correlate with one another. The market price of risk affected option values much more than forward prices, mainly due to the payoff specification. Their numerical analyses show that the market price of risk associated with the temperature variable is insignificant in most cases, especially when risk aversion is high or when the aggregate dividend process is close to a random walk. Their results also show that the so-called historical simulation method can lead to significant pricing errors due to its erroneous implicit assumptions.

The impact of weather can be classified as catastrophic or non-catastrophic depending on how severe it is. Floods, hurricanes, and tornadoes are examples of catastrophic weather, which comprises phenomena with low probability of occurrence but significant financial losses. Non-catastrophic weather refers to weather that is only slightly different from average or typical weather, such as warmer winters and rainier summers. The major distinction is that non-catastrophic weather has an impact on businesses but does not endanger people or property. Non-catastrophic weather risk is described as uncertainty in future cash flows caused by seasonal variations from the average, or normal weather (**Brockett et.al, 2005**)³⁷.

Linn et.al (2008)³⁸ studied the agriculture risk management in Georgia. In Georgia, although annual rainfall is adequate for most agricultural crops, the distribution of rainfall across a year is highly unpredictable. Irrigation is extensively used in Georgia to offset the impact of rainfall variability on crop yield and to reduce the risk associated with weather variability. The study showed that a weather derivative based on rainfall does not change a producer's irrigation decisions for any soil type, regardless of the level of risk aversion. Unexpectedly, risk-adverse corn producers in Mitchell County are not generally made better off by purchasing rain-based insurance contracts. The optimal strikes are much lower than the expected rainfall during the growing season, making the indemnity each year very low, and leads to low fair premium and loaded premium rates. As a result, producers gain little from buying weather derivative contracts each year, and the 10% proportional load only increases their cost.

³⁵ Brockett P.L., Wang M. and Yang C. (2003). Pricing Weather Derivatives Using the Indifference Pricing Approach, *Working Paper*, University of Texas, Austin.

³⁶ Melanie Cao and Jason Wei (2004). Weather Derivatives Valuation and Market Price of Weather Risk, *Journal of Futures Markets*, 24(11), 220-32

³⁷ Brockett P.L., Wang M. and Yang C. (2005). Perspectives Weather Derivatives and Weather Risk Management, *Risk Management Insurance Revision*, 8, 127-140.

³⁸ Angela Yu-Chen Lin, Tsung-Hsien Yu and Cheng-Fang Lin (2008). The agriculture risk management in Georgia, *Chemosphere*, 74, 131-141.

Ines Kapphan (2012)³⁹ proposed a method for structuring index- based weather insurance such that it yields optimal hedging effectiveness for the insured. For a given weather index and an actuarially fair premium, the optimal payoff structure was derived (in an expected utility framework) taking the non-linear relationship between weather and yields into account. He found that the benefits of hedging weather with adjusted contracts almost triple for the insured, and insurers' expected profits increase by about 240% when offering adjusted contracts. The loss in risk reduction from hedging agricultural weather risk with linear derivatives was also evaluated. Study showed that hedging weather risk with linear contracts decreased the insured's hedging benefits, as well as the insurer's profits, by about 20 to 24% compared to the optimal non-linear contracts.

Ivana Štulec (2017)⁴⁰ studied the performance of monthly temperature put options throughout the summer by conducting an empirical examination of beverage sales in 60 large food stores in Croatia. Based on empirical data, temperature put options are created for food retailers as risk-reduction strategies against the summer's negative effects of temperature on beverage sales. There are total 35 temperature put options because the options are created to cover all five months and seven cities. Their effectiveness is measured by the decline in the projected economic value of beverage sales volatility. The performance of temperature put options varies between months and cities, according to the results. Temperature put options often work well in July, August, and September, reducing sales volatility by 1.6% to 98.3% on average.

The objective of this study conducted by **Takashi Kanamura, Lasse Homann and Marcel Prokopczuk (2021)**⁴¹ is to analyse the theoretical pricing of wind power derivatives, which is important for renewable energy risk management but has a problem in the pricing due to the illiquidity of the assets and to show the application of the theory to the practical implementation of the pricing. The study makes three contributions to the literature. First, this study is the first to conduct a detailed econometric analysis of the wind power futures underlying, i.e., the electricity production based on windmills, resulting in strong support of seasonality and mean reversion in the logit-transformed wind power load factors. Second, after proposing a new model of wind power load factors based on the econometric findings, the study analyses the theoretical prices of wind power futures and call option contracts to which the good-deal bounds pricing within an illiquid market situation is applied as well as we show the application of the theory to the practical pricing with the illiquidity. Third, the study's empirical pricing analysis shows that theoretical wind power futures prices derived using seasonal modelling more accurately reflect reality than those derived without seasonality compared to market observations, resulting in the importance of seasonality modelling in theoretical wind power derivatives pricing. In particular, considering that the upper and lower price boundaries represent the selling and the buying prices in the incomplete market, respectively, it shows that the pricing of the short position is more affected by the seasonality than the pricing of the long position.

According to **Shuying Lai et al. (2022)**⁴², with the increase of extreme weather events and the penetration of distributed energy resources, electricity retailers will encounter more risks at both transmission and distribution levels during the business operation process. For risks at the transmission level, huge damages to the transmission lines and towers caused by extreme events, like bushfires, ice storms, and flooding, will lead to power shortage.

³⁹ Ines Kapphan (2012). Climate change, Weather Insurance Design and Hedging Effectiveness, *Geneva Papers on Risk and Insurance - Issues and Practice*, 37(2), 286-317.

