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The Impact of the Strategic Use of Financial Derivatives on the Effectiveness of Interest Rate Risk Management of Non-financial Firms in China

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Abstract

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Key Words: Interest Rate Risk Management, Financial Derivatives, Non-financial Firms, Market Conditions, Emerging Markets

Purpose: This study investigates the effectiveness of using financial derivatives for interest rate risk management in non-financial firms in China, and examines the moderating role of market conditions on this relationship.

Methodology: The empirical study utilizes panel data analysis techniques, primarily employs fixed effects models, selected based on the Hausman test, and supplemented by pooled OLS models as a baseline for comparison. Robustness checks include gradually adding control variables and incorporating lagged effects to address potential endogeneity issues. Heteroskedasticity and autocorrelation are diagnosed using White's test, Cameron & Trivedi's decomposition of the IM test, and the Wooldridge test.

Theoretical Perspectives: The theoretical perspective of this study is based on risk management theory, including hedging theory, capital structure theory and financial flexibility theory, as well as new economic institutional theory.

Empirical Foundations: This study takes non-financial listed companies in the Shanghai and Shenzhen stock markets as the research sample, and the research scope is from 2017 to 2022. After data cleaning, 14,436 valid data records were finally obtained for empirical research, of which 1,960 were identified as using interest rate derivatives.

Conclusions: The findings confirm that the use of financial derivatives significantly reduces the financial expense ratio, indicating effective interest rate risk management. Additionally, the effectiveness of derivatives is enhanced under volatile market conditions, underscoring the importance of strategic risk management in emerging markets.

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1. Introduction

1.1 Background

Against the backdrop of escalating economic globalization and market liberalization, not only traditional financial industries but also non-financial corporations are increasingly vulnerable to interest rate fluctuations. These fluctuations impact corporate borrowing costs, investment decisions, and overall financial stability. Particularly, the acceleration of interest rate marketization in China has made interest rate risk an important issue that cannot be ignored (Huang, 2001). The presence of interest rate risk affects not only the financial stability and profitability of enterprises but also may have adverse effects on their long-term development. Derivatives such as swaps, options, and futures provide complex mechanisms for companies to hedge these risks, allowing them to lock in costs or profits and reduce the unpredictability caused by market rate fluctuations (Li, 2006). For non-financial corporations, the prudent use of derivative financial instruments not only effectively manages interest rate risk but also enhances financial stability and profitability through hedging strategies (Chen, 2019).

However, despite the theoretical advantages of financial derivatives in risk management, practical challenges still exist, especially in China, where the financial markets are less mature compared to Western developed countries. The immaturity of the derivatives market and regulatory challenges limit the ability of corporations to effectively use these tools for risk management (Bai, 2012). A lack of expertise and experience often leads to operational difficulties and insufficient risk management when corporations utilize derivatives (Wenxin & Wen, 2011).

This thesis will explore the strategic use of financial derivatives by non-financial corporations in China, with a focus on the effectiveness of derivatives in managing their interest rate risks. Although financial institutions have been at the forefront of research on the use of derivatives, non-financial corporations, which also face substantial interest rate risks, have not been extensively studied, especially in emerging markets like China.

1.2 Purpose and Research Question

The dynamic landscape of global financial markets has necessitated robust risk management

practices, especially in the context of interest rate fluctuations which can significantly impact corporate financial stability (Li, 2007). This study aims to investigate the use of financial derivatives as a strategic tool for managing interest rate risks within non-financial companies in China. With the growing complexity of financial instruments and varying market conditions, it is crucial to understand how effectively these tools are being utilized and what factors may influence their efficacy. The purpose of this research is to provide empirical insights into the effectiveness of derivatives in mitigating risks associated with interest rate changes, and to explore the moderating role of market conditions on this effectiveness. This will aid non-financial corporations in enhancing their financial stability and profitability through informed use of derivatives.

This study is guided by the following research questions:

RQ1: How effective are derivatives in managing interest rate risks within non-financial companies in China?

The investigation for this question will quantify the impact of derivatives on managing such risks, aiming to determine if their use leads to measurable benefits in risk reduction.

RQ2: How do prevailing market conditions moderate the effectiveness of derivatives in managing interest rate risks among non-financial companies in China?

This involves examining how external economic environments may enhance or diminish the effectiveness of derivatives in stabilizing interest rate exposures.

By addressing these issues, this study will provide valuable insights into the practices of interest rate risk management for non-financial companies in emerging market conditions and offer empirical evidence on the effectiveness of financial derivatives in hedging interest rate risks in highly volatile market environments.

1.3 Empirical Findings

The empirical findings of this study highlight the significant role of financial derivatives in managing interest rate risk among non-financial companies in China. It was demonstrated that derivatives effectively reduce financial expense ratios, particularly when more control variables are considered, which clarifies their utility in mitigating costs associated with interest rate fluctuations. Additionally, the study reveals that market conditions play a critical moderating role, enhancing the effectiveness of derivatives in more volatile environments.

This interaction suggests that the strategic use of derivatives is crucial in times of market uncertainty. Robustness checks, including the use of lagged variables and robust standard errors, further confirmed the reliability of these findings, underscoring the effectiveness of derivatives as a risk management tool in the dynamic economic landscape of emerging markets.

1.4 Contributions

Among the current existing studies, most of the research on the use of financial derivatives for interest rate risk management focuses on the financial industry, while there are relatively few studies on non-financial enterprises that also face significant interest rate risks. This article contributes to understanding the strategic use of financial derivatives by Chinese non-financial firms, a topic that has been underexplored in contemporary financial research, particularly in the context of emerging markets. It broadens the existing literature on how non-financial firms manage their interest rate risk by providing an analysis of how these firms use derivatives to manage interest rate risk. The research provides valuable insights into the utility of derivatives in less mature financial markets.

Additionally, by identifying key factors influencing the adoption and effectiveness of these tools, this research informs corporate decision-makers and managers in developing stronger risk management strategies and helps shape regulations tailored to the nuances of emerging markets. policy. The results of this study provide a perspective on the application of derivatives in emerging markets and enhance the academic and practical understanding of how non-financial enterprises can conduct effective interest rate risk management in the diverse economic landscape of emerging markets.

1.5 Outline

The subsequent sections of this paper are structured as follows. Section 2 introduces the theoretical background of this study, including theories related to risk management and new institutional economics. Based on previous literature and research, section 3 provides an extensive review of interest rate risk and its impacts, an overview of financial derivatives, the application of derivatives in risk management practices, the motivations and strategies for using derivatives, the practices of interest rate risk management in non-financial firms, and

the specific policy context of non-financial firms' interest rate risk management in China. Section 4 elucidates the hypotheses development of this study. Section 5 is concerned with data collection and descriptive statistics of the sample. Section 6 reviews the methodologies used in this study and specific research designs. Section 7 offers a detailed analysis and discussion based on regression results and statistical tests, concluding with an analysis of the limitations of the research. Section 8 summarizes the paper.

2. Theoretical Background

2.1 Theories of Risk Management

2.1.1 Hedging Theory

The core of hedging theory lies in the use of financial derivatives to reduce or eliminate the impact of specific risks. Financial derivatives, such as options, futures, and swap contracts, provide a mechanism that allows investors to lock in future transaction prices, thus protecting themselves from fluctuations in market prices (Tebogo, 2011). This mechanism is particularly important for managing changes in interest rates, as variations in rates directly affect a company's financing costs and investment returns.

According to Froot et al.(1993), companies hedge to smooth income and ensure sufficient internal funds to finance investment opportunities. Hedging allows companies to manage their risk profiles more effectively, aligning risk with their risk tolerance levels and strategic objectives. By reducing the variability of cash flows, firms can avoid the costs associated with external financing and invest in growth opportunities even during volatile market conditions.

Numerous studies have validated the hedging theory by demonstrating how hedging can lower the cost of capital and increase firm value. Smith and Stulz (1985) argued that risk management enhances firm value by reducing the expected costs of financial distress. A seminal paper by Tufano (1996) showed that gold mining companies that hedged their gold price exposure had higher market valuations compared to those that did not hedge.

In the context of non-financial firms, especially those operating in emerging markets like China, hedging interest rate risk becomes critical as these markets often experience greater financial volatility and less predictable monetary policy actions (Bloom, 2009). Non-financial firms, unlike financial institutions, typically engage in hedging to protect cash flows and secure competitive pricing rather than speculative purposes (Allayannis & Weston, 2001).

2.1.2 Capital Structure Theory

Capital Structure Theory explores how the composition of a company's liabilities and equity affects its overall value and the cost of its capital. The theory is often discussed in the context of Modigliani and Miller's (1958) proposition, which suggests that in perfect markets, the value of a firm is unaffected by its capital structure. However, when introducing real-world factors such as taxes, bankruptcy costs, and agency costs, the capital structure becomes a vital element in a firm's financial strategy. This is because debt can offer tax advantages but also brings higher risk of financial distress (Modigliani & Miller, 1963).

Derivatives are used by firms not only for hedging against market risks but also as a tool to manage the costs associated with their capital structure. By using interest rate swaps, futures, or options, firms can better control the variability of interest payments, which directly influences their leverage and the weighted average cost of capital (WACC). This practice aligns with the trade-off theory, which posits that firms balance the tax benefits of additional debt against the costs of potential financial distress (Kraus & Litzenberger, 1973).

Empirical studies such as those by Graham and Rogers (2002) have shown that firms with higher debt levels are more likely to use derivatives to hedge against interest rate risks. This behavior is consistent with the desire to minimize the risk of cash flow instability and financial distress that can be exacerbated by rate fluctuations.

For non-financial firms, particularly in volatile economic environments like those often found in emerging markets, managing capital structure through the strategic use of derivatives is crucial. The capacity to stabilize interest expenses and other financial obligations enhances their ability to invest in core business activities without the constant threat of financial volatility undermining their strategic goals (Myers, 1977).

2.1.3 Financial Flexibility Theory

Financial flexibility refers to the capacity of a company to react to unexpected financial needs and opportunities by accessing or conserving cash in a cost-effective manner. Myers (1977) argued that firms should maintain financial slack to safeguard against future uncertainties and potential investment opportunities. This slack can be in the form of liquid assets, low

leverage, or unused debt capacity, which provides firms with the needed agility to manage sudden financial or operational changes. Financial flexibility theory highlights the importance of maintaining a reserve of financial options that allow firms to seize investment opportunities and manage risks efficiently.

