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Hedging with derivatives and firm value: The role of geographic diversification

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Abstract

This paper explores the relationship between geographical diversification and derivative hedging, as well as their impact on corporate value. We employed multivariate regression analysis using a sample of 211 publicly listed U.S. companies on the S&P 500 index from 2019 to 2023 to examine this relationship. Our focus is foreign exchange hedging and the interaction between hedging and firm value for diversified firms. However, interest rate and commodity risk are critical for diversified firms due to their impact on costs, financial performance, and market competitiveness, impacting the firm value. Thus, we control interest rate and commodity hedging as well as other variables, including cash ratio, firm size, leverage, growth opportunities, profitability, and dividends, to prevent research bias. Our findings suggest a positive effect between foreign exchange hedging and firm value, but negative effect between interest rate and commodity hedging and firm value which indicates that the effect of hedging on firm value depends on the categories of risk hedges. This implies that the foreign exchange hedging can enhance the firm value, but the interest rate and commodity hedging reduce the firm value. Lastly, this study finds evidence that diversification moderates the impact of foreign exchange hedging on firm value.

Keyword: Corporate risk management, Corporate hedging, Firm value, Foreign exchange hedging, Geographic diversification

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1. Introduction

1.1 Background

Over time, including during periods of financial and economic crises, firms have increasingly realized the importance of corporate risk management. As evidenced by prior research findings, risk management has been shown to contribute significantly to enhancing productivity (Cornaggia, 2011). Moreover, it plays a crucial role in mitigating underinvestment risks (Kristine W. Hankins & Gerard Hoberg, 2022) and can also optimize and reduce capital costs (Hann, Ogneva, and Ozbas, 2013). In a previous study, Bodnar et al. (2003) demonstrated that hedging influences firm value. Conversely, Aretz and Bartram (2009) utilized empirical evidence alongside detailed theoretical arguments to establish that hedging can indeed create corporate value. This is also one of the reasons why some companies favor using hedging for risk management, as it provides a reliable mechanism for price management and risk control. Moreover, hedging strategies can help corporate firms with long-term planning and establish strong partnerships with investors. Hedging can mitigate the impact of market fluctuations, interest rate changes, and currency fluctuations on risk exposure. By doing so, businesses can minimize financial risk and enhance their value.

Certainly, there are also studies indicating that hedging strategies may not influence the value of a company. Jin and Jorion (2006) discovered that there was no distinction between companies that hedged and those that did not. Fauver and Naranjo (2010) also demonstrated in their study that in situations of weak corporate governance and relaxed supervision, hedging strategies can even have a negative impact on firm value, thereby reducing it. Therefore, the research background of this article focuses on the changes in firm value under effective hedging strategies.

To a certain extent, effective hedging strategies can enhance investors' confidence in a company, making it more stable and sustainable, thereby increasing its value. Hedging can reduce capital costs by lowering financing costs. It also effectively improves the operational efficiency of enterprises, as companies can focus more on their core businesses, thereby enhancing production efficiency and market competitiveness. The study has classified hedging risk types into the following three categories: foreign exchange rates, interest rates, and commodity prices.

As the scale of non-financial companies expands, their geographical or international risks may decrease, as the impact of specific economic shocks on companies operating within a single city or country diminishes. However, multinational corporations can directly hedge cross-border currency price risks using standard foreign exchange derivative instruments, thereby mitigating currency risk when repatriating overseas income. Financial hedging involves issuing debt in foreign currencies, local currencies, or synthetic local currencies to reduce risk exposure, particularly for multinational corporations receiving income in foreign currencies. Previous literature suggests that diversification plays four important roles in hedging. Firstly, it can lower country-specific risks; John A Doukas and Ozgur B Kan (2006) show that geographical diversification can enhance firm value. Secondly, Allayannis, G., Ihrig, J., and Weston, J. P. (2001) find that geographically diversified firms have an advantage in hedging currency risks. Géczy, C., Minton, B. A., and Schrand, C. (1997) find that multinational corporations effectively manage foreign exchange risks and enhance financial stability through financial hedging instruments. Kim, W. C., and Hwang, P. (1992) demonstrate that geographical diversification can improve operational efficiency and competitiveness. Therefore, it can be inferred that integrating financial hedging plans with geographical diversification strategies is most effective, reducing exposure to country-specific risks through hedging and adjusting the scale of hedging with the level of risk exposure. As there is no empirical research exploring how geographical diversification moderates the relationship between hedging and firm value, this paper contributes to the literature by studying the impact of integrating geographical diversification with foreign exchange hedging on firm value.