⁴⁰ Ivana Štulec (2017). Effectiveness of Weather Derivatives as a Risk Management Tool in Food Retail: The Case of Croatia, *IJFS, MDPI*, 5(1), 1-15.

⁴¹ Takashi Kanamura, Lasse Homann and Marcel Prokopczuk (2021). Pricing analysis of wind power derivatives for renewable energy risk management, *Applied Energy*, Volume 304, 15 December 2021, 117827.

⁴² Shuying Lai, Jing Qiu, Yuechuan Tao and Yinyan Liu (2022). Risk hedging strategies for electricity retailers using insurance and strangle weather derivatives, *International Journal of Electrical Power & Energy Systems*, Volume 134, January 2022, 107372.

For risks at the distribution level, demand variations in accordance with temperature change will result in energy procurement difficulty for the retailers.

2.5 Corporate Risk Management & Derivative Instruments

Risk management has become a critical dimension of corporate financial policy, particularly in light of recent global financial and economic crises. It is widely appreciated that companies can enhance their values if they are able to mitigate some of the costly impacts of risk. The corporate risk management literature focuses on the potential benefits of hedging with financial derivatives, addressing questions of why companies do (or should) use derivatives and under what circumstances value is created through such use. A separate strand of the corporate finance literature analyzes the rationale and benefit of cash holdings, including understanding the precautionary motive for liquidity in the presence of uncertainty. Yet another branch of corporate finance explores the value of operating flexibility, such as real options to shut down facilities or switch modes of production. (Gamba & Triantis, 2011)⁴³

The optimum hedging policies are preceded by Modigliani and Miller (1958)⁴⁴ model who gave the popular theory of MM approach for firm valuation. The implementation of hedging policies and tools are described by Smith and Stulz (1985)⁴⁵ in their research study under two circumstances. The first situation is financial distress cost when the organisation hedge against haphazard risks and the second situation is for risk-averse managers whose compensation and wealth are related to the firm-value. The survey study conducted by block et al. (1986)⁴⁶ showed that hedging devices are primarily used by larger firms. Similar results are approved by Nance (1993)⁴⁷, judge (2003)⁴⁸ and Ameer (2010)⁴⁹. These studies found that most of the managers lack knowledge about the derivatives and other hedging tools and therefore they resist the use of derivatives.

According to Bessembinder (1991)⁵⁰, use of derivatives reduce the volatility of returns and made value addition in incremental investment, which ultimately results in the growth in firm's value. According to Gay (1999)⁵¹, there is a positive relationship between a firm's growth opportunities and derivatives usage. Underinvestment is also a determinant of hedging policy. The results of the study suggest that derivatives use can reduce firm's

⁴³ Gamba A. and Triantis A. (2014). Corporate Risk Management: Integrating Liquidity, Hedging, and Operating Policies, *Management Science*, 60(4), 203-235.

⁴⁴ Modigliani F. and Miller M.H. (1958). The cost of capital, corporation finance and the theory of investment, *American Economic Review*, 48(3), 261-97.

⁴⁵ Smith C.W. and Stulz R.M. (1985). The determinants of firms' hedging policies, *Journal of Financial and Quantitative Analysis*, 20(4), 391-405.

⁴⁶ Block S.B. and Gallagher T.J. (1986). The Use of Interest Rate Futures and Options by Corporate Financial Managers, *Financial Management*, 15, 73-78.

⁴⁷ Nance D.R., Smith C.W. and Smithson C.W. (1993). On the Determinants of Corporate Hedging, *The Journal of Finance*, 48, 267-284.

⁴⁸ Judge A. (2003). Why Do Firms Hedge? A Review of the Evidence, *Journal of Issues in Finance and Monetary Policy*, 9, 1-67.

⁴⁹ Ameer R. (2010). Determinants of Corporate Hedging Practices in Malaysia, *The International Business Research*, 3(2), 120-130

⁵⁰ Bessembinder H. (1991). Forward contracts and firm value: investment incentive and contracting effects, *The Journal of Financial and Quantitative Analysis*, 26(4), 519-32.

⁵¹ Gay G. and Nam J. (1999). The underinvestment problem and corporate derivatives use, *Financial Management*, 27(4), 53-69.

potential underinvestment problems. According to **Fok et al. (1997)**⁵², the larger firms are more likely to hedge as compared to the small firms.

Evidence of the firms' usage of derivatives tools like future, swaps, forwards, warrant and options are provided by **Nance et al. (1993)**⁵³. In a sample of 104 firms their study proved that use of hedging policies reduce tax liability, control the agency issues and lower the expected transactional cost. According to **Slutz (1996)**⁵⁴, A firm can achieve optimal capital structure and optimal ownership structure by controlling financial distress. **Mian (1996)**⁵⁵ examined the effects of corporate hedging decisions by taking a large sample of 771 firms. As per the findings of this study the hedging activities result in the economies of scale. The hedging policies of oil and gas firms are determined by **Haushalter (2000)**⁵⁶. He found a correlation between the prices and the trading which facilitates hedging work and results in economies of scale and risk reduction.

Whether the firms use derivatives for hedging or for speculation, this question was determined by **Allayannis et al. (2000)**⁵⁷ by collecting data of 500 non-financial firm's derivatives transactions. They concluded that firms' exposure to foreign sales and trade, decide the level of derivatives usage. **Bartram (2000)**⁵⁸ stated that the firm's value is influenced by unexpected changes in foreign exchange rates, interest rates and commodity prices. For organizational growth and value, this problem must be resolved. The same results are provided by **Solomon et al. (2002)**⁵⁹ which highlighted that the institutional investors. The disclosure of increased risk by organization will help institutional investors in managing their portfolio risk and making investment decisions.