In the context of interest rate risk management, financial flexibility can be significantly enhanced through the use of financial derivatives. Derivatives like interest rate swaps and options allow firms to manage their exposure to fluctuating interest rates actively. By locking in interest rates or capping potential increases in borrowing costs, firms can maintain their financial flexibility and ensure that they have sufficient funds available for strategic initiatives (Géczy et al., 1997).

For non-financial firms, especially those in emerging markets such as China, maintaining financial flexibility is crucial. These markets often exhibit higher volatility and unpredictability, making it imperative for firms to manage their financial resources prudently. The strategic use of derivatives as part of a comprehensive risk management framework can help these firms avoid situations where financial inflexibility could lead to missed opportunities or excessive risk exposure (Byoun, 2008).

2.2 New Institutional Economics Theory

New Institutional Economics (NIE) Theory extends the traditional economic frameworks by incorporating institutions into the analysis of economic processes and behaviors (Dequech, 2006). It emphasizes the role of institutions—such as legal systems, government policies, and market regulations—in shaping economic decisions and outcomes (Klein, 1997). This theory is particularly important for studying the strategies of non-financial corporates in China using derivatives because China has a unique regulatory regime and the financial market and regulatory environment are still developing, especially in the context of the ongoing interest rate liberalization reforms.

NIE can explain the variations in how non-financial firms use financial derivatives across different institutional contexts. For instance, firms in countries with more developed and stable financial markets are more likely to use derivatives sophisticatedly due to better regulatory frameworks and more advanced financial infrastructure (Williamson, 2007).

Conversely, in emerging markets like China, where financial markets and regulatory systems are still developing, the adoption and effectiveness of financial derivatives might be influenced by institutional inefficiencies and transitional market dynamics.

Empirical studies, such as those by La Porta et al. (1998), have shown that legal and institutional frameworks significantly affect the corporate finance practices of firms. Firms in countries with strong investor protections and well-developed legal systems are more likely to engage in complex financial practices, including the use of derivatives for hedging purposes.

For non-financial firms in emerging markets, understanding and navigating the institutional landscape is key to effectively managing interest rate risk through financial derivatives. The theory suggests that institutional reforms and improvements in institutional quality (e.g., better regulation, more transparent markets) can improve the ability of these firms to use financial derivatives more effectively and efficiently.

3. Literature Review

3.1 Interest Rate Risk and Its Impact on Firms

3.1.1 Definition and Sources of Interest Rate Risk

Interest rate risk refers to the potential financial losses due to fluctuations in market interest rates. It primarily affects financial assets and liabilities that are directly tied to market interest rates. The risk of interest rate fluctuations in the market arises not only from the actions of banks and other financial institutions but also from macroeconomic factors.

For instance, studies in the United States have shown that factors such as the real risk-free interest rates, inflation rates, unemployment rates, GDP and industrial production growth, growth in national debt and current account deficits, growth in the money supply, and the yield spread between short-term and long-term securities all influence the interest rate risk premium (Arize et al., 2013).

Financial derivatives and instruments, such as options and futures, are also subject to interest rate risk. The value of these tools fluctuates with changes in interest rates, thereby necessitating their risk to be managed and priced by investors (Black & Scholes, 1973).

Moreover, monetary policy decisions by central banks, such as adjustments to the benchmark interest rate, can also impact market rates, subsequently affecting the value of all interest rate-dependent financial assets and liabilities. Such policy changes can lead to sudden shifts in market rates, resulting in unexpected risk exposures (Frisancho-Mariscal & Howells, 2009).

3.1.2 Impacts of Interest Rate Changes on Corporate Finance

The impact of interest rate changes on corporate finance involves various aspects including financing decisions, investment behavior, and capital structure.

Firstly, changes in interest rates directly affect corporate financing costs and choices. In the

absence of an interest rate swap market, the uncertainty of interest rates may cause companies to prefer long-term financing over short-term financing (Titman, 1992). However, when interest rate swaps are available, companies expected to improve in credit quality tend to borrow short-term funds and use swap contracts to hedge interest rate risks (Titman, 1992). This shows that changes in interest rates impact a firm’ s capital structure and financial strategy by influencing financing costs and choices.

Secondly, changes in interest rates significantly impact corporate investment decisions. Lowering interest rates reduces the threshold rate of return for investment projects, thereby encouraging firms to invest (Han et al., 2023). This effect was particularly evident during financial crises, as reduced rates decreased the cost of capital, increasing the opportunity cost of immediate investments (Han et al., 2023). Additionally, for highly liquid firms, reduced rates accelerate investment decisions, while for less liquid firms, the optimal investment threshold is unaffected by rate changes but is influenced by changes in credit supply frictions (Han et al., 2023).

Furthermore, changes in interest rates also affect adjustments in corporate capital structure. Studies have shown that interest rate changes significantly impact corporate leverage ratios, which are positively correlated with both long-term and short-term rates and the term spread, and linked to the critical role liquidity requirements play in corporate financing decisions (Vega-Gutierrez & Rodriguez-Sanz, 2022). Moreover, changes in interest rates affect corporate debt policies, especially for those using interest rate swaps, which might expand the impact of corporate size on dynamic debt policies (Yang et al., 2001).

3.2 An Overview of Financial Derivatives

Financial derivatives are complex financial instruments that play a crucial role in modern financial markets. The primary purpose of these instruments is to transfer risk between different parties (Hull, 2016). According to Hull (2016), derivatives can be classified into four main types: futures, forwards, options, and swaps. Each type serves different market needs and exhibits distinct risk and return profiles.

Futures and forwards are contractual agreements to buy or sell an asset at a predetermined future date and price. Futures are standardized contracts traded on an exchange, whereas

forwards are customized contracts traded over-the-counter (OTC). The use of futures and forwards in hedging commodity price risks is extensively documented in the literature (Kolb and Overdahl, 2010).

Options give the buyer the right, but not the obligation, to buy (call option) or sell (put option) an underlying asset at a specified price before a certain date. The theoretical framework for pricing options was revolutionized by the Black-Scholes model, which provided an analytical closed-form solution for pricing European call and put options (Black and Scholes, 1973).

Swaps are agreements between two parties to exchange sequences of cash flows for a set period of time. Commonly, these involve swapping fixed interest rate payments for floating rate ones, known as interest rate swaps. Swaps are particularly useful in managing interest rate risks and are widely utilized by financial institutions (Smith, Smithson, and Wilford, 1989).

The application of derivatives has been both praised for providing financial markets with tools for risk management and criticized for their role in financial market crises, such as the 2008 financial crisis. Critics argue that derivatives contribute to market opacity and can lead to systemic risks if not properly managed (Stulz, 2004). Therefore, though they offer significant benefits in terms of risk management and investment opportunities, it also pose challenges in terms of risk control and regulation (Stulz, 2004; Hull, 2016).

3.3 The Application of Financial Derivatives in Risk Management

In the exploration of how financial derivatives are applied in corporate risk management, previous research provides comprehensive insights into the strategic use and implications of these financial instruments across various global markets and industries.

In Greece, for instance, Kapitsinas (2008) notes that only a small percentage of non-financial firms use derivatives, primarily for hedging against basic financial risks. This conservative approach is shaped by complex regulatory requirements and a lack of sophisticated risk management infrastructure, a theme that is consistent in smaller European economies. Similarly, Bodnar et al. (2008) observe in Italy that while derivatives are mainly utilized by larger firms to manage foreign exchange and interest rate risks, their use is restricted by

challenges in effectiveness monitoring and measurement.

Contrastingly, in Asia, derivatives have a more pronounced positive impact on firm performance. Lee (2019) finds that in eight Asian countries, derivatives not only mitigate risks but also enhance firm performance, a process supported by strong corporate governance structures. In Malaysia, Pyeman et al. (2019) further detail that companies with higher levels of debt and capital investment are more likely to use derivatives for hedging. The study also highlights a significant relationship between profitability and the likelihood of using financial derivatives, suggesting that companies with stronger profitability are better able to utilize these tools for effective risk management.

The insurance industry also shows significant utilization of derivatives, particularly for hedging purposes rather than speculation. Cummins et al. (2001) emphasize that derivatives are strategically used in this sector to align risk management with corporate policy goals, influenced by both firm-specific factors and broader economic conditions. This strategic application highlights the complexity of derivatives usage, which, although effective, requires nuanced management strategies to align with corporate objectives. Sajjad et al. (2013) discuss the impact of derivatives within the financial services sector in Pakistan, illustrating that derivatives are vital for managing both systemic and non-systemic risks. Their findings advocate for the development of derivatives markets as essential components of robust financial risk management strategies.

Moreover, Sahoo (2015) conducted an exhaustive review of the use of financial derivatives in corporate risk management over the past three decades, discussing their application across various risk categories including foreign exchange, interest rates, commodities, and equity markets. A significant finding of this review is the clear lack of comprehensive research on the use of derivatives in emerging markets like India and China, compared to the extensive studies conducted in Western economies such as the US, UK, Germany, and Australia. This gap underscores the need for targeted research to better understand the utilization of financial derivatives in these markets, aiming to gain a better understanding of local practices and challenges.

3.4 Motivations and Strategies for Using Financial Derivatives

Non-financial firms employ financial derivatives as part of a multifaceted strategy to align with broader financial and risk management goals, which include risk mitigation, financial performance enhancement, and capital structure optimization. These strategies reflect the diverse motivations, corporate policies, market conditions, and regulatory environments that influence their use.

One primary motivation for using derivatives is to hedge against various financial risks such as exchange rate fluctuations, interest rate volatility, and commodity price changes. For example, research like Yang et al. (2023) underscores that Chinese firms use derivatives to reduce the cost of financial distress and avoid underinvestment, employing these tools as a defensive strategy against market volatilities. Conversely, Hentschel and Kothari (2001) found that while derivatives are used to manage exposure to financial risks, they do not significantly alter a firm's risk profile, suggesting their role is more about risk management than risk elimination.

Derivatives are also strategically used to optimize the capital structure. Guay (1999) discovered that derivatives have a positive impact on firm performance metrics such as Return on Assets and Tobin’ s Q, indicating that these instruments can enhance firm value. This is achieved by optimizing capital usage and stabilizing earnings, which can influence debt levels and equity valuations, thereby affecting the overall financial strategy of a firm.

While traditional reasons like tax considerations are often cited, Bartram et al. (2009) found that these are not strong predictors of derivatives usage, pointing to a complex interplay between financial strategy and tax planning. This suggests that derivatives are part of a broader set of financial management tools used not solely for tax benefits but for comprehensive financial management.