1.2 Aim and Research Question

The aim of this study is to investigate the role of geographic diversification in the impact of hedging on companies, and in our model examination, we will also derive conclusions regarding the relationship between derivative hedging and firm value. Prior research has put forth conflicting theories on this issue. According to the Modigliani-Miller theorem and assuming the effectiveness of CAPM, investors can manage portfolio risk exposure in perfect markets, rendering hedging worthless. This implies that hedging adds no value to firms (Smith and Stulz, 1985). However, Froot et al. (1993) argue that hedging can help companies avoid underinvestment problems stemming from reduced cash flow volatility, thus retaining internal capital for favorable

investment opportunities. As operating in an imperfect capital market, expected derivative hedging is positively correlated with firm value. Furthermore, through a review of relevant literature on hedging strategies, it has been found that according to the study by Allayannis, Ihrig, and Weston (2001), multinational corporations can mitigate non-diversifiable exposures arising from any single country. Geographic diversification is even beneficial for multinational corporations as it helps avoid over-concentration in any one market, providing greater growth potential despite costs such as adverse currency fluctuations and political system instability. It can be inferred that the effect of geographic diversification is maximized when combined with financial hedging strategies. In this scenario, multinational corporations are expected to adopt more foreign exchange hedging strategies to mitigate losses associated with currency fluctuations when operating in multiple countries. Therefore, the impact of foreign exchange hedging will be more significant for multinational corporations with higher foreign income, and vice versa. Hence, we anticipate that geographic diversification will moderate the relationship between hedging and firm value.

How hedging with derivatives is related to firm value and what is the role of geographic diversification in such a relation?

1.3 Outline of the Thesis

The outline of the paper is as follows: the second section will review the existing literature, while the third section will provide the theoretical framework, discussing the impact of using derivative instruments for hedging and geographic diversification on firm value, and will present the two hypotheses of this study. The fourth section will describe the data collection process and the variables used. Additionally, this section will cover the empirical model and the econometric methods implemented. The fifth section will analyze the empirical results and conduct robustness tests. Finally, the sixth section will summarize the findings and offer suggestions for future research.

2. Related Literature

Despite the convincing economic arguments, the empirical evidence for the effect of hedging on firm value is mixed. Allayannis and Weston (2001) provide evidence of an increase in firm value (Tobin's Q) of almost 5%, on average, for firms using foreign currency derivatives. Carter et al. (2006) highlights an increase in firm value of more than 10% for airline business which use hedge strategies to hedge the future jet fuel price. Aretz and Bartram (2009) support the view that hedging can enhance firm value. There are also studies which note that the effect of hedging on firm value is country-related and depends on the industry, firm size, degree of business geographic diversification, the holdings on liquid assets, operating hedging, dividend policy, and debt level and maturity. In single country studies, Jankensgård (2015), Vivel Búa, Otero González, Fernández López, and Durán Santomil (2015), as well as Clark and Judge (2009), report evidence that firms using derivatives increase the firm value in Sweden, Spain and the UK, respectively.

On the other hand, Jin and Jorion (2006) find that there is little difference between valuation effect of the hedging and non-hedging firms in the oil and gas industry. Hagelin et al (2007) highlight the use of foreign currency derivatives can lower the firm's value due to satisfied managerial interest. Fauver and Naranjo (2010) highlight a weak relationship between hedging and firm value due to the negative effect of agency and monitoring problems. Panaretou (2014) reports evidence that there is a positive effect on firm value from foreign exchange hedging, but weak evidence in terms of interest rate hedging for the UK firms. For a sample of French firms over the period of 2002-2005, Belghitar, Clark, and Mefteh (2013) find no evidence of no association between derivative usages and firm value. Based on a sample of Australian firm, Nguyen and Faff (2007) illustrate a negative relationship between the firm value and the use of derivative.

The impact of geographic diversification on firm value is ambiguous. Geographic diversification can increase firm value by location-specific advantages, economies of scale, and synergy effects. Hence, it is significant for exploiting foreign market opportunities and imperfections through internalization (Hymer 1970, Dunning and Rugman 1985, and Rugman 1977). Geographically diversified firms reap the monopoly rents gained through intangible assets, which are not efficient to transfer (Errunza and Senbet 1984, and Morck and Yeung 1991). Based on a sample of U.S. firms over the period of 1984-1997, Bodnar et al. (1999) finds that geographic diversification is

associated with a significant increase in firm value and consistent with the benefits of internalization theory of geographic diversification. Bodnar, Tang, and Weintrop (1999) figure out that geographic diversification adds firm value.

On the contrary, Denis et al. (2002) find that the valuation effects of both geographic and industrial diversification are negative since more diversified firms are less transparent than single domestic firms and diversification makes it harder for board and internal control systems to prevent sub-optimal decisions by managers or the CEOs. Thus, International operation cost may outweigh the benefit of global diversification due to certain inherent risks, such as unexpected changes in regulatory requirements and tariffs, local political and economic developments, difficulties in staffing and managing foreign operations, exchange controls, and expropriation. Hitt, Hoskisson and Kim (1997) indicates a non-linear relationship between global diversification and firm performance.