The effect of derivatives usage on the financing strategies is explored by **Adam (2002)**⁶⁰. This study found a positive relationship between investment expenditure and minimum revenue guaranteed by the hedging policies. **Alkeback et al. (2002)**⁶¹ compared the use of derivatives in USA, Sweden and New Zealand and the study showed 53%, 52% and 39% of derivative usage in these countries respectively. Derivatives are used for the purpose of

⁵² Fok R., Carroll C. and Chiou C. (1997). Determinants of corporate hedging and derivatives: a revisit, *Journal of Economics and Business*, 49, 569-85.

⁵³ Nance D.R., Smith C.W. and Smithson C.W. (1993). On the Determinants of Corporate Hedging, *The Journal of Finance*, 48, 267-284.

⁵⁴ Stulz R. (1996). Rethinking risk management, *Journal of Applied Corporate Finance*, 9, 8-25.

⁵⁵ Mian S.L. (1996). Evidence on corporate hedging policy, *Journal of Financial and Quantitative Analysis*, 31(3), 419-39.

⁵⁶ Haushalter G.D. (2000). Financing policy, basis risk, and corporate hedging: evidence from oil and gas producers, *The Journal of Finance*, 55(1), 107-52

⁵⁷ Allayannis G. and Ofek E. (2000). Exchange rate exposure, hedging, and the use of foreign currency derivatives, *Journal of International Money and Finance*, 20(2), 273-296.

⁵⁸ Bartram S.M. (2000). Corporate Risk Management as a Lever for Shareholder Value Creation, *Financial Markets, Institutions and Instruments*, 9(5), 279-324.

⁵⁹ Solomon J.F., Solomon A., Norton S.D. and Joseph N.L. (2000). A conceptual framework for corporate risk disclosure emerging from the agenda for corporate governance reform, *British Accounting Review*, 32(4), 447-478.

⁶⁰ Adam T. (2002). Do Firms Use Derivatives to Reduce their Dependence on External Capital Markets? *European Finance Review*, 6, 163-187.

⁶¹ Alkeback P. and Hagelin N. (2002). Derivative Usage by Nonfinancial Firms in Sweden with an International Comparison, *Journal of International Financial Management and Accounting*, 10(2), 105-120.

hedging risks and are used by larger firms as compared to the smaller one. **Elliott et al. (2003)**⁶², examined the relationship among foreign currency exposure, foreign denominated debt (FDD) and foreign currency derivatives (FCD). The study showed a negative relationship between foreign denominated debt (FDD) and foreign currency derivatives (FCD). Hedging is value enhancing or not, this hypothesis was investigated by **Carter et al. (2006)**⁶³. By following the procedure of **Froot (1993)**⁶⁴ and **Mian (1996)**⁶⁵, this study revealed this hypothesis to be true and concluded a positive relation between hedging and value enhancement.

Pramborg (2004)⁶⁶ studied the Swedish firms for the period 1997-2001 to determine the effect of derivatives usage on hedging policies. The study revealed a positive impact of transitional exposure but value addition is not caused by the transitional exposure. Interest rate derivatives are negatively related to the firm's value (**Nguyen et al., 2007**)⁶⁷. **Bali et al. (2007)**⁶⁸ examined use of foreign exchange derivatives and interest rate derivatives by non-financial firms for the period of 1995 to 2001. This study revealed that besides the firm's rate of return, many other non-financial and economic factors affect the hedging decisions and derivatives use. According to **Sprcic et al. (2008)**⁶⁹ corporate performance is more influenced by commodity risk, foreign exchange and price risk, than a firm's performance. This study also revealed that firms don't have documented risk management practices.

The determinants of the hedging decision are investigated by **Singh and Upneja (2008)**⁷⁰ by study of lodging firms for the period 2000-2004. According to this study underinvestment costs, cash-flow volatility, foreign sales ratio, financial distress costs, and firm size are major determinants of hedging decision. The determinants of firms hedging particularly in Malaysia are pointed out by **Ameer (2010)**⁷¹. This study showed that foreign sales, liquidity, managerial ownership and firm's growth respectively are the major determinants of hedging decision and have significant relationship with hedging.

⁶² Elliott W.B., Huffman S.P. and Makar S.D. (2003). Foreign Denominated debt and foreign currency derivatives: complements or substitutes in hedging foreign currency risk?, *Journal of Multinational Financial Management*, 13, 123-139.

⁶³ Carter D.A., Rogers D.A. and Simkins B.J. (2006). Does hedging affect firm value? Evidence from the US airline industry, *Financial Management*, 35, 53-88.

⁶⁴ Froot K.A., Scharfstein D.S. and Stein J.C. (1993). Risk management: coordinating corporate investment and financing policies, *The Journal of Finance*, 4(5), 1629-58.

⁶⁵ Mian S.L. (1996). Evidence on corporate hedging policy, *Journal of Financial and Quantitative Analysis*, 31(3), 419-39.

⁶⁶ Pramborg B. (2004). Derivatives hedging, geographical diversification and firm market Value, *Journal of Multinational Financial Management*, 14, 117-133.