Managerial strategies and perceptions also play a crucial role in the decision to use derivatives. Pyeman et al. (2019) demonstrate that leverage and profitability significantly determine the adoption of derivatives among Malaysian firms, with financially stronger firms more likely to use derivatives to effectively hedge against risks.

Furthermore, the implementation of specific accounting standards, such as SFAS No. 133[1], influences how companies manage and report their use of derivatives. Bhamornsiri and Schroeder (2004) explored how these standards necessitate reporting derivatives at fair value, impacting managerial decisions regarding their use, particularly in terms of income statement and balance sheet presentations.

The use of derivatives also varies significantly across different sectors depending on the specific risk exposures and financial strategies. Bodnar et al. (2008) highlighted that in Italy, larger firms are more inclined to use derivatives across all types of risks due to their ability to manage the associated costs more effectively.

Moreover, international and cultural factors significantly influence the adoption and use of derivatives. For example, Bodnar and Gebhardt (1999) highlight notable differences in the usage between U.S. and German firms, driven by varying cultural and regulatory frameworks that dictate risk management strategies and objectives.

3.5 Interest Rate Risk Management Strategies of Non-financial Firms

Interest rate risk management for non-financial corporations involve various risk management tools and strategies. Firstly, non-financial corporations manage their interest rate risk by utilizing interest rate derivatives such as swaps. These instruments allow firms to convert fixed-rate debts into floating-rate debts, or vice versa, thus reducing or increasing sensitivity to specific interest rate movements (Fenn et al., 1997). Moreover, research indicates that there are differences in derivative use across firms of different sizes; smaller firms tend to use derivatives to hedge interest rate risks in their liabilities, while larger firms are more likely to limit their interest rate exposure through the choice of debt structure rather than derivative use (Covitz & Sharpe, 2005).

Empirical studies in Pakistan by Bashir et al. (2019) suggest that interest rate risk

[1] SFAS No. 133, "Accounting for Derivative Instruments and Hedging Activities," is a significant financial accounting standard issued by the Financial Accounting Standards Board (FASB). This standard aims to regulate the accounting of derivative instruments by requiring all entities to report their derivatives as either assets or liabilities on the balance sheet and to measure them at fair value (Finnerty & Grant, 2002). Additionally, SFAS No. 133 specifies methods for testing hedge effectiveness, allowing businesses, under certain conditions, to match the gains and losses from hedge transactions with the corresponding risk positions to avoid distorting the income statement (Finnerty & Grant, 2002).

management strategies in non-financial firms is also influenced by firm characteristics such as liquidity, financial leverage, profitability, dividend payout ratios, and interest coverage multiples. For instance, firms with high foreign sales, low financial leverage, low profitability, low dividend payout ratios, and low interest coverage multiples are more likely to use interest rate derivatives as risk management tools.

Furthermore, the interest rate risk management strategies of non-financial companies are also influenced by the macroeconomic environment. For example, the rapid monetary policy tightening implemented in most developed economies during 2022 and 2023 led to significantly higher interest rates for new borrowings, which not only increased the cost of new loans but could also result in increased repayment costs for existing debt, thus affecting the firm's financial conditions and risk management strategies (Kitsul, 2023).

3.6 Impacts of China's Interest Rate Liberalization on Non-Financial Firms' Interest Rate Risk Management Strategies

As China's financial market reforms deepen, particularly with the acceleration of interest rate liberalization, non-financial corporations face an increasingly complex and volatile financing environment (Cheung et al., 2019). Interest rate liberalization not only raises the cost of capital but also increases the sensitivity of corporations to risks in capital operations (Huang, 2001). This requires non-financial corporations to adopt more sophisticated and diversified risk management strategies to cope with market changes.

Interest rate liberalization reforms have granted commercial banks and other financial institutions greater autonomy in areas such as loan pricing and capital management, directly affecting the financing costs and structures of non-financial corporations (Cheung et al., 2019). For example, partial liberalization measures eliminating the lower limit on bank loan rates have affected short-term repo rates, though long-term rates have not seen significant changes (Cheung et al., 2019). These changes force non-financial corporations to be more cautious in choosing financing channels, while also necessitating the diversification of financing strategies to spread risks.

Moreover, interest rate liberalization has promoted the development and perfection of financial markets, enhancing their efficiency and transparency (Cheung et al., 2019). For

non-financial corporations, this means they can more easily access market information, thereby making more rational financial decisions. However, it also means that corporations need to possess stronger abilities to identify and manage risks in the face of market fluctuations.

During the process of interest rate liberalization, non-financial corporations also need to monitor changes in the risk profile of the banking system. Research indicates that the risk level of banks is closely related to their lending rates (Geng, 2016). Therefore, when engaging in debt financing, non-financial corporations must consider not only their own financial conditions and financing needs but also assess the overall risk status of the banking system to avoid increased financing costs and constraints on financing channels due to rising bank risks.

4. Hypotheses Development

Based on an extensive literature review and a discussed theoretical framework, this study proposes two hypotheses aimed at exploring the strategic use of financial derivatives to manage interest rate risks by non-financial corporations in China and the factors influencing their effectiveness in managing interest rate risk.

Hypothesis 1: The use of derivatives is positively related to the effectiveness of interest rate risk management in non-financial companies in China.

This hypothesis suggests that the use of financial derivatives is positively related to the effectiveness of interest rate risk management in non-financial firms in China. The premise is based on the role of derivatives as financial instruments that allow firms to hedge against the variability in interest rates, thereby directly affecting and potentially stabilizing their interest expenses. Instruments such as interest rate swaps, futures, and options provide firms with the tools to manage exposure to fluctuating interest rates, which is crucial for maintaining control over financial costs in an unpredictable economic environment (Stulz, 1985; Bodnar et al., 1999).

Empirical research by Bodnar et al. (1998) has shown that derivatives serve as effective hedging tools that can secure interest costs and limit the volatility of interest expenses, which are significant components of financial costs for companies. These mechanisms are particularly important in contexts like China, where financial markets are still developing, and interest rate movements can be abrupt and significant due to ongoing financial reforms and regulatory adjustments.Furthermore, studies by Nance et al. (1993) and Haushalter (2000) support the idea that effective derivative usage is crucial for companies facing high exposure to interest rate changes. These studies highlight that tailored hedging strategies involving derivatives can mitigate risks associated with interest rate fluctuations, thus enhancing a firm’s ability to manage its financial costs more predictively and efficiently.

By testing this hypothesis, the research aims to elucidate the correlation between derivative usage and the management of interest rate risk as reflected through the volatilit of interest expenses in non-financial firms. The findings are anticipated to deepen the understanding of

hedging practices and their practical impacts on risk management in the evolving economic and regulatory backdrop of China’s financial markets.

Hypothesis 2: The effectiveness of the use of derivatives in managing interest rate risk among non-financial companies in China is moderated by prevailing market conditions. This hypothesis is informed by the understanding that the effectiveness of financial derivatives is not only a function of the instruments themselves but also the conditions under which they are utilized. Research by Smith and Stulz (1985) and Froot et al. (1993) discussed how market conditions influence hedging behavior and its effectiveness. Additionally, studies by Campello et al. (2011) and Chen & King (2014) indicated that market volatility and economic cycles impact corporate financial strategies, including hedging. Furthermore, empirical evidence provided by Kapitsinas (2008) and Sahoo (2015) suggests that market conditions, including regulatory changes and economic cycles, significantly affect the utility and effectiveness of derivatives. The framework of new institutional economics also highlights that regulatory frameworks, market liquidity, and the overall maturity of financial markets play crucial roles in shaping the effectiveness of financial instruments (Williamson, 2007). In China, financial market reforms and interest rate liberalization are underway, and market interest rates are experiencing frequent and significant fluctuations. These external conditions may influence the effectiveness of companies using derivatives to manage risk.

By testing these hypotheses, this study aims to deepen the understanding of how non-financial corporations in China use financial derivatives to manage interest rate risks under different market conditions. The findings will not only contribute to academic knowledge by bridging gaps in the literature on financial risk management in emerging markets but also provide practical insights for business managers and policymakers in developing effective risk management strategies that align with market dynamics and regulatory frameworks.

5. Data and Descriptive Statistics

5.1 Selection of Sample and Research Period

The study uses non-financial companies listed on the Shanghai and Shenzhen stock markets as research samples, covering the period from 2017 to 2022. All data and corporate annual reports used in the study are sourced from the CSMAR[2] database. The choice of 2017 to 2022 as the study period is due to several significant policy changes and economic events affecting both China and the global economy during these years, including the US-China trade war, changes in financial regulatory policies, and the global impact of the COVID-19 pandemic. These events have significantly influenced the financial market environment in China, particularly interest rate volatility, providing a rich practical backdrop for studying how non-financial companies manage interest rate risk through financial derivatives.

In the process of sample selection, we first excluded financial companies (e.g. banks and insurance companies), as well as companies in the real estate industry, because their capital structures and risk management systems differ fundamentally from those of non-financial companies. Their sensitivity to and management strategies for interest rate fluctuations might distort the understanding of non-financial corporate behavior. Additionally, companies that had been specially treated (ST[3] or *ST[4]) were also excluded, as these typically face more severe financial difficulties, and their financial decisions may be influenced by extraordinary factors, thus affecting the general applicability of the research.

Given the lack of direct data on corporate use of interest rate derivatives in public databases, we opted to search through annual reports of all non-financial listed companies from 2017 to 2022 for keywords including "interest rate swaps," "interest rate options," and "interest rate

[2] CSMAR (China Stock Market & Accounting Research) Database is a comprehensive financial database developed by Guotai Junan Securities, providing detailed data on China's stock markets, financial statements, corporate governance, and other key financial metrics. It is widely used in academic research for its extensive coverage and accuracy.

[3] ST (Special Treatment): This identifier is used for listed companies that have reported losses for two consecutive years, indicating a risk of delisting. Stock market regulations require the prefix "ST" to be added to the names of these companies' stocks to warn investors of the risk.

[4] *ST (Special Transfer): This identifier is used for listed companies facing more severe issues, such as extremely poor financial conditions or the activation of certain delisting criteria. These companies are considered to be in a delisting consolidation period, which means they may be ultimately delisted if conditions do not improve.

futures" to identify companies that use interest rate derivatives. After verifying the search results, we cleaned the data by excluding companies with missing data during that period.