3. Theoretical framework

3.1 The Modigliani and Miller theorem

In risk management, there has been highly controversial about the use of derivatives and how it affects firm value. Under certain assumption related to perfect capital markets, the Modigliani and Miller theorem (M&M) suggests that the firm value is not affected by how the firm chooses to finance its investment or operation regarding issuing equity, borrowing debts, spending cash, or using retained earnings if the CAPM holds. The necessary criteria must be held to assume the existence of perfect capital markets under the proposition proposed by M&M such as the absence of taxes, agency costs, bankruptcy costs, and asymmetric information. According to this theory, the firm's value is independent from the choice of its capital structure whether it is financed by debt or equity and the firm's dividend policy. This aligns with the finding of Fama (1978) that the firm's market value is not affected by its capital structure. Moreover, all investors are assumed to have homogenous expectations and make the same choices in a given situation. Atomistic competition exists in the market as every firm competing in the market is a price-taker with no control over the market price of specific products or service. The firm value is determined by its earnings generated and risk of its underlying assets, so there is no relevance to the creation of firm value.

Due to the M&M debt irrelevance theorem, a firm's hedging policy does not affect its value since investors can undo any hedging activities implemented by the firm. Thus, investors would not require the firm to hedge on their behalf, as they can achieve the same hedging objective by diversifying and hedging on their own at a similar cost. This implies that it is not necessary for the firm to hedge the risk exposure (Bessler, Conlon, & Huan, 2019). However, under the imperfect capital market, hedging activities would affect the firm value through taxes, cost of financial distress, and managerial risk aversion (Smith and Stulz, 1985).

3.2 Financial Distress Cost

Transactions cost of bankruptcy could induce the firms to hedge as the lower the bankruptcy cost, the higher the expected payoffs to firm's claimholders. Hedging can lower the variability of the future value of the firm and the probability of encountering bankruptcy cost. This benefits the

shareholders. The simple model presented by Smith and Stulz (1985) considers the debt issue by the firm to create the tax shield. Denoting P_i be the price today of one dollar delivered in state i and $T(V_i)$ is the tax rate, if the pre-tax firm value is V(0). The levered firm issues the pure discount bonds with face value F and pays taxes on its behalf of pre-tax value net of its payment to bondholders, so the after-tax value of the levered firm is V(F). If $V_j < F < V_k$, the bankruptcy costs are given by $C(V_i) \leq V_i$ when $V_i < F$. The equation of difference in the value of the levered firm and unlevered is given by

$$V(F) - V(0) = \sum_{i=1}^{j} P_i(T(V_i)V_i - C(V_i)) + \sum_{k=1}^{s} P_i(T(V_i)F$$

By inspection, the value of the levered firm equals the value of the unlevered firm minus the present value of the bankruptcy costs plus the present value of the tax shield from interest payments. As a result, the decrease in the expected bankruptcy cost will increase the value of the levered firm.

To examine the effect of hedging on expected bankruptcy costs, the firm reduces bankruptcy costs by holding a hedge portfolio that has positive payoff. However, the firm would be bankrupt due to no hedging. Considering a hedge that pays $H_g < 0$ in state g and $H_m > 0$ in state m, the hedge portfolio involves $P_gH_g + P_mH_m = 0$ and $V_g + H_g > F$ and $V_m + H_m > F$. $V^H(F)$ is the value of the levered firm in case of hedging. Without hedging, $V_g < F$ indicates that the firm would be bankruptcy in state g. Assuming no current cash flow and a constant tax rate T, the benefit of hedging is given by

$$V^H(F) - V(F) = P_gC(V_g) + P_gT(F - V_g)$$

The hedge decreases the present value of bankruptcy costs and increases the present value of the tax shield of debt. Due to $C(V_g) > 0$ and $V_g < F$, the effect of hedging is always positive. However, shareholders should account for the cost of hedging when they decide among alternative hedging strategies even if the costly hedging is still generally profitable to hedge. Mayer and Smith (1990)

find that the firm can reduce cash flow volatility through hedging which can reduce bankruptcy costs and minimize the loss of tax shields.

3.3 Tax Incentives for Hedging

The second theoretical argument why firm may benefit from hedging is Tax incentive. Tax incentive is advantageous for firms to take positions in derivative instruments. Hedging can reduce the variability of pre-tax firm values. The expected corporate tax liability is decreased, and then the expected post-tax value of the firm is increased in case of costless hedging. This is why hedging could increase the firm's value (Smith and Stulz, 1985). To analyze the effect of hedging on the present value of the firm's after-tax cash flow in the absence of leverage, the equation is given by

$$V(0) = \sum_{i=1}^{s} P_i(V_i - T(V_i)V_i)$$

The model of firm value assumes that there are s states of the world with V_i defined as the pre-tax value of the firm in state of the world i. P_i is the price today of one dollar to be delivered in state of the world i and $T(V_i)$ is the tax rate of the before-tax firm's value.