⁶⁷ Nguyen H.V., Mensah M.O. and Fan Y. (2007). Derivative Instruments and Their Use for Hedging by U.S. Non-Financial Firms: A Review of Theories and Empirical Evidence, *Journal of Applied Business and Economics*, 7, 35-57.

⁶⁸ Bali T.G., Hume S.R. and Martell T.F. (2007). A new look at hedging with derivatives: Will firms reduce market risk exposure?, *Journal of Future Markets*, 27, 1053-1083.

⁶⁹ Sprcic D., Tekavcic M. and Sevic Z. (2008). Corporate Risk Management practices in Croatian companies, *Ekonomski Pregled*, 59(7-8), 344-369

⁷⁰ Singh A. and Upneja A. (2008). The determinants of the decision to use Financial Derivatives in the Lodging industry, *Journal of Hospitality and Tourism*, 32(4), 423-447.

⁷¹ Ameer, R. (2010) 'Determinants of Corporate Hedging Practices in Malaysia', *The International Business Research*, 3(2), 120-130.

Lingsha Cheng and Adrian (Waikong) Cheung (2021)⁷² opined that in the absence of agency problems, firms with able managers are expected to use derivatives effectively for risk management purposes. But the agency theory suggests that self-interested managers may use derivatives to their advantage for rent-seeking activities. Using a sample of Chinese listed firms from 2008 to 2019, the study found strong evidence consistent with this rent-seeking idea. In particular, it finds that the relationship between the use of derivatives and firm risk is negative, but this negative relationship is less pronounced for firms with high-ability managers compared to firms with low-ability managers, suggesting that managerial ability has a positive moderating effect on this negative relationship.

In this manner, an extensive literature has been reviewed for the study which is summarized in following Table

Author(s) Name	Title	Study Objective/ Study Description	Data Analysis Method	Findings/ Conclusion
Phillips A. (1995)	Derivatives Practices and Instruments Surveys	To conduct survey for evidence of derivatives use by non-financial firms	Descriptive Analysis	63.2% of the respondents informed that they used derivatives to hedge financial risk, 90.4% of them faced interest rate risk, 75.4% faced currency risk, while commodity risk was faced by just 36.6% of users.
Bodnar G., Hayt G. and Marston R. (1998)	1998 Wharton Survey of Financial Risk Management by U.S. Non-Financial Firms	To find out whether concerned derivative users, the most is the accounting treatment of the	Descriptive Analysis	For 67% users, the main objective of the hedging strategy is to reduce the cashflow volatility

⁷² Lingsha Cheng and Adrian (Waikong) Cheung (2021). Is there a dark side of managerial ability? Evidence from the use of derivatives and firm risk in China, *Journal of Contemporary Accounting & Economics*, Vol. 17, Issue 2, August 2021, 100258

		contracts or not		while 76% of users have reported a documented policy regarding derivatives use.
Henk Berkman, Michael E. Bradbury and Stephen Magan (1997)	An International Comparison of Derivatives Use	To make an International Comparison of Derivatives Uses between USA and New Zealand firms	Descriptive Analysis	The use of Derivatives seems to be the result of the need to manage risks rather than their availability as low-cost financial instruments.
Khim E.M. and Liang D.L. (1997)	The use of derivative financial instruments in company financial risk management: the Singapore experience	The usage and effect of financial derivative instruments on company risk management	Empirical analysis	The study found that the volatility and uncertainty in the world financial markets had affected companies in Singapore differently.
Grant K. and Marshall A.P. (1997)	Large UK companies and derivatives	To survey the largest UK companies (FTSE 250) between 1994 and 1995	Descriptive analysis	The study indicated that derivatives were mostly used to reduce volatility of firm's cash flows. Swaps, forwards and options were commonly used to manage foreign exchange and interest rate risks.
Bodnar G. and	Derivative Usage in Risk	To compare the use of derivatives in	Descriptive	German nonfinancial

Gebhart G. (1998)	Management by U.S. and German Non-Financial Firms: A Comparative Survey	Germany with the 1998 Wharton Survey in the United States	Analysis	Firms seem to consider it more important to hedge their accounting earnings relative to their corporate cashflows.
Kapitsinas S. (2008)	Derivatives Usage in Risk Management by Non-Financial Firms: Evidence from Greece	To conduct survey about the use of derivative contracts in the risk management process by Greek non-financial firms	Empirical study	The use of derivatives in risk management is not wide spread among domestic firms, while it is observed that large firms are more likely to use derivatives contrary to the small-size ones.
Selvi Y. and Turel A. (2010)	Derivatives Usage in Risk Management by Turkish Non-Financial Firms and Banks: A Comparative Study	Compared the derivative uses by Turkish nonfinancial firms and banks	Descriptive Analysis	Banks and the non-financial companies listed in the ISE-100 Indices, which represent 86% of the market capitalization, use derivatives mainly for hedging purposes.
Hon Tai-Yuen (2012)	The behavior of small investors in the Hong Kong derivatives markets: A factor analysis	To identify the methods used by the Hong Kong companies in the Hang Seng Index Constituent Stocks to manage their	Descriptive analysis	The companies preferred to use interest rate swaps to hedge interest rate risk and forward contracts to hedge foreign