Ultimately, we obtained 14,436 valid data records, of which 1,960 were identified as using interest rate derivatives. To ensure a balanced dataset for empirical analysis, we used Propensity Score Matching (PSM) to match companies using interest rate derivatives (treatment group) with those not using them (control group) at a ratio of 1:4, resulting in 7,268 matched data points used for the empirical analysis. This process ensured comparability between the two groups on key covariates.

5.2 Descriptive Statistics

5.2.1 Summary Statistics Before Propensity Score Matching（PSM）

Table 1 displays the summary statistics before Propensity Score Matching (PSM), the sample included 14,436 observations covering several key financial metrics. Notably, the mean value of the dependent variable financial expense ratio (FinExpRatio) is 0.012, and the standard deviation is 0.028, indicating that there are significant changes in the data. This difference may reflect large differences in financial structure and cost management efficiency among the sample firms. The range between the minimum value of -0.048 and the maximum value of 0.152 further indicates that some companies may have efficient financial and interest cost management mechanisms, while others face the challenge of high financial and interest costs.

The mean value of the independent variable Derivatives Use (DerivativesUse) in Table 1 is 0.136, indicating that approximately 13.6% of the companies in the sample use derivatives to manage risks. Although this ratio is not high, given that non-financial companies have varying needs and understandings of derivatives, this number provides a baseline for the practical application of derivatives in non-financial areas.

5.2.2 Summary Statistics After Propensity Score Matching（PSM）

As can be seen from Table 2, the sample size was reduced to 7,268 after matching, mainly to ensure high similarity between the treatment and control groups regarding key variables. The mean Financial Expense Ratio slightly increased to 0.015, and the standard deviation rose

from 0.028 to 0.029, reflecting that even in a carefully matched sample, there remains a high variability in financial expense ratios. This may indicate that companies still differ in their responses and management strategies towards interest rate risks, even under similar financial and operational conditions.

A significant increase in the usage rate of derivatives to 0.269 post-matching is a key outcome of the matching process, showing that in companies using derivatives, the control group post-matching aligns more closely with the treatment group in terms of derivatives usage. This increase emphasizes the balanced nature of the post-matching sample on key research variables, providing a solid foundation for further causal inference analysis.

6. Methodology

6.1 Overview of Research Approaches and Design

This study based on existing research and methods on the use of financial derivatives by corporations, with a focus on exploring the effectiveness of interest rate risk management using derivatives among non-financial firms—a topic less covered in previous literature, which has largely concentrated on financial companies. Our empirical research employs panel data analysis techniques, utilizing panel data from listed non-financial companies in China from 2017 to 2022. This data includes variables such as the use of interest rate derivatives, financial expense ratio, changes in market conditions, and other key financial indicators. The financial expense ratio is selected as the dependent variable to measure the effectiveness of derivatives in managing interest rate risks.

Our study primarily employs fixed effects or random effects models for regression analysis, supplemented by pooled Ordinary Least Squares (OLS) models to provide a baseline for comparison. To determine which model, fixed effects or random effects, is more suitable for our data, this study will use the Hausman test to assess whether the differences between the two models are statistically significant, thus aiding in selecting the most appropriate model. The supplementary pooled OLS model integrates all cross-sectional and time series data, and although the pooled OLS model cannot distinguish individual heterogeneity, it provides a unified framework for initially exploring the overall trend of the dependent variable (Woolridge, 2016). By comparing the results of fixed effects or random effects models with those of the pooled OLS model, we can better understand how the choice of model might impact the results. This method helps us verify the factors affecting the dependent variable (financial expense ratio) from various angles, ensuring the robustness and reliability of our research findings.

In terms of robustness testing, the study uses a variety of methods to ensure the reliability and robustness of the results. First, in order to systematically examine the impact of each control variable, we adopt the strategy of gradually adding control variables. In addition, to mitigate potential reverse causality issues, we lagged key variables by one year and then ran

regressions again to test whether the results were still significant. Furthermore, considering the potential problems of heteroscedasticity and autocorrelation in the model, this study applies White's test, Cameron and Trivedi's IM test decomposition, and Wooldridge's test for diagnosis. White's test is used to detect heteroscedasticity within the model; Cameron and Trivedi's decomposition further dissects the skewness and kurtosis of the model, providing deeper diagnostic insights; Finally, the Wooldridge test is used to detect first-order autocorrelation in panel data . The comprehensive application of these tests ensures the accuracy and explanatory power of the estimation results.

6.2 Panel Regression Model Specification

Panel regression analysis is the core statistical method of this study, which is mainly used to analyze the effectiveness of non-financial companies' use of interest rate derivatives for risk management and to examine the moderating effect of market conditions on this relationship. This section will elaborate on the setting of the panel regression model based on the two main assumptions of the study.

Hypothesis 1 explores whether the use of derivatives is positively related to the effectiveness of interest rate risk management in non-financial companies. In order to comprehensively analyze this hypothesis, we set the following three models, including Pooled OLS, fixed effects and random effects models, and will select a more appropriate model between fixed effects and random effects through Hausman test. As a baseline model, Pooled OLS can provide a preliminary understanding of the overall trend of influencing factors, ignore heterogeneity among individuals, and help observe the overall effect of explanatory variables (Woolridge, 2016). The fixed effects model allows this study to focus on the internal dynamics of how derivative use affects the financial expense ratio by controlling for invariant factors across all cross-sectional units (Woolridge, 2016). And when individual-specific effects are assumed to be independent of the explanatory variables, random effects models can provide efficient estimates while accounting for random individual differences (Woolridge, 2016). The model specifications are as follows:

Pooled OLS (Ordinary Least Squares) Model (For Hypothesis 1):

$$FinancialExpenseRatio_{it} = \beta_0 + \beta_1 DerivativesUseDummy_{it} + \beta_2 FirmSize_{it} + \beta_3 Leverage_{it} + \beta_4 FirmAge_{it} + \beta_5 ROA_{it} + \beta_6 PBRatio_{it} + \beta_7 CurrentRatio_{it} + \beta_8 RevenueGrowth_{it} + \beta_9 R\&DExpenseRatio + \beta_{10} CFRatio + \epsilon_{it}$$

Fixed Effects Model (For Hypothesis 1):

$$FinancialExpenseRatio_{it} = \beta_0 + \beta_1 DerivativesUseDummy_{it} + \beta_2 FirmSize_{it} + \beta_3 Leverage_{it} + \beta_4 FirmAge_{it} + \beta_5 ROA_{it} + \beta_6 PBRatio_{it} + \beta_7 CurrentRatio_{it} + \beta_8 RevenueGrowth_{it} + \beta_9 R\&DExpenseRatio + \beta_{10} CFRatio + \alpha_i + \gamma_t + \epsilon_{it}$$

Random Effects Model (For Hypothesis 1):

$$FinancialExpenseRatio_{it} = \beta_0 + \beta_1 DerivativesUseDummy_{it} + \beta_2 FirmSize_{it} + \beta_3 Leverage_{it} + \beta_4 FirmAge_{it} + \beta_5 ROA_{it} + \beta_6 PBRatio_{it} + \beta_7 CurrentRatio_{it} + \beta_8 RevenueGrowth_{it} + \beta_9 R\&DExpenseRatio + \beta_{10} CFRatio + \alpha_i + \gamma_t + \epsilon_i + \mu_i$$

As Hypothesis 2 further explores how market conditions moderate the relationship between derivatives use and financial expense ratios. To this end, we added market conditions as a moderating variable based on the model of Hypothesis 1, and introduced interaction terms to explore this potential moderating effect. By introducing an interaction term between market conditions and derivatives use, we can assess the impact of changes in market conditions on the effectiveness of derivatives management, thereby providing insights into moderating effects. The model specifications are as follows:

Fixed Effects Model (For Hypothesis 2):

$$FinancialExpenseRatio_{it} = \beta_0 + \beta_1 DerivativesUseDummy_{it} + \beta_2 MarketConditions_{it} + \beta_3 (DerivativesUseDummy_{it} \times MarketConditions_{it}) + \beta_4 FirmSize_{it} + \beta_5 Leverage_{it} + \beta_6 FirmAge_{it} + \beta_7 ROA_{it} + \beta_8 PBRatio_{it} + \beta_9 CurrentRatio_{it} + \beta_{10} RevenueGrowth_{it} + \beta_{11} R\&DExpenseRatio + \beta_{12} CFRati + \alpha_i + \gamma_t + \epsilon_{it}$$

Random Effects Model (For Hypothesis 2):

$$FinancialExpenseRatio_{it} = \beta_0 + \beta_1 DerivativesUseDummy_{it} + \beta_2 MarketConditions_{it} + \beta_3 (DerivativesUseDummy_{it} \times MarketConditions_{it}) + \beta_4 FirmSize_{it} + \beta_5 Leverage_{it} + \beta_6 FirmAge_{it} + \beta_7 ROA_{it} + \beta_8 PBRatio_{it} + \beta_9 CurrentRatio_{it} + \beta_{10} RevenueGrowth_{it} + \beta_{11} R\&DExpenseRatio + \beta_{12} CFRatio + \alpha_i + \gamma_t + \epsilon_{it} + \mu_i$$

Where:

$\boldsymbol{FinancialExpenseRatio_{it}}$ represents the Financial Expense' Ratio of firm i at time t.

$\boldsymbol{DerivativesUseDummy_{it}}$ represents the usage of financial derivatives. If the firm uses interest rate derivatives during the observation period, the variable is assigned a value of 1;

otherwise, if the enterprise does not use it, the variable is assigned a value of 0.

$\boldsymbol{DerivativesUseDummy_{it} \times MarketConditions_{it}}$ is the interaction term used to assess how market conditions affect the effectiveness of interest rate derivatives in financial risk management.

$\boldsymbol{FirmSize_{it}}$ is the logarithm of total assets.

$\boldsymbol{FirmAge_{it}}$ is the age of company i in year t, which is calculated by subtracting the year of incorporation from year t.

$\boldsymbol{Leverage_{it}}$ is the leverage ratio which is the ratio of total liabilities to total assets.

$\boldsymbol{ROA_{it}}$ represents Return on Assets of firm i in year t. It is a key metric of firms financial performance.

$\boldsymbol{PBRatio_{it}}$ is the price-to-book ratio of firm i at year t. It is calculated by dividing the market price per share of a company's stock by its book value per share.