Hedging can reduce the expected taxes and increase the value of the firm if there are two states, j and k, such that the tax rates are $T(V_j) < T(V_k)$. Suppose the firm holds self-financing hedge portfolio in the sense that $V_j + H_j = V_k + H_k$ and $P_jH_j + P_kH_k = 0$. Let $V^H(0)$ be the value of the hedged firm. The equation of the hedging value is given by

$$\begin{aligned} V^H(0) - V(0) = {} & P_j(T(V_j)V_j - T(V_j + H_j)(V_j + H_j)) \\ & + P_k(T(V_k)V_k - T(V_k + H_k)(V_k + H_k)) > 0 \end{aligned}$$

The definition of a concave function is implied by Jensen's inequality. This analysis implies that costless hedging increases the firm's value even if there is incomplete hedging, the firm's value still rises if the effective marginal tax rates on firm are an increasing function of the pre-tax firm value. Thus, the after-tax firm value is a concave function of its pre-tax value as the firm value will increase if the tax rate rises. However, hedging could reduce the expected tax payments if the firm tax schedule is a convexity (Mayers & Smith, 1982) which indicates that the firm will faces

higher expected tax burden in case of high volatility in pre-tax income than that of in case of stable income, and corporate debt tax shields would prevent firms from hedging (Kale and Noe, 1990). Therefore, if the firm's effective tax rate is low and the bankruptcy cost is low, then the effect of hedging will lower the firm's value.

3.4 Underinvestment

The third theoretical argument why hedging could increase firm value is underinvestment problem. Firms' investment decision may be affected by information asymmetries in which firms may face costs associated with external financing. Myers & Majluf (1984) indicate that firms may pass investment opportunities with positive NPV due to costs associated with external financing. Froot et al. (1993) note that hedging could help firms to maintain internal funds available for good investment opportunities which avoid underinvestment problems. Without risk management, firms are sometimes forced to pursue less optimal investment opportunities since a low cash flow may prevent firms from pursuing optimal investment opportunities. Hence, everything else being equal, the more difficulties firms face in obtaining external financing, the less adequate their cash flow, in which firms need to pay a higher hedge premium which can create negative results in firm value. Gay and Nam (1998) show that firms can avoid potential underinvestment problem by using derivatives.

3.5 Geographic Diversification

In geographic or international risk, diversifiable risks disappear or zero impact when a business scales up in the setting of non-financial firms. A company operating in a single city or country is exposed to the unique economic shocks of that city. This indicates that the company is willing to expand geographically, so the risk of any one city becomes immaterial. Similarly, this applies to multinational corporations. When the company operates in only 1-2 nations, the cash flow would be significantly impacted by the political, economic, or environmental shocks. Compared to 10 nations operating company, it faces less exposure due to the diversification effect and flexibility to adjust operations across the nations to absorb the shock (Lucas, 1977). However, it has been challenged by Acemoglu (2012) since the effect of diversification would be limited due to the strong international network links between countries.

Multinational firms use standard foreign exchange derivatives to directly hedge against price risk across nations as the currency prices fluctuate. This allows firms to mitigate the currency exposure when they repatriate revenue from abroad. Even if derivatives can be used as the hedging instruments for the price risk, firms can lose efficacy in terms of quantity risk due to highly uncertainty when there is uncertainty in the number of future quantities sold (Rolfo, 1980). This implies that firms tend to hedge short-horizon risk more than long-horizon risk since firms have a harder time determining quantities in the long term and preferably taking smaller derivative position becomes a safer strategy, albeit imperfect.

Financial hedging entails the use of various characteristics' debt that can reduce the risk exposure. Allayannis, Brown, and Klapper (2003) focus on three categories of debt: issued in foreign currency, in local currency, or in synthetic local currency. The authors indicate that multinational companies receiving foreign revenue might issue debt in the foreign currency to better match between cash inflow and outflow. This reduces the net dependence on the foreign exchange conversion and exposure to exchange rates. The choice of synthetic-local versus pure-local debt might be driven by the relative cost and liquidity of the need for derivatives.