		financial risks with derivatives		exchange risk.
Kozarevic E., Kestovic I., Kokorovic-Jukan M. and Civic B. (2012)	The Usage of Derivatives in Financial Risk Management by Companies in Bosnia and Herzegovina	To find the Slovenian and Croatian companies use of derivatives in comparison to Bosnia and Herzegovina companies	Empirical analysis	Major rationales for a low use of derivative instruments are due to lack of information about procedures of derivatives use and lack of knowledge about potential benefits of these instruments in the domain of risk management.
Zivanovic B. and Mina K. (2017)	The Usage of Financial Derivatives in Financial Risk Management by Non-Financial Companies in Servia	To analyze the research results regarding derivative usage in Serbian, Croatian and Slovenian companies	Empirical analysis	The comprehensive analysis of the derivative usage in Serbia has demonstrated clear evidence that a more substantial use of hedging instruments bring numerous benefits.
Chang-Mo Kang and Donghyun Kim (2022)	Risk management transparency and compensation	To examine the optimal design of managerial compensation	Empirical analysis	The study found that FAS 133 enhances the awarding of convex compensation to

				financial officers who manage and oversee corporate derivative programs.
Geczy C., Minton A. and Schrand C. (1997)	Why Firms Use Currency Derivatives	To examine the determinants of corporate use of currency derivatives from the perspectives of managers, debt holders and equity-holders	Univariate and multivariate tests	the differences between currency derivatives users and non-users were not found significant.
Brown G.W. (1999)	Managing Foreign Exchange Risk with Derivatives	To study a company's named HDG Inc's foreign exchange risk management program	Descriptive Analysis	Informational asymmetries, facilitation of internal contracting and competitive pricing concerns motivate hedging.
Dhanani A. (2003)	Foreign Exchange Risk Management: A Case in the Mining Industries	To compare the management of exchange rate risk at ABC Plc UK multi-national company with academic theory	Descriptive Analysis	The firm managed its transaction risk, which was also a cash flow risk with implications for the overall corporate value.
Pramborg B. (2004)	Derivatives Hedging, Geographical Diversification and Firm Market Value	To analyze country differences in foreign exchange risk-management practices between	Empirical comparative study	Korean firms were more likely to focus on minimizing fluctuations of

		Swedish and Korean firms		cash flow rather than accounting earnings, while Swedish firms were more likely to focus on accounting numbers.
Adkins L., Carter D. and Simpson W. (2006)	Managerial Incentives and The Use of Foreign Exchange Derivatives by Bank	To find out managerial incentives and use of Foreign Exchange Derivatives	Empirical study	Greater equity holdings by managers are associated with a greater probability of hedging, and given the decision to hedge, a greater level of derivatives usage.
Afza T. and Alam A. (2011)	Corporate derivatives and foreign exchange risk management: A case study of non-financial firms of Pakistan	To explore the usage of derivatives to hedge foreign exchange and interest rate risk in by taking 105 non-financial firms listed in Karachi stock exchange	Empirical study	The firms having higher exposure of foreign exchange are more convergent towards hedging.
Xiangchao Hao, Qinru Sun and Fang Xie (2022)	International evidence for the substitution effect of FX derivatives usage on bank capital buffer	To find out the effect of FX derivatives usage on bank capital buffer	Empirical analysis	Findings of the study support policymakers, especially in developing economies, in

				promoting the development of FX derivatives market to facilitate the risk management of banks.
Dow J. and Gorton G. (1994)	Noise trading, delegated portfolio management, and economic welfare	To find out the relationship between risk and derivatives in banking	Descriptive Analysis	It is very difficult to estimate the exposure of banks to interest-rate movements.
Ahmed S., Beatty A. and Takeda C. (1997)	Evidence on Interest Rate Risk Management and Derivatives Usage by Commercial Banks	To study the Interest Rate Risk (IRR) management activities of commercial banks including their use of derivatives	Empirical study	The interest rate sensitivity of net income, as opposed to the interest rate sensitivity of stock returns, was the key focus of Interest Rate Risk (IRR) management.
Froot K. and Stein J. (1998)	Risk Management, Capital Budgeting and Capital Structure Policy for Financial Institutions: An Integrated Approach	The effect of duration targeting by dealers due to capital constraints	Descriptive analysis	Government bond market dealers engage in duration targeting, behaving as if they have a comparative advantage in bearing interest rate risk.
Brewer E.J., Jackson W.E. and Moser J.T. (2001)	The value of using interest rate derivatives to manage risk at U.S. banking organizations	To measure and manage interest rate risk includes gap analysis, duration analysis, simulation and scenario analysis	Empirical study	Interest rate risk can be controlled optimally by using derivatives along with traditional methods

Bali T.G., Hume S.R. and Martell T.F. (2007)	A new look at hedging with derivatives: Will firms reduce market risk exposure?	To examine use of foreign exchange derivatives and interest rate derivatives by nonfinancial firms	Descriptive study	Besides the firm's rate of return, many other non-financial and Economic factors affect the hedging decisions and derivatives use.
Sprcic D., Tekavcic M. and Sevic Z. (2008)	Corporate Risk Management practices in Croatian companies	To find out influencers of corporate performance	Descriptive study	Corporate performance is more influenced by commodity risk, foreign exchange and price risk, then a firm's performance.
Singh A. and Upneja A. (2008)	The determinants of the decision to use Financial Derivatives in the Lodging industry	To investigate the determinants of the hedging decision of lodging firms	Empirical analysis	This study found that underinvestment costs, cash-flow volatility, foreign sales ratio, financial distress costs, and firm size are major determinants of hedging decision.
Ulrich Hege, Elaine Hutson and Elaine Laing (2021)	Mandatory governance reform and corporate risk management	To identify the impact of corporate governance reform on foreign exchange risk hedging	Analysis using the Sarbanes-Oxley Act of 2002 as a quasi-natural experiment	The findings are corroborated by cross-sectional evidence, showing that firms with larger foreign markets exposure

				and a larger distortion in CEO incentives react more strongly to the reform.
Lingsha Cheng and Adrian (Waikong) Cheung (2021)	Is there a dark side of managerial ability? Evidence from the use of derivatives and firm risk in China	To find out whether in the absence of agency problems, firms with able managers can use derivatives effectively for risk management purposes	Empirical analysis	The study finds that the relationship between the use of derivatives and firm risk is negative, but this negative and less pronounced for firms with high-ability managers compared to firms with low-ability managers