$\boldsymbol{CurrentRatio_{it}}$ represents the current ratio of firm i at year t. It is the ratio of current assets to current liabilities.

$\boldsymbol{RevenueGrowth_{it}}$ represents he revenue growth rate of firm i at year t.

$\boldsymbol{R\&DExpenseRatio}$ is the R&D spending ratio of firm i at year t. It is the ratio of R&D expenses to total revenue.

$\boldsymbol{CFRatio}$ represents the cash flow ratio of firm i at year t. It is the ratio of operating cash flow to total assets.

$\boldsymbol{\alpha_i}$ represents industry fixed effects to control for all industry-related unobserved factors that may vary across industries but are constant for all companies in the same industry.

$\boldsymbol{\gamma_t}$ **r**epresents year fixed effects to control for all time-related external influences, such as macroeconomic conditions, policy changes, etc., which affect companies in all industries.

$\boldsymbol{\epsilon_{it}}$ is the error term.

$\boldsymbol{\mu_i}$ is the random effect assumed to be uncorrelated with the explanatory variables.

6.3 Definition and Measurement of Variables

6.3.1 Dependent Variable

As far as the hypotheses of this study and based on previous research and relevant theories, we employ the Financial Expense Ratio as the dependent variable to measure the effect of non-financial enterprises using derivatives to manage interest rate risk. The Financial Expense Ratio is the proportion of a company's financial expenses to its operating income,

and its calculation formula is as follows:

$$\textbf{Financial Expense Raio}_{\textbf{it}} = \textbf{Financial Expense}_{\textbf{it}} / \textbf{Operating Income}_{\textbf{it}}$$

Where:

$\text{Financial Expense Ratio}_{it}$ represents the financial expense (e.g. interest expense, bank charges, amortization of financial costs) of firm *i* in year *t*.

$\text{Operating Income}_{it}$ represents the profit earned from core business operations of firm *i* in year t.

Financial expenses primarily consist of interest expenses and other funding costs, with interest expenses being a significant factor influencing a company's financial expenses (Chen, 2016). Thus, the Financial Expense Ratio not only directly shows the impact of interest rate changes on a company's financial burden but also indirectly reflects the effectiveness of the company's risk management using interest rate derivatives. Additionally, according to perspective from Luo (2011), from a financial risk management perspective, a higher Financial Expense Ratio often indicates that a company needs a larger proportion of its income to pay debt interest, which may suggest lower capital use efficiency and potentially greater financial pressure in high-interest environments or volatile market conditions. Conversely, a lower Financial Expense Ratio usually signifies that a company has a stronger ability to pay interest and a lower financial risk exposure.

Furthermore, companies manage interest rate risks by using derivatives such as interest rate swaps and options, which can effectively control fluctuations in financial costs due to market interest rate volatility, thereby maintaining or reducing the Financial Expense Ratio (Li, 2007). According to Zhou and Li (2008), interest rate swaps allow companies to lock in interest rates for a future period, which can significantly reduce the fluctuation of interest costs caused by market rate changes, thereby reducing corporate financial risk. This method not only helps companies stabilize or reduce their Financial Expense Ratio but also enhances their financial flexibility to cope with market uncertainties. As China's interest rate market reforms deepen, frequent and significant fluctuations in interest rates have become the norm. Zhang and Yan (2008) point out that the first step in managing interest rate risk is to accurately measure the interest rate risk exposure in the corporate financial statements and to control these risks using appropriate technical methods, among which financial derivatives serve as an efficient strategy. Within this framework, the Financial Expense Ratio serves as a

crucial indicator to assess the impact of interest rate changes on corporate finances. This ratio vividly demonstrates the financial burden enterprises bear due to interest rate fluctuations, thereby reflecting their debt servicing capability and financial health. The use of derivatives can stabilize or reduce financial expenses related to interest payments, and by monitoring changes in the Financial Expense Ratio, companies can effectively evaluate the effectiveness of their interest rate risk management strategies, thereby taking appropriate measures to ensure financial stability. Thus, employing the Financial Expense Ratio as the dependent variable provides a solid empirical foundation for our hypothesis, evaluating the application effects of derivatives in managing interest rate risk.

6.3.2 Independent Variable

This study employs Derivatives Use Dummy as independent variable. We define the use of interest rate derivatives as a dummy variable to indicate whether a company engages in interest rate risk management through instruments such as interest rate swaps, options, and futures. This variable is assigned a value of 1 to denote the use of derivative products and 0 for non-use, thus forming a treatment group (companies using interest rate derivatives) and a control group (companies not using these instruments). The purpose of introducing this variable is to analyze whether companies using these financial tools have superior financial performance and risk management capabilities compared to those that do not.

6.3.3 Moderator Variable

Considering the significant changes and turbulence in the Chinese financial market from 2017 to 2022, including adjustments in monetary policy, the US-China trade war, deepening of interest rate marketization, and economic instabilities due to the global pandemic, we have chosen the annualized volatility of the Shanghai Interbank Offered Rate (SHIBOR[5]) as the independent variable to measure market conditions. SHIBOR, as the benchmark interest rate of China's money market, is widely recognized for its stability, market representativeness, and benchmarking capabilities (Xiang & Li, 2014). Its volatility reflects the overall liquidity conditions of the Chinese financial market and market participants' expectations for future

[5] The Shanghai Interbank Offered Rate (SHIBOR), calculated, published, and named by the National Interbank Funding Center in Shanghai as its technical platform, is an arithmetic average interest rate determined by the quoted rates from a group of banks with high credit ratings. It is a simple interest rate, unsecured, and wholesale rate. Since its launch on January 4, 2007, SHIBOR has become an important benchmark interest rate in China's financial market. The market representativeness, benchmark nature, and stability of SHIBOR are its core attributes as a benchmark rate in the money market.

economic and policy environments (Xiang & Li, 2014). Based on the daily data of SHIBOR collected from 2017 to 2022, we calculate the log returns between consecutive days. Subsequently, we compute the standard deviation of these daily log returns to obtain daily volatility. Finally, the daily volatility is converted into annualized volatility by multiplying by the square root of 252 (the number of trading days in a year). The use of SHIBOR's annualized volatility provides a quantified measure of market conditions for this study, thereby supporting the analysis of the effectiveness of risk management with interest rate derivatives under various market conditions.

6.3.4 Control Variables

In this study, several control variables are incorporated to ensure a comprehensive evaluation of the factors influencing the financial expense ratio among non-financial firms in China. These variables include firm size, leverage, firm age, return on assets (ROA), price-to-book ratio (PB Ratio), current ratio, revenue growth, R&D expense ratio, and cash flow ratio. Each variable is selected based on its relevance and potential impact on the dependent variable, ensuring a robust model specification.

Firm size is measured by taking the logarithm of a firm's total assets, which is included to control for the effects of company scale on financial management and risk exposure. Larger firms may have better access to capital markets and more sophisticated risk management tools (Deng et al., 2018). This potentially influencing their financial expense ratio.

Leverage measures the proportion of debt in a firm's capital structure. Higher leverage indicates a greater reliance on debt financing, which may affect the firm's risk profile and its ability to manage interest rate risks effectively（Gong, 2007).

Firm Age is considered to account for the maturity of the company. Older firms might have more established relationships with banks and financial institutions, possibly leading to more favorable terms in derivative transactions and other financial activities (Loderer & Waelchli, 2015).

Return on Assets (ROA) indicates how efficiently a company converts its investments into profits. This efficiency affects how a company manages its finances, including interest rate

risk. High ROA means that the company can effectively use its assets to generate profits, which may reduce dependence on external financing and lower financial expense ratios (Modigliani & Miller, 1958).

Price-to-Book Ratio (PB Ratio) reflects the market's valuation of a company relative to its book value. Variations in this ratio might influence a firm's strategic decisions, including those related to risk management practices.

Current Ratio is a measure of liquidity and indicates a firm's ability to meet short-term obligations. Higher liquidity might reduce the need for external financing, thereby influencing the financial expense ratio.

Revenue Growth serves as an indicator of the firm's economic performance. Fast-growing companies may require more capital to support their expansion and therefore may seek more external financing, increasing financial risks.

R&D Expense Ratio is included to explore the impact of investment in innovation on financial stability and risk management. Companies that invest heavily in R&D may face different financial pressures that affect their risk management (Ho et al., 2004). Investment in R&D can improve a company's innovation capabilities and competitive advantage, but it may also increase its financial burden in the short term.

Cash Flow Ratio measures the financial fluidity of a company and its capacity to generate cash to meet obligations, which is crucial for maintaining stability in the face of financial market fluctuations.

These control variables are included to provide a comprehensive understanding of how they individually and collectively affect a company's financial management and risk exposure.

6.3.5 Interaction Term

To assess the effectiveness of interest rate derivatives in managing interest rate risks and the moderating role of market conditions, this study constructs an interaction term between the dummy variable for derivatives use and market conditions (i.e. the annualized volatility of

SHIBOR) as the moderating variable. Research by Kapitsinas (2008) and Sahoo (2015) indicates that changes in market conditions, including regulatory reforms and economic cycles, significantly impact the utilization and effectiveness of derivatives. Interest rate derivatives, such as swaps or options, are commonly used to hedge against interest rate risks, but their effectiveness can be influenced by fluctuations in market interest rates.

By exploring the coefficients of the interaction term, this study aims to validate whether market conditions influence the effectiveness of derivatives in managing interest rate risks for non-financial companies. Particularly in China, an emerging market with evolving economic and financial systems, especially during the period of high volatility from 2017 to 2022, these external conditions may affect the effectiveness of derivatives in managing interest rate risks.

6.4 Propensity Score Matching

To ensure a balanced structure of the panel dataset and to minimize selection bias, this study employs the Propensity Score Matching (PSM) method to systematically match companies that use interest rate derivatives with those that do not. This method involves estimating the probability of each sample using derivatives—i.e., the propensity score—and using this score to pair companies that use and do not use interest rate derivatives, ensuring comparability on multiple key covariates between the two groups. This matching process not only helps control for potential observable confounding factors, thereby avoiding selection bias, but also addresses endogeneity issues arising from sample selection to a certain extent. Through these rigorous data processing steps, we have obtained a carefully screened and matched final sample set, which is intended to provide a more accurate and reliable data foundation for subsequent empirical analysis.