Allayannis, Ihrig, and Weston (2001) indicates that multinational firms operating in many nations have relatively little residual undiversified exposure to risks that might emerge in any single nation. This is the effect of geographic diversification. Nevertheless, authors suggest that this strategy works best when used with financial hedging programs. Hoberg and Moon (2017) point out the operational hedge of purchasing inputs in the same nations where output is sold. This strategy matches the same currency of cash inflows and outflows to reduce net exposure to the risks of the given nation. Moreover, the scale of the hedge naturally scales up with the degree of quantity risk exposure.

3.6 Hypotheses

There are contradictory theories about whether the firms should hedge or not. According to M&M theorem, hedging is worthless since investors can manage to reduce the exposure to the risk in their portfolio by themselves in the perfect market assuming the CAPM hold. This implies that hedging does not create any value for the firm. Nevertheless, in the presence of realistic capital

market imperfections due to reducing financial distress cost and tax payment, corporate hedging will increase the firm's value (Smith and Stulz, 1985). Froot et al (1993) indicate that hedging could help firms to avoid underinvestment problems due to lowering the firm's cash flow volatility which results in maintaining internal capital for good investment opportunity. We expect a positive relation between derivative hedging and firm value. Hence, the first hypothesis is as follows:

Hypothesis 1: *Hedging is positively related to the firm value.*

According to Allayannis, Ihrig, and Weston (2001), multinational companies could mitigate undiversified exposure to risks that might emerge in any single nation. Even geographic diversification could benefit for multinational firms to avoid excessive concentration in any one market and offer greater potential growth, it comes with costs such as unfavorable currency fluctuations and unstable political systems. The effect of geographic diversification works best when used with financial hedging programs. We expect that multinational firms tend to use more foreign currency hedging strategies to mitigate losses associated with currency fluctuation when they operate in multiple countries. Thus, foreign exchange hedging would have a higher effect on firm value for multinational firms with higher foreign revenue and vice versa. The second hypothesis is as follows:

Hypothesis 2: *Higher diversifications strengthen the relation between foreign exchange hedging and firm value.*

4. Data and Methodology

4.1 Financial Data Collection

The financial data is obtained from The Standard and Poor's 500, or simply the S&P500, which is a stock market index tracking the stock performance of the largest 500 companies listed in the United States (US). We collect the firm-specific derivative usage from each firm's annual report or 10-K report posted on each firm's website over the sample period from 2019 to 2023. In each year of data sampling collection, we classify the derivative usage into three categories: foreign exchange, interest rate, and commodity derivatives. This information is disclosed in the annual report or 10-K report under the section "Quantitative and Qualitative disclosures about market risk" due to the requirement from the Exchange Act Reporting and Registration (SEC) to disclose the usage of derivative instruments on an ongoing basis to protecting investors, maintaining fair orderly, and facilitating efficient market and capital information. We carefully examine whether the firm use any derivatives or not through the following keywords: "Derivative instruments", "Hedging", "Foreign exchange risk", "Interest rate risk", "Commodity price risk", "Market risk", "Interest rate swap", "Forward contract", and "Future contract" before classifying the firm as hedger for that year. Furthermore, the firm significantly discloses that the derivative instruments are used for hedging purposes and not for speculative purposes to ensure that our data collected is aligned with the purpose of hedging usage for business operation. However, if the firm explicitly discloses that it does not use any hedging instruments or we cannot find any result from the searched keywords, the firm is classified as a non-hedger for that year. As a result, we collect the sample of 211 US firms in S&P500 and a total of 967 firm-year observations, excluding the financial service and utility industry as well as the incomplete data. The reason is that many financial service firms are market makers and use derivative instruments for different purposes compared with the non-financial firms, so we exclude the financial service firms from the sample. Moreover, we also exclude firms operating in the utility industry due to heavily regulated by the regulator. Apart from hedging and non-hedging data collection, we obtain the data for calculating the dependent and control variables from CapitalIQ which are described in section 4.2. The choice of sample selection is very significant to the accuracy of results since the sample is limited to only the large US firms in different industries with different growth rates. Hence, the comparison bias might occur as the firm value might be affected by other variables not included in the analysis.

4.2 Definition of Variables

The purpose of this section describes the impact of hedging and other variables on firm value. Throughout the section, we describe the theoretical background of variables and how they are measured. The dependent variable is firm value and independent variables including derivative usage and geographic diversification are measured. There are other variables that might affect the firm value which we need to control to infer the marginal effect of hedging with derivatives on firm value. Taking those variables into account, a multivariate model will be used to test the hypothesis.