3. Summary & Findings

The results of academic studies indicate that financial price risks might affect expected returns on stocks and, consequently, stock prices themselves, contrary to the Capital Asset Pricing Model's implications. For instance, there is strong evidence that financial institutions' stock returns are sensitive to changes in interest rates. Additionally, industrial enterprises with international sales and cash flows (though not extensive international operations) are more sensitive to fluctuations in foreign exchange rates than the majority of exclusively domestic firms. The research also points to a reduction in the sensitivity of a corporation's stock returns to certain "diversifiable" risks when managing risks with derivatives. The use of derivatives and increased share values are clearly correlated, according to several more recent research. in managing interest rate risk and foreign exchange rate risk.

Prior to the development of weather derivatives, businesses had few options for managing non-catastrophic weather risk. Many businesses either chose to ignore the weather risk or made every effort to deal as best they could with its effects. Due to the ongoing economic crisis and rising weather unpredictability brought on by climate change, weather risk management techniques are more important than ever now. Weather forecasts and appropriate preventative steps can help to lessen some of the negative consequences of the weather in the short term, but in the long term, accurate weather predictions are impossible, necessitating solutions that offer remedies. Weather derivatives offer adaptable options for managing weather risk with entirely objective payoffs, reducing issues with moral hazard and adverse selection.

Numerous researches related to the use of derivatives by companies in many countries have already been conducted, with general conclusion that most of the companies are dependent on financial derivatives in their risk management strategies. The often-cited Wharton Surveys (Bodnar et al., 1998) provide detailed descriptions of derivatives usage among US non-financial firms. A number of similar studies have examined derivatives usage in

several countries. Studies include: New Zealand (Berkman et al., 1997), Sweden (Alkeback and Hagelin, 1999), Germany (Bhamornsiri and Schroeder, 2004), Belgium (De Ceuster et al., 2000), UK (Joseph, 2000, El-Masry, 2006), Singapore (Khim and Liang, 1997), Germany (Bodnar & Gebhardt, 1999), Croatia and Slovenia (Miloš Sprčić, D., 2007), Greece (S K Kapitsinas, 2008), Turkey (Selvi & Turel, 2010), Hong-Kong (Tai-Yuen Hon, 2012) & Serbia (Živanović et.al, 2017). These studies suggested that the use of derivatives by institutional investors is widespread, covering all investor categories and sizes.

Firms use derivatives mainly to manage their interest rate risk and foreign exchange risk. In addition, the studies verify that derivatives are not used for speculation against market movements, but mainly for hedging anticipated transactions and firm's commitments. The major sources of concern for derivatives users are the accounting treatment of derivatives and the requirement to disclose their use. The increased mandated disclosure and fair value measurement of derivatives increases the quality and homogeneity of information regarding their use and corporate risk management.

References

- [1] Adam, T. (2002) 'Do Firms Use Derivatives to Reduce their Dependence on External Capital Markets?', *European Finance Review*, 6, 163-187.
- [2] Adkins, L. and Carter, D. and Simpson, W. (2006) 'Managerial Incentives and The Use of Foreign Exchange Derivatives by Bank', *The Journal of Financial Research*, 30(3), 399-413.
- [3] Afza, T. and Alam, A. (2011) 'Corporate derivatives and foreign exchange risk management: A case study of non-financial firms of Pakistan', *Journal of Risk Finance*, 12(5), 409-420.
- [4] Ahmed, S. and Beatty, L. and Takeda, C. (1997) 'Evidence on Interest Rate Risk Management and Derivatives Usage by Commercial Banks'.
- [5] Alkeback P. and Hagelin N. (2002) 'Derivative Usage by Nonfinancial Firms in Sweden with an International Comparison', *Journal of International Financial Management and Accounting* 10(2), 105-120.
- [6] Allayannis, G. and Ofek, E. (2000) 'Exchange rate exposure, hedging, and the use of foreign currency derivatives', *Journal of International Money and Finance*, 20(2), 273- 296.
- [7] Ameer, R. (2010) 'Determinants of Corporate Hedging Practices in Malaysia', *The International Business Research*, 3(2), 120-130.
- [8] Arrow, Kenneth J. (1965) 'Insurance Risk and Resource Allocation,' in Kenneth J. Arrow,
- [9] Aspects of the Theory of Risk Bearing, Helsinki: Helsinki, Yrjo Jahnsson Lectures.
- [10] Auer, J. (2003) 'Weather Derivatives Heading for Sunny Times', Available online:<http://www.dbresearch.com/PROD/999/PROD0000000000052399.pdf> (accessed on 9 July 2020).
- [11] Bali, T. G. and Hume, S. R. and Martell, T. F. (2007) 'A new look at hedging with derivatives: Will firms reduce market risk exposure?', *Journal of Future Markets*, 27, 1053-1083.
- [12] Bartram, S.M. (2000) 'Corporate Risk Management as a Lever for Shareholder Value Creation, Financial Markets', *Institutions and Instruments*, 9(5), 279-324.
- [13] Beets, S. (2004), 'The Use of Derivatives to Manage Interest Rate Risk in Commercial Banks', *Investment Management and Financial Innovations*, 2, 60-74.
- [14] Berkman, H. and Bradbury, M. and Magan S. (1997) 'An International Comparison of Derivatives Use', *Financial Management*, 26(4), 69-73.
- [15] Bernstein, Peter L. (1996) *Against the Gods: The Remarkable Story of Risk*, John Wiley & Sons, New York.
- [16] Bessembinder, H. (1991), 'Forward contracts and firm value: investment incentive and contracting effects', *The Journal of Financial and Quantitative Analysis*, 26(4), 519-32.
- [17] Block, S. B. and T. J. Gallagher (1986) 'The Use of Interest Rate Futures and Options by Corporate Financial Managers', *Financial Management*, 15, 73-78.