6.5 Statistical Tests and Model Diagnostics

In the statistical tests and model diagnostics section of this study, we systematically undertook multiple steps to ensure the reliability and accuracy of our analysis. Initially, faced with multiple panel data models to choose from, we used the Hausman test to decide whether to use a fixed effects model or a random effects model. This test helped us assess whether there is a systematic difference between the coefficients of the fixed and random effects models, allowing us to select the most suitable model to describe our data (Hausman, 1978).

Secondly, to enhance the robustness of our models, we conducted two important robustness checks: firstly, incrementally adding control variables to systematically assess the impact of each control variable on the main results; secondly, lagging key explanatory variables by one and two year to explore potential dynamic relationships between variables and to mitigate possible issues of reverse causality. Regarding heteroscedasticity, we employed White's test to diagnose the presence of heteroscedasticity within the regression models. This step was crucial as heteroscedasticity can lead to inaccurate standard error estimates, thereby affecting the validity of inferential statistics (White, 1980). Furthermore, to detect potential first-order autocorrelation within the models, we utilized the Wooldridge test. This test is particularly suitable for panel data, helping us to ascertain the presence of autocorrelation in time-series data, thus ensuring the consistency and efficiency of model estimates (Wooldridge, 2010).

7. Empirical Analysis

7.1 Propensity Score Matching (PSM) Analysis

The propensity score matching (PSM) results in Table 5 can provide a preliminary understanding of the impact of the use of derivatives on the financial expense ratio of Chinese non-financial companies. According to Table 5, it can be seen that before matching, the financial expense rate of the treatment enterprise is 0.013574282, while the financial expense rate of the control enterprise is slightly lower, 0.012286207. The Average Treatment on the Treated (ATT) value of -0.002926804 (with a standard error of 0.00071286) and a T-statistics (Tstat) of -4.11 clearly indicates that, post-matching, the treated firms (those using derivatives) experienced a significant reduction in financial expenses compared to what they would have incurred without derivatives. This outcome initially supports the hypothesis that derivatives use is effective in managing financial costs related to interest rate fluctuations.

Furthermore， according to Table 6 and Graph 1, it can be seen that matching successfully reduces the deviation of key variables such as ROA, company age, and company size (as shown by the deviation reduction percentage and t-statistics), which indicates that the PSM technique effectively balances the treatment groups. and control groups to make them comparable for further analyses. Additionally, financial indicator variables such as firm size (FirmSize) and leverage (Lev) are crucial because they directly influence financial strategy and risk management capabilities. The substantial bias reduction in these variables post-matching confirms that the matched groups are homogeneous in terms of size and leverage, thus isolating the effect of derivatives use.

It can also be seen intuitively from Graph 1 that the deviations of all covariates are significantly reduced after matching. Points (asterisks) for matched data are closer to the zero line than points for unmatched data (points), indicating that the matching process is effective. Graph 2 shows a good overlap in the propensity scores between treated and untreated groups post-matching, which is crucial for a valid causal inference. The substantial part of the distribution is centered around similar scores, with about 65% of untreated on support, suggesting that a large portion of control units had a counterpart in the treated group that was

quite similar. Graph 3 shows the distribution curves before and after matching. There are significant differences between the treatment group and the control group before matching, and they converge after matching. And there is considerable overlap between the matched curves, which validates the effectiveness of matching in creating comparable groups.

7.2 Panel Regression Results

This study explore the effectiveness of Chinese non-financial firms' use of derivatives for interest rate risk management and the moderating effect of market conditions on its impact through a panel data regression model. All panel regression results are presented in Table 4 .

Firstly, to explore Hypothesis 1, this study employed Pooled OLS models (Models A to C) and a Fixed Effects model (Model D). From Model A to Model C, as control variables are progressively added, it allows us to observe how the coefficients and significance of the main explanatory variable, the Financial Expense Ratio (FinExpRatio), change under different layers of control. This approach helps to ensure the stability of the main explanatory variable's impact, minimizing bias from omitted variables, and by comparing the coefficients and statistical significance across different models, it enhances the robustness of the regression results. In the Pooled OLS models, the initial coefficient of the independent variable DerivativesUse (0.001** in Model A) indicates a slight positive correlation with the financial expense ratio, possibly reflecting the initial direct cost impact. However, as more control variables are introduced (Models B and C), the coefficient of DerivativesUse turns negative (-0.004 and -0.003, respectively), and the p-values are both less than 0.01, whitch shows that the use of derivatives actually helps to reduce the financial expense ratio after controlling for other factors, a result that supports Hypothesis 1.

Furthermore, the Fixed Effects model (Model D) is utilized to control for potential unobserved individual heterogeneity and time trends, making the negative impact of DerivativesUse on FinExpRatio (-0.003***) in the regression results more robust, further validating the significant effect of using derivatives to reduce interest rate risk. This strongly supports Hypothesis 1, indicating that after controlling for endogeneity, the use of derivatives effectively lowers the financial costs associated with interest rate risks.

For Hypothesis 2, Model E introduces the market conditions variable (MktCond) and its

interaction term with DerivativesUse (DerivativesUse*MktCond) to test if market conditions affect the efficacy of derivatives in managing interest rate risk. The regression results from Model E reveal that the interaction term coefficient between DerivativesUse and MktCond is 0.001***, directly validating Hypothesis 2. This finding suggests that as market volatility increases, the effectiveness of derivatives in reducing interest rate risk becomes more pronounced.

7.3 Results Interpretation and Discussion

This section synthesizes our empirical analysis of the effectiveness of derivatives in managing interest rate risks among non-financial Chinese firms and how external market conditions may moderate this effectiveness. We integrate the panel regression results with theoretical and empirical insights from previous literature, offering a detailed and holistic perspective on the role and strategic use of derivatives in non-financial corporate risk management.

Our study's findings for Hypothesis 1 show that the use of derivatives is indeed positively correlated with effective interest rate risk management, as derivatives significantly lower the financial expense ratios of non-financial firms. This reduction in finance-related costs associated with interest rate fluctuations confirms the protective value of derivatives, consistent with earlier theories and research, such as those by Black & Scholes (1973), Titman (1992), and Frisancho-Mariscal & Howells (2009). Specifically, the regression results from Models A to D demonstrate that initially, in Model A, the coefficient for DerivativesUse is positive, suggesting that derivatives slightly increase financial costs, likely reflecting the direct costs of implementing derivative strategies. However, as more control variables are introduced in Models B and C, the coefficient for DerivativesUse turns negative, indicating that derivatives significantly alleviate financial expenses. This suggests that when effectively used within a comprehensive risk management framework, derivatives can mitigate the financial burdens associated with interest rate volatility. The negative coefficients in Models B, C, and particularly the fixed effects Model D, which controls for unobserved individual heterogeneity, provide robust empirical support for Hypothesis 1. This confirms the effectiveness of derivatives as crucial strategic tools within corporate financial risk management strategies, in line with the theoretical insights from Black & Scholes (1973) who postulated that derivatives as risk management tools aim to minimize the volatility of

financial costs associated with financial liabilities.

For Hypothesis 2, the interaction term included in Model E offers deeper insight into how external factors influence the effectiveness of derivatives. The significant positive coefficient of the interaction term DerivativesUse*MktCond confirms Hypothesis 2, indicating that the effectiveness of derivatives in reducing financial expense ratios is enhanced under volatile market conditions. This result echoes the dynamics discussed by Vega-Gutierrez and Rodriguez-Sanz (2022), who emphasized how external economic and policy changes significantly impact corporate financial strategies. Additionally, this aligns with Frisancho-Mariscal & Howells (2009) who highlighted how adjustments in monetary policy can trigger rapid changes in market rates, affecting all interest rate-dependent financial instruments.

The regression results for Hypothesis 2 support the view that under more volatile market conditions, the strategic use of derivatives becomes even more crucial as they enable firms to more effectively navigate the uncertainties of interest rate fluctuations. This insight builds on the research by Arize et al. (2013), who connected macroeconomic factors such as GDP growth and inflation rates to the interest rate risk premium, highlighting how external economic conditions can influence internal corporate risk management strategies. Similarly, our findings are consistent with the theoretical models proposed by Black and Scholes (1973), where the value of derivatives as risk management tools increases with their ability to hedge against market volatilities. This result emphasizes the dynamic nature of financial markets and the critical role that macroeconomic environments play in determining the effectiveness of financial instruments. As studies by Lee (2019) and Pyeman et al. (2019) point out, the impact of derivatives varies with market conditions and regulatory environments.

Additionally, the timeframe we selected for our study encompasses significant events such as the COVID-19 pandemic and the US-China trade war. These events have undoubtedly impacted financial markets and the use of financial derivatives. Therefore, we controlled for the macroeconomic changes experienced by all sample companies during this period by introducing time fixed effects into our regression model. This approach allows us to isolate the impact of these events on the use of financial derivatives, making our analysis more accurate and meaningful.

In summary, this study provides strong empirical evidence for the strategic use of derivatives in managing interest rate risks among non-financial firms in China. Moreover, the results indicate that while derivatives are effective in managing interest rate risks, their efficacy also depends to an extent on current market conditions and the consistency of the company's risk management strategies with these financial tools. This is in line with the broader discourse in financial literature that the strategic application of financial derivatives is crucial for navigating the complexities of global financial markets (Stulz, 2004; Bodnar et al., 2008; Hull, 2016; Lee, 2019). Therefore, this study not only supports the theoretical propositions regarding the efficacy of derivatives usage but also enriches the understanding of how external market conditions modulate their impact.

Furthermore, the results also contribute to ongoing discussions about the regulatory and strategic frameworks required for the effective use of financial derivatives. As Stulz (2004) indicated, although derivatives offer significant benefits in terms of risk management, they also require complex frameworks to ensure their efficacy and mitigate potential systemic risks. By linking empirical data with theoretical insights and prior research, this study helps deepen our understanding of the practical roles of financial derivatives in financial risk management within non-financial companies, providing valuable insights for practitioners and policymakers in emerging markets.

7.4 Hausman Test

As shown in Table 3, the Hausman test yields a significant chi-squared value of 2328.36, which robustly indicates systematic differences between the fixed effects (FE) and random effects (RE) models, particularly in the influence of variables such as DerivativesUse, ROA, FirmAge, and FirmSize on financial expense ratios. Notably, the difference in coefficients for DerivativesUse between FE and RE models is 0.0012123 with a standard error of 0.0001858, highlighting a substantial discrepancy that decisively supports the use of the fixed effects model for our analysis.