Firm value: According to Allayannis and Weston (2001), Tobin's Q is used to estimate the firm value since it is easily to compare the firm value across firms than using stocks returns or accounting measures where a risk adjustment or normalization is required. Tobin's Q is defined as the ratio of the market value of the firm to replacement cost of assets. Due to the argument of Hagelin et al. (2007) to Allayannis and Weston (2001), the use of book values as replacement cost does not affect the results compared to the use of more sophisticated estimations. Hence, we will use the same proxy as Hagelin et al. (2007) which Tobin's Q is defined as:

$$\text{Tobin's Q} = \frac{(BV\ of\ Total\ Assets - BV\ of\ Equity + MV\ Equity)}{BV\ of\ Total\ Assets}$$

Due to the positive skewness in distribution, we will take the log transform Tobin's Q from the study of Jankensgard (2015). This enables us to interpret the coefficients of the regression in percentage terms.

Hedging: Dummy variable will be used to represent our variable Hedging. If the firm uses financial derivatives to hedge any kind of risk, we will take the value 1 and 0 otherwise. Based on Jin and Jorion (2006), Hagelin et al. (2007), and Jankensgard (2015), measuring hedging activity with dummy variable is a standard approach since not all firms could provide sufficient information to measure hedging activity in a continuous variable.

Foreign exchange hedging: Dummy variable (FXH) will be used to represent the foreign exchange hedging if the firm uses financial derivatives to hedge the foreign exchange risk, FXH will take the value 1 and 0 otherwise. Bartram et al (2009) study the usage of derivatives for hedging foreign exchange, interest rate, and commodity risks to investigate the determinants of hedging policies. Due to the use of hedging derivatives for different types of risks, it gives insight into the overall effect of hedging specific financial risks. Allayannis et al. (2012) report strong evidence that the use of foreign exchange hedging is associated with a significant premium on firm value. Bartram et al. (2011) show that the effect of derivatives on firm value is statistically significant and positive, but it is sensitive to the endogeneity issue. Jin and Jorion (2006) indicate that foreign exchange risk has different exposure from commodity risk.

Interest hedging: Dummy variable (IRH) will be used to represent the interest hedging if the firm uses financial derivatives to hedge the interest rate risk, IRH will take the value 1 and 0 otherwise. Allayannis et al. (2012) study the effect of interest rate and foreign exchange hedging on firm value across countries.

Commodity hedging: Dummy variable (CMH) will be used to represent the commodity hedging if the firm uses financial derivatives to hedge the commodity price risk, CMH will take the value 1 and 0 otherwise.

Geographic diversification: Allayannis and Weston (2001) and Da Silva Jorge and Gomes Augusto (2011) describe that a firm with higher geographically diversified sales face higher foreign exchange risk. Hence, our variable Geo-Div is measured based on the Herfindahl index:

$$\text{HERF}_{i,t} = \sum_{j=1}^{n} (FSALE/SALE)^2$$

Where FSALE is the total foreign sales of the firm and SALE is the firm's total sales of firm i in that year. The variable HERF indicates that the higher HERF corresponds with greater geographic diversification. Studies by Allayannis and Weston (2001), Choi et al. (2020), and Denis et al. (2002) indicate a negative effect between foreign sales and firm value, while Bodnar et al. (1997) and Morck and Yeung (1991) report a positive relationship between foreign sales and firm value.

The effect of firm value depends on the effectiveness of corporate hedging. In this study, we are interested in beta coefficients of the interaction variable FXH x Geo-Div.

Cash ratio: Our variable Cash ratio is measured as cash and equivalents divided by total assets. Cash holdings may have a positive effect on firm value in case of reduction in costs associated with financial distress and underinvestment. However, firms with low cash holdings may have higher Tobin's Q because they are more likely to invest in positive NPV projects. Related to the argument from Jensen (1986) of the free cash flow hypothesis, firms tend to invest in negative NPV projects when they have excess free cash flow. August Beckman and Albin Nilsson (2023) suggest that there is no evidence of cash holdings moderating the effect of derivative hedging on firm value.

Firm size: Allayannis and Weston (2001) and Pramborg (2004) found that firm size is a common factor used to characterize the firm, strongly related to the firm value. This indicates that larger firms tend to have lower Tobin's Q than that of small firms. Alkeback and Hagelin (1999) found that the use of derivatives hedging is more common among large firms than that of medium or small firms. Hence, our variable Firm size is calculated based on the natural logarithm of total assets same as the previous studies from Jin and Jorion (2006) and Hagelin et al. (2007).

Leverage: In M&M theorem (1958), financial leverage is unrelated to firm value under the frictionless world. However, a firm's capital structure is positive related to its firm value in the world with tax-deductible interest payments (Antwi, Mills & Zhao, 2012). This indicates that the firm's value might be affected by its capital structure. Our variable leverage is defined as the ratio of total debt to total assets from the study of Jankensgard (2015). According to Smith and Stulz (1985), the study presents that hedging can reduce the expected costs of financial distress cost. Purnanandam (2008) indicates that there is a positive relation between leverage and foreign exchange as well as leverage and commodity price hedging when financial distress costs hold. Hence, we need to control leverage due to a positive relationship between hedging and leverage.