-
- [18] Bodnar, G. and Gebhart, G. (1998) 'Derivative Usage in Risk Management by U.S. and German Non-Financial Firms: A Comparative Survey', *Journal of International Financial Management and Accounting*, 10 (3), 153-187.
 - [19] Bodnar, G. and Hayt, G. and Marston, R. and Smithson, C., (1995) '1994 Wharton Survey of Derivatives Usage by US Non-Financial Firms', *Financial Management, Contemporary Issues*, 24 (2), 104- 114.
 - [20] Bodnar, G. and Hayt, G. and Marston, R., (1996) '1995 Wharton Survey of Derivatives Usage by US Non-Financial Firms', *Financial Management, Contemporary Issues*, 25 (4), 113-133.
 - [21] Bodnar, G. and Hayt, G. and Marston, R., (1998) '1998 Wharton Survey of Financial Risk Management by U.S. Non-Financial Firms', *Financial Management*, 27 (4), 70-91.
 - [22] Bodnar, G. M. and Gebhart, G. (1998) 'Derivative Usage in Risk Management by U.S. and German Non-Financial Firms: A Comparative Survey', *Journal of International Financial Management and Accounting*, 10(3), 153-187.
 - [23] Brewer, E.J. and Jackson, W.E. and Moser, J.T. (2001) 'The value of using interest rate derivatives to manage risk at U.S. banking organizations', *Economic perspectives*, 25(3), 49-55.
 - [24] Brockett, P. L. and M. Wang, and C. Yang (2003) 'Pricing Weather Derivatives Using the Indifference Pricing Approach', Working Paper, University of Texas at Austin.
 - [25] Brockett, P.L. and Wang, M. and Yang, C. (2005) 'Perspectives Weather Derivatives and Weather Risk Management', *Risk Management Insurance Revision*, 8, 127–140.
 - [26] Brown, G. (1999) 'Managing Foreign Exchange Risk with Derivatives', *General of Financial Economics*, 60(2), 401-448.
 - [27] Carter, D. A. and Rogers, D. A. and Simkins, B. J. (2006) 'Does hedging affect firm value? Evidence from the US airline industry', *Financial Management*, 35, 53-88.
 - [28] Chang-Mo Kang and Donghyun Kim (2022). Risk management transparency and compensation, *Journal of Corporate Finance*, Vol. 75, August 2022, 102245.
 - [29] Chernenko, S. and Faulkender, M. (2008) 'The Two Sides of Derivatives Usage: Hedging and Speculating with Interest Rate Swaps', *Journal of Financial and Quantitative Analysis*, 46(6), 1727 – 1754.
 - [30] Dhanani, A. (2003) 'Foreign Exchange Risk Management: A Case in the Mining Industries', *The British accounting Review*, 35, 35-63.
 - [31] Dow, J., and G. Gorton. (1994) 'Noise trading, delegated portfolio management, and economic welfare', Working Paper No. 4858. National Bureau of Economic Research.
 - [32] Elliott, W.B. and Huffman, S. P. and Makar, S. D. (2003) 'Foreign Denominated debt and foreign currency derivatives: complements or substitutes in hedging foreign currency risk?', *Journal of Multinational Financial Management*, 13, 123-139.
 - [33] El-Masry, A., (2006) 'Derivatives use and risk management practices by UK non-financial companies', *Managerial Finance*, 32 (2), 137-159.
 - [34] Fok, R. and Carroll, C. and Chiou, C. (1997), "Determinants of corporate hedging and derivatives: a revisit", *Journal of Economics and Business*, 49, 569-85.
 - [35] Froot K. and Stein J. (1998) 'Risk Management, Capital Budgeting and Capital Structure Policy for Financial Institutions: an integrated approach', *Journal of Financial Economics*, 47, 55-82.
 - [36] Froot, K.A. and Scharfstein, D.S. and Stein, J.C. (1993), "Risk management: coordinating corporate investment and financing policies", *The Journal of Finance*, 4(5), 1629-58.
 - [37] Gamba, A. and Triantis, A. (2014) 'Corporate Risk Management: Integrating Liquidity, Hedging, and Operating Policies', *Management Science*, 60(4), 203-235.
 - [38] Gay, G. and Nam, J. (1999) 'The underinvestment problem and corporate derivatives use', *Financial Management*, 27(4), 53-69.
 - [39] Gay, G.D. and Nam, J. (1998), "The underinvestment problem and corporate derivatives use", *Financial Management*, 27(4), 53-69.
 - [40] Geczy, C. and Minton, A. and Schrand C. (1997) 'Why Firms Use Currency Derivatives', *The Journal of Finance*, 52 (4), 1323-1354.