The presence of significant differences, such as a 0.0082801 change in ROA with a standard error of 0.0006974 and a 0.0103533 difference in FirmAge with a standard error of 0.0013359, suggests that individual-specific effects are indeed correlated with the predictors in our model. This correlation justifies the need for controlling these individual-specific

effects to avoid biased results. Furthermore, fixed effects models are particularly adept at handling unobserved heterogeneity when such heterogeneity is correlated with independent variables over time (Hausman, 1978). This methodological choice allows us to effectively control for unobserved heterogeneity, ensuring that our analysis captures the intrinsic impacts of derivatives usage, accurately adjusted for firm-specific characteristics.

7.5 Robustness Checks

In this study, to ensure the robustness and reliability of the empirical results, we employed two main methods for robustness checks: the method of gradually increasing control variables and the analysis of lagged effects. These methods are essential in addressing potential endogeneity issues and assessing the temporal stability of the effects of derivatives use on financial expense ratios.

First, in the panel regression process, this study used a stepwise addition of control variables, as demonstrated from Model A to Model C in Table 4. This method allowed us to closely observe how the impact of derivatives use (DerivativesUse) on the financial expense ratio (FinExpRatio) changes when controlling for variables at different levels. Additionally, to further verify the enduring effect of derivatives use over time, we conducted robustness checks for lagged effects (Table 7). Models F and G considered one-year (L1_DerivativesUse) and two-year lagged effects (L2_DerivativesUse) of derivatives use, respectively. The negative coefficient of one-year lagged derivatives use in Model F (-0.003***) indicates that the use of derivatives in the previous year significantly reduces the current financial expense ratio, and the two-year lagged effect in Model G also shows a negative impact (-0.002**), further confirming the persistent effect of derivatives use in reducing financial costs.

The robustness checks confirm that the negative impact of derivatives use on the financial expense ratio is not due to omitted variable bias or model specification errors. The consistent negative coefficients of derivatives use across different model specifications and the introduction of lagged effects strengthen the credibility of the study's results.

7.6 Heteroskedasticity Test

In the heteroskedasticity tests for this study, we initially employed White's Test to diagnose

the presence of heteroskedasticity in our regression models. As shown in Table 8, the White's Test results in a very high chi-squared value (2790.42) with a P-value less than 0.0001, compelling us to reject the null hypothesis of homoscedasticity and confirm the presence of heteroskedasticity.

To further dissect the nature of heteroskedasticity, we incorporated Cameron & Trivedi's decomposition of the IM-test, which examines not only the model's heteroskedasticity but also tests for skewness and kurtosis in the data (Cameron & Trivedi, 2005). As presented in Table 9, the chi-squared test results for all three components exhibit extremely low P-values (all at 0.0000), reaffirming the presence of heteroskedasticity and suggesting that the non-normal distribution of data could partly account for this issue.

Given these significant findings of heteroskedasticity, to ensure the robustness and accuracy of the regression analysis, this study employs robust standard errors across all panel regression analyses. This method not only corrects for the impacts of heteroskedasticity but also ensures the validity of statistical inferences despite violations of model assumptions. Using robust standard errors is a widely accepted approach to address regression model heteroskedasticity, enhancing the credibility of the model results and the feasibility of policy recommendations. This approach ensures the rigor and applicability of the research findings.

7.7 Autocorrelation Test

In this study, the Wooldridge test for autocorrelation in panel data was employed to detect the presence of first-order autocorrelation within the residual terms of our regression models. As shown in Table 10, the F-statistic is significantly high at 152.264, and the p-value is less than 0.0001, leading us to reject the null hypothesis of no first-order autocorrelation.

The presence of autocorrelation in panel data can severely distort the efficiency of the estimators and potentially lead to misleading inference, as standard errors could be underestimated (Wooldridge, 2010). To address this issue and ensure the robustness of the regression results, robust standard errors have been utilized throughout the analysis. The application of robust standard errors mitigates the impact of autocorrelation by adjusting the variance estimates of the regression coefficients, thereby providing more reliable statistical inferences and enhancing the credibility of the study's conclusions. This method is critical in

maintaining the integrity and validity of the econometric analysis, especially when dealing with panel data that could be susceptible to time-related serial correlations (Wooldridge, 2010).

7.8 Limitations

This study explores the effectiveness of the use of financial derivatives for interest rate risk management among non-financial companies in China and the moderating role of market conditions. Although this study provides insights into highly volatile market conditions based on data from 2017 to 2022, its applicability may be limited by the temporal scope and geographical characteristics of the data. Additionally, although the study employed fixed effects models and compared these with pooled OLS models as a baseline, these models assume linear relationships between variables, which may not capture more complex dynamics or potential nonlinear interactions among variables. Furthermore, the generalizability of the findings might be limited to China, and differences in market structures and regulatory environments across different countries and regions could lead to different conclusions. Lastly, despite efforts to control for various potential confounders, the interference of unobserved variables may still affect the accuracy of the results' interpretation. Therefore, it is recommended that future research should expand the range of data, employ more complex models, and explore additional emerging markets to enhance the robustness and applicability of the findings.

8. Conclusion

This study has provided a comprehensive examination of the use of financial derivatives for interest rate risk management among non-financial companies in China, highlighting their effectiveness in mitigating the impacts of volatile market conditions. The empirical analysis has confirmed that derivatives significantly reduce financial expense ratios, particularly when markets are unstable. This underscores their strategic value in corporate financial management, where they serve as crucial tools for shielding companies from the adverse effects of interest rate fluctuations.

The findings suggest that derivatives are not just defensive mechanisms but integral components of a proactive financial strategy, especially in emerging markets characterized by rapid economic changes and financial instability. By effectively employing derivatives, companies can stabilize their financial expenses, enhancing their overall financial stability. This is particularly important in China, where economic transitions can influence market conditions swiftly and unpredictably.

For practitioners, the study advocates a more integrated approach to using financial derivatives within risk management strategies. This involves tailoring derivative strategies to align with both current market conditions and predictive economic trends, thereby optimizing their protective benefits. Furthermore, the insights from this research should encourage policymakers to develop regulatory frameworks that support informed and transparent derivative use. Such policies could include educational initiatives and guidelines that aid non-financial firms in understanding and leveraging derivatives effectively.

However, the research is not without limitations. The focus on Chinese non-financial firms means the findings may not be directly applicable to firms in other sectors or regions without additional analysis. Future studies could broaden the scope of research to different sectors and more diverse economic settings to verify and extend these findings. Additionally, employing advanced econometric models to explore potential non-linear interactions and dynamic effects could provide deeper insights into the long-term impact of derivatives on corporate financial strategies.

In conclusion, this thesis underscores the critical role of financial derivatives in enhancing the financial resilience of non-financial firms against economic shocks and interest rate risks, particularly in the complex landscape of emerging markets. The careful management and strategic application of these instruments are vital, aligning short-term financial management with long-term corporate objectives to bolster economic stability and growth.

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Appendices

Table 1 - Summary Statistics (Before Matching)

Variables	Obs	Mean	SD	Min	Median	Max
FinExpRatio	14436	0.012	0.028	-0.048	0.007	0.152
DerivativesUse	14436	0.136	0.343	0.000	0.000	1.000
ROA	14436	0.040	0.061	-0.225	0.039	0.209
FirmAge	14436	2.974	0.283	2.197	2.996	3.526
FirmSize	14436	22.375	1.288	20.128	22.210	26.369
Lev	14436	0.409	0.184	0.069	0.406	0.837
PB	14436	3.040	2.377	0.537	2.366	14.424
CurrentRatio	14436	2.330	1.933	0.373	1.701	11.777
RevenueGrowth	14436	0.235	0.517	-0.640	0.113	2.947
RDExpenseRatio	14436	0.036	0.042	0.000	0.029	0.218
CFRatio	14436	0.108	0.142	-0.303	0.093	0.618

Table 2 - Summary Statistics (After Matching)

Variables	Obs	Mean	SD	Min	Median	Max
FinExpRatio	7268	0.015	0.029	-0.048	0.008	0.152
DerivativesUse	7268	0.269	0.444	0.000	0.000	1.000
ROA	7268	0.036	0.060	-0.225	0.035	0.209
FirmAge	7268	2.998	0.275	2.197	3.045	3.526
FirmSize	7268	22.721	1.375	20.128	22.526	26.369
Lev	7268	0.450	0.183	0.069	0.452	0.837
PB	7268	2.862	2.368	0.537	2.167	14.424
CurrentRatio	7268	1.996	1.605	0.373	1.522	11.777
RevenueGrowth	7268	0.208	0.474	-0.640	0.103	2.947
RDExpenseRatio	7268	0.037	0.043	0.000	0.030	0.218
CFRatio	7268	0.107	0.138	-0.303	0.090	0.618

Table 3- Hausman Test

	---- Coefficients ----			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	FE	RE	Difference	Std. err.
DerivativesUSe	.0000139	-.0011984	.0012123	.0001858
ROA	-.049678	-.0579582	.0082801	.0006974
FirmAge	-.0197591	-.0094058	-.0103533	.0013359
FirmSize	-.000887	-.0001909	-.0006961	.0004795
Lev	.0629197	.0605076	.0024121	.0011358
PB	.0003344	.0001012	.0002332	.0000343
CurrentRatio	.0001162	-.0003694	.0004856	.0000648

RevenueGrowth	-.0008797	-.0010928	.0002131	.0000792
RDExpenseRatio	-.0095798	-.0421638	.032584	.0028216
CFRatio	.0100691	.0171968	-.0071278	.0002447

b = Consistent under H0 and Ha; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.
Test of H0: Difference in coefficients not systematic
chi2(10) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 2328.36
Prob > chi2 = 0.0000