Growth opportunities: Our variable InvGrowth will be defined as capital expenditure over total assets from the studies of Jin and Jorion (2006) and Hagelin et al. (2007). Growth opportunities

might have positive impact on the firm value since firms are more likely to invest more when they have valuable investment opportunities from the studies of Allayannis and Weston (2001), Kim et al. (2006), Hagelin et al. (2007), Júnior & Laham (2008), and Vivel Búa et al. (2015).

Profitability: Profitable firms are more likely to trade at a premium or tend to have higher firm value compared to less profitable firms. Our variable Profitability is equal to Net Income/Total assets (ROA) based on the studies of Allayanis and Weston (2001) and Jankengard (2015).

Dividends: Dummy variable will be used to represent the control for dividend policy if the firm pays dividend, we will take the value 1 and 0 otherwise. Studies by Kane, Lee & Marcus (1984) and Murdoch (1992) report that dividend payout announcement can impact firm value due to higher dividend payout rate and the higher tax cost of the dividend dampens the increase in firm value. However, Jin and Jorison (2006) report that dividend payout enhances firm value as it signals to market about the good financial shape for the questioned firm and in turn the investors could reward the higher firm value. Fama & French (1998) shows that the dividends may convey information about profitability in the future, resulting in a positive beta.

Industry effects: Due to the studies of Allayannis and Weston (2001) and Hagelin et al. (2007), we control industry effects by using dummy variables based on the Global Industry Classification Standard (GICS). The reason is that hedgers might have higher firm value in case of concentrating in industries with a higher Tobin's Q not the use of hedging derivatives.

Time effects: Ascribed to Allayannis and Weston (2001) and Hagelin et al. (2007), we control time effects by using dummy variables for each year. The reason is that hedgers might have higher firm value since their hedging activities might concentrate in years with higher Tobin's Q because of macroeconomic factors not the use of hedging derivatives.

4.3 Empirical Models

The models describe the basic structure of regression models where i refers to "firm" and t to "year". The equations of the regression model are as follows:

$$\text{Tobin's } Q_{i,t} = \alpha + \beta_1 FXH_{i,t} + \beta_2 \text{Geo-div}_{i,t} + \beta_3 FXH \times \text{Geo-Div} + \beta \boldsymbol{X}'_{i,t} + \varepsilon_{i,t}$$

We define the dependent variable Tobin's Q as the proxy of firm value where α is the constant or intercept term and ε is the error term. We are interested in FXH and diversification to investigate whether higher diversifications drive the relation between FXH and firm value. Thus, we treat FXH and diversification as independent variables. Moreover, we control the IRH and CMH to avoid research bias by limiting the influence of confounding and other extraneous variables and to ensure our results are solely caused by our independent variables. The equation defines the first variable *FXH* as a dummy variable for foreign exchange hedging, the second variable *Geo-Div* as the influence of geographic diversification on firm value, the third variable *FXH x Geo-Div* as an interaction variable to capture how geographic diversification moderate the effect of foreign exchange hedging on firm value, and last variable *X'* as a vector of control variables including IRH, CMH, cash ratio, firm size, leverage, growth opportunities, profitability, and dividends.

4.4 Econometric Approach and Issue

Due to the data collected on different cross sections across time, we will obtain the panel data used in the empirical models presented in section 4.3. To deal with panel data, we will use a pool-OLS regression and disregard the time dimension. Brooks (2019) defines that the average values and relationships between the variables are constant across entities and time due to the assumption of pooling data. Therefore, the benefit of panel data to address entity and time heterogeneity are lost when we use the pool-OLS regression. To address the problem of heterogeneity, we apply the firm and time effects which we can select whether random or fixed effect depended on the sample. Brooks (2019) demonstrates that all explanatory variables are uncorrelated with the composite error term under the assumption of random effect. The random effect is more appropriate when the sample is randomly selected from the population. The estimated parameters will be biased and inconsistent if the random effect assumption does not hold. Hence, it is better to use fixed effect over random effects due to the consistent coefficients. The fixed effect model is more plausible

when the sample effectively constitutes the entire population and allows cross-sectional heterogeneity. Hausman & Taylor (1981) describe that all unobservable firm characteristics affecting firm value can be controlled since each firm assign a unique intercept when using fixed effect model. We test the assumption by a Hausman specification test and the p-value from the test is 0.000. Thus, we reject the null hypothesis of using the random effect and consequently fixed effect is preferred to capture cross-sectional differences that are constant over time.

Under the study of Allayannis and Weston (2001), the fixed effect estimations correct the heterogeneity but failing to address the endogeneity problem. Roberts & Whited (2013) reports the benefit of fixed effect in the regression models is to partially capture effects from omitted variables causing the endogeneity problem. Because of using panel data which might not be independent as we observe the same firm for several years, we apply the Huber-White estimator to all the regressions to produce robust variance estimates, avoid biased standard errors, and correct heteroscedasticity.