-
- [41] Gorton, G., and R. J. Rosen. (1995) 'Corporate control, portfolio choice, and the decline of banking', Working paper, University of Pennsylvania.
 - [42] Haushalter, G.D. (2000), "Financing policy, basis risk, and corporate hedging: evidence from oil and gas producers", *The Journal of Finance*, 55(1), 107-52.
 - [43] Judge, A. (2003) 'Why Do Firms Hedge? A Review of the Evidence', *Journal of Issues in Finance and Monetary Policy*, 9, 1-67.
 - [44] Kapitsinas, S. (2008) 'Derivatives Usage in Risk Management by Non-Financial Firms: Evidence from Greece', MPRA
 - [45] Khim, E.M. and Liang, D.L. (1997), 'The use of derivative financial instruments in company financial risk management: the Singapore experience', *Singapore Management Review*, 19(2), 17-44.
 - [46] Kozarević, E. and I. Kestović and M. Kokorovic-Jukan and B. Čivić (2012) 'The Usage of Derivatives in Financial Risk Management by Companies in Bosnia and Hercegovina', *Economic Review – Journal of Economics and Business*, 10(2), 59-72.
 - [47] Lingsha Cheng and Adrian (Waikong) Cheung (2021). Is there a dark side of managerial ability? Evidence from the use of derivatives and firm risk in China, *Journal of Contemporary Accounting & Economics*, Vol. 17, Issue 2, August 2021, 100258
 - [48] Mian, S.L. (1996), "Evidence on corporate hedging policy", *Journal of Financial and Quantitative Analysis*, 31(3), 419-39.
 - [49] Miloš Sprčić, D. (2007) 'The Derivatives as Financial Risk Management Instruments: The Case of Croatian and Slovenian Non-financial Companies', *Financial Theory and Practice*, Vol. 31 (4), 395-420.
 - [50] Modigliani, F. and Miller, M.H. (1958), "The cost of capital, corporation finance and the theory of investment", *American Economic Review*, 48(3), 261-97.
 - [51] Nance, D. R. and Smith C. W. and Smithson, C. W. (1993) 'On the Determinants of Corporate Hedging', *The Journal of Finance*, 48, 267-284.
 - [52] Nguyen, H. V. and Mensah, M. O. and Fan, Y. (2007) 'Derivative Instruments and Their Use for Hedging by U.S. Non-Financial Firms: A Review of Theories and Empirical Evidence', *Journal of Applied Business and Economics*, 7, 35-57.
 - [53] Phillips, A., (1995) 'Derivatives practices and instruments surveys', *Financial Management*, 24 (2), 115-125.
 - [54] Pramborg, B. (2004) 'Derivatives hedging, geographical diversification and firm market Value', *Journal of Multinational Financial Management*, 14, 117-133.
 - [55] Selvi, Y. and Turel, A. (2010) 'Derivatives Usage in Risk Management by Turkish Non-Financial Firms and Banks: A Comparative Study', *OECONOMICA*, 12(2), 662-671.
 - [56] Shuying Lai, Jing Qiu, Yuechuan Tao and Yinyan Liu (2022). Risk hedging strategies for electricity retailers using insurance and strangle weather derivatives, *International Journal of Electrical Power & Energy Systems*, Volume 134, January 2022, 107372.
 - [57] Singh, A. and Upneja A. (2008) 'The determinants of the decision to use Financial Derivatives in the Lodging industry', *Journal of Hospitality and Tourism*, 32(4), 423- 447.
 - [58] Smith, C.W. and Stulz, R.M. (1985), "The determinants of firms' hedging policies", *Journal of Financial and Quantitative Analysis*, 20(4), 391-405.
 - [59] Solomon, J.F. and Solomon A. and Norton, S. D. and Joseph, N.L. (2000) 'A conceptual framework for corporate risk disclosure emerging from the agenda for corporate governance reform', *British Accounting Review*, 32(4), 447–478.
 - [60] Sprcic, D. and Tekavcic, M. and Sevic Z. (2008) 'Corporate Risk Management practices in Croatian companies', *Ekonomski Pregled*, 59(7-8), 344–369.
 - [61] Stulz, R. (1996) 'Rethinking risk management', *Journal of Applied Corporate Finance*, 9, 8-25.
 - [62] Stulz, R.M. (1984), "Optimal hedging policies", *Journal of Financial and Quantitative Policies*, 19(2), 127-40.
 - [63] Takashi Kanamura, Lasse Homann and Marcel Prokopczuk (2021). Pricing analysis of wind power derivatives for renewable energy risk management, *Applied Energy*, Volume 304, 15 December 2021, 117827.

-
- [64] Thomasvan der Zwaard, Lech A. Grzelak and Cornelis W. Oosterlee (2022). Relevance of Wrong-Way Risk in Funding Valuation Adjustments, *Finance Research Letters*, Vol. 49, October 2022, 103091.
- [65] Xiangchao Hao, Qinru Sun and Fang Xie (2022). International evidence for the substitution effect of FX derivatives usage on bank capital buffer, *Research in International Business and Finance*, Vol.62, December 2022, 101687.
- [66] Zivanovic, B. and Mina, K. (2017) ‘The Usage of Financial Derivatives in Financial Risk Management by Non-Financial Companies in Serbia’, *Industriia*, 45(3), 65-82.