Table 4 - All Regression Results

Variables	(1) Model A (PooledOLS) FinExpRatio	(2) Model B (PooledOLS) FinExpRatio	(3) Model C (PooledOLS) FinExpRatio	(4) Model D (FE) FinExpRatio	(5) Model E (FE) FinExpRatio
DerivativesUse	0.001**	-0.004***	-0.003***	-0.003***	-0.005***
	(2.084)	(-6.318)	(-5.768)	(-4.962)	(-5.481)
ROA		-0.071***	-0.102***	-0.090***	-0.090***
		(-18.264)	(-22.097)	(-20.386)	(-11.389)
FirmSize		0.001***	-0.001***	-0.001***	-0.001**
		(5.507)	(-2.602)	(-5.250)	(-3.223)
Lev		0.061***	0.059***	0.064***	0.063***
		(40.602)	(28.844)	(30.824)	(34.698)
FirmAge			-0.002***	-0.001	-0.002*
			(-2.715)	(-0.959)	(-2.189)
PB			-0.000**	-0.000***	-0.000
			(-2.276)	(-3.029)	(-1.026)
CurrentRatio			-0.001***	-0.001***	-0.001**
			(-8.055)	(-5.387)	(-3.391)
RevenueGrowth			-0.002***	-0.002***	-0.002***
			(-4.254)	(-4.639)	(-4.627)
RDExpenseRatio			-0.052***	0.004	-0.016
			(-10.414)	(0.606)	(-1.310)
CFRatio			0.053***	0.039***	0.040***
			(20.968)	(16.622)	(14.938)
MktCond					-0.001
					(-0.877)
DerivativesUse* MktCond					0.001***
					(5.972)
_cons	0.012***	-0.035***	0.010**	0.026***	0.022*
	(48.703)	(-8.046)	(2.263)	(5.298)	(2.532)
N	14436	14436	14436	14436	14436
R^2	0.000	0.250	0.328	0.395	0.386
Year Control	NO	NO	NO	YES	YES
Industry Control	NO	NO	NO	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 - Propensity Score Matching (PSM) Results

Variable	Sample	Treated	Controls	Difference	S.E.	Tstat
FinExpRatio	Unmatched	.013574282	.012286207	.001288076	.000674629	1.91
	ATT	.013574282	.016501086	-.002926804	.00071286	-4.11
	ATU	.01235525	.010458988	-.001896262	.000612189	-3.10

Table 6 - Covariates Balance Before and After Matching

	Unmatched	Mean			%reduce bias			
Variable	Matched	Treated	Control	%bias		t stat	p>t	V(C)
ROA	U	0.03575	0.04023	-7.7		-3	0.003	0.76*
	M	0.03575	0.03545	0.5	93.3	0.16	0.871	0.79*
FirmAge	U	2.9997	2.9701	10.6		4.33	0	0.95
	M	2.9997	3.0085	-3.1	70.5	-1	0.318	1.02
FirmSize	U	22.887	22.294	43.7		19.16	0	1.38*
	M	22.887	22.891	-0.3	99.2	-0.1	0.923	0.98
Lev	U	0.46491	0.40028	35.8		14.56	0	0.93
	M	0.46491	0.46143	1.9	94.6	0.6	0.55	0.90*
PB	U	2.8036	3.0767	-11.7		-4.73	0	0.89*
	M	2.8036	2.7962	0.3	97.3	0.1	0.92	0.89*
CurrentRatio	U	1.9035	2.3967	-27.9		-10.54	0	0.59*
	M	1.9035	1.9152	-0.7	97.6	-0.24	0.813	0.94
RevenueGrowth	U	0.20093	0.24093	-8.1		-3.19	0.001	0.76*
	M	0.20093	0.20066	0.1	99.3	0.02	0.985	0.98
RDExpenseRatio	U	0.03743	0.03568	4.3		1.72	0.086	0.81*
	M	0.03743	0.03722	0.5	87.8	0.16	0.873	0.71*
CFRatio	U	0.10592	0.10876	-2.1		-0.82	0.412	0.74*
	M	0.10592	0.10678	-0.6	69.9	-0.2	0.841	0.77*

Table 7 - Robustness Check: Lagged Effects

	(1)	(2)
	Model F (FE)	Model G (FE)
	FinExpRatio	FinExpRatio
L1.DerivativesUse	-0.003***	-0.001
	(-4.440)	(-0.815)
L2.DerivativesUse		-0.002**
		(-2.131)
ROA	-0.089***	-0.096***
	(-19.480)	(-18.519)
FirmAge	-0.000	-0.000
	(-0.469)	(-0.438)
FirmSize	-0.001***	-0.001***
	(-4.949)	(-4.909)
Lev	0.065***	0.064***
	(28.292)	(24.492)
PB	-0.000***	-0.000**
	(-2.733)	(-1.993)
CurrentRatio	-0.001***	-0.001***
	(-6.159)	(-5.641)
RevenueGrowth	-0.002***	-0.002***
	(-4.249)	(-3.959)
RDExpenseRatio	0.011*	0.016**
	(1.699)	(2.248)
CFRatio	0.040***	0.040***
	(15.076)	(13.498)
_cons	0.022***	0.024***
	(3.982)	(3.821)
N	12030	9624
R^2	0.402	0.395
Year Control	YES	YES
Industry Control	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8 - White's Test

Null Hypothesis (H0)	Chi-squared	P-value	Decision
Homoskedasticity	2790.42	<0.0001	Reject H0

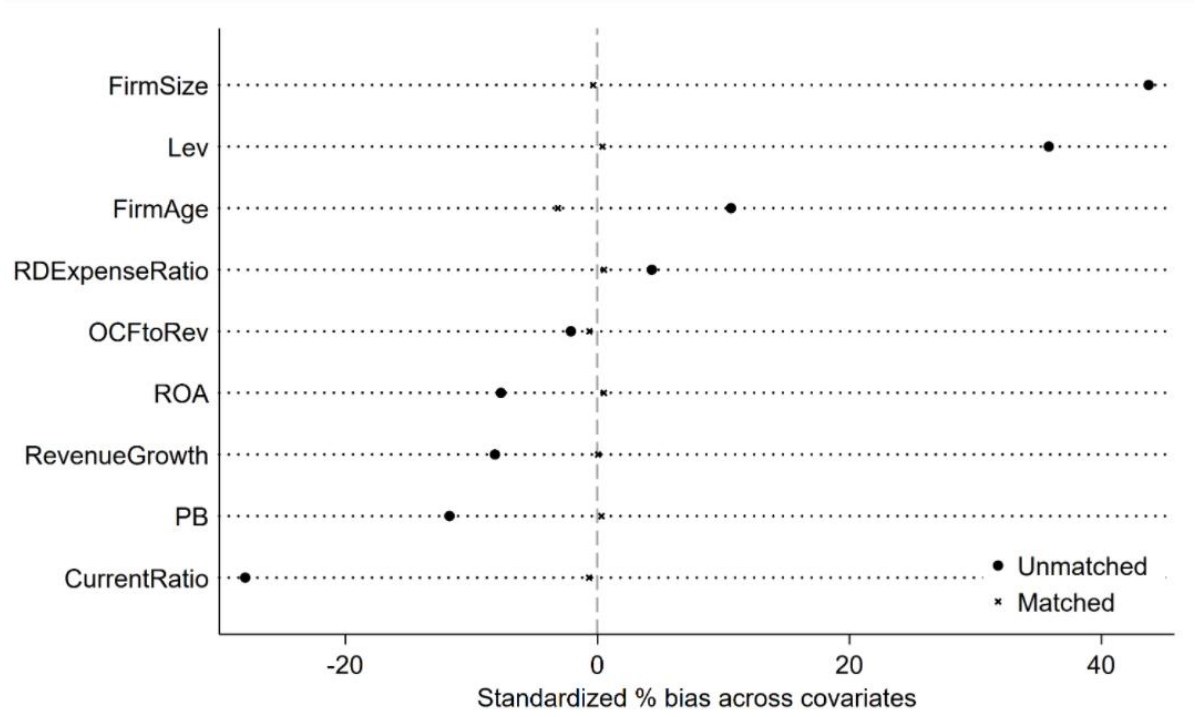
Table 9 - Cameron & Trivedi's Decomposition of IM-test

Source	chi2	df	P-value
Heteroskedasticity	2790.42	64	0.0000
Skewness	793.87	10	0.0000
Kurtosis	200.88	1	0.0000
Total	3785.16	75	0.0000

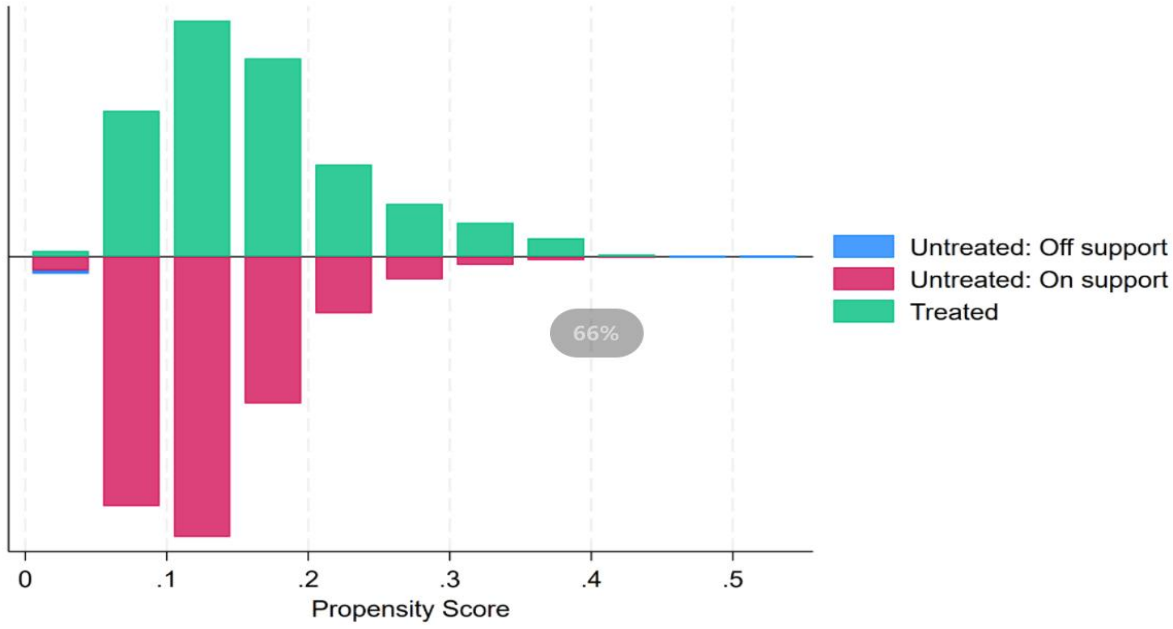
Table 10 - Woolridge Test for Autocorrelation in Panel Data

Null Hypothesis (H0)	F statistics	df1	df2	P-value	Decision
No first order autocorrelation	152.264	1	2405	<0.0001	Reject H0

Graph 1 - Standardized Percent Bias of Covariates Before and After Matching



Graph 2 - Propensity Score Distribution Histogram



Graph 3 - Propensity Score Distribution Before and After Matching