5. Analysis and Results

5.1 Descriptive statistics

Table 1 presents the full sample descriptive statistics of 211 companies listed on the US S&P500, spanning from 2019 to 2023. The average Tobin's Q value for the companies in the sample is 2.4508, with a median of 2.1314, indicating a significant deviation. Regarding another variable, the mean value of hedging at 0.8459 suggests that 84.59% of the companies in the sample utilized derivative instruments during the annual observations. Further observing the mean values for FXH, IRH, and CMH in the table, it is noted that 72.60% of companies hedged foreign exchange risk using derivatives during the annual observations, 69.08% used derivatives to hedge interest rate risk, while only 32.68% of companies hedged commodity risk. It can be observed that hedging foreign exchange risk using derivatives is the most common strategy, whereas the probability of companies using derivative instruments to hedge commodity risk is relatively low. Overall, these findings highlight that using derivative instruments to hedge foreign exchange risk is the most prevalent strategy, while the strategy of using derivatives to hedge commodity risk is less commonly adopted by companies. The average value of Geo-div in the table is 0.4957, indicating that the use of geographical diversification strategies by companies is relatively frequent, and non-US domestic sales as a proportion of total annual sales are significant. The company holds an average of 8.69% of total assets as cash and cash equivalents, with a median of 6.06%, suggesting that most companies have cash ratios below the average level. The standard deviation of 0.0869 indicates significant variability, possibly due to some companies having very high or very low cash ratios. The median firm size is 9.971, close to the mean of 10.046, indicating relatively symmetrical data collection or a relatively even distribution. The standard deviation of 1.079 suggests differences in company sizes may exist. The leverage's mean of 0.346 is close to the median of 0.335, indicating that the debt levels of the companies in the data set are relatively low. The average investment growth of 0.028 implies an average growth rate of 2.80%, with a standard deviation of 0.028 indicating significant variability, possibly due to large differences in investment growth rates among companies. The average ROA (Return on Assets) is 6.20%, with a minimum of –4.76% and a maximum of 17.97%, indicating significant differences between profitable and loss-making companies. The average DIV (Dividend) payout ratio is 0.780, implying an average dividend payout ratio of 78.0%, with a median of 1 indicating that a considerable proportion of

companies pay out all profits as dividends. The standard deviation of 0.415 suggests significant variability, with some companies having substantially different dividend payout ratios.

Table 1 Descriptive statistics

Variable	Mean	Median	Std.dev	Min	Max
Tobin's Q	2.4508	2.1314	1.1570	0.3558	6.0179
Hedging	0.8459	1.0000	0.3612	0.0000	1.0000
FXH	0.7260	1.0000	0.4463	0.0000	1.0000
IRH	0.6908	1.0000	0.4624	0.0000	1.0000
CMH	0.3268	0.0000	0.4693	0.0000	1.0000
Geo-Div	0.4957	0.3811	0.4133	0.0000	5.0400
Cash ratio	0.0869	0.0606	0.0869	0.0011	0.5348
Firm size	10.0458	9.9708	1.0786	7.3411	13.2207
Leverage	0.3463	0.3346	0.1665	0.0000	0.9978
Inv Growth	0.0275	0.0192	0.0280	0.0000	0.2181
ROA	6.1993	5.6408	3.6255	-4.7592	17.9651
DIV	0.7797	1.0000	0.4146	0.0000	1.0000

This table presents the full sample descriptive statistics of 211 companies listed on the US S&P500 index, spanning from 2019 to 2023. The variables include mean, median, standard deviation (Std. dev.), minimum, and maximum values. Tobin's Q serves as a proxy variable for company value, Hedging represents a dummy variable for companies using derivative instruments for hedging, while FXH, IRH, and CMH are dummy variables for hedging foreign exchange, interest rate, and commodity risks, respectively. Geo-div indicates the impact of geographical diversification on company value, calculated as the square of the ratio of non-US domestic sales to total sales. Cash Ratio represents the ratio of cash and cash equivalents held by the company to total assets. Firm Size is the untransformed total asset book value, Leverage is defined as the ratio of debt to total assets, and Inv Growth is the ratio of capital expenditure to total assets. ROA is the ratio of net income to average total assets, and Dividend is a dummy variable taking a value of 1 if the company pays dividends and 0 otherwise.

5.2 Univariate Analysis

In the chapter on univariate analysis, we compared companies using derivative tools to hedge risk against those that do not, observing significant differences in terms of company value and characteristics (such as size, scale, etc.). Tables 2 and 3 present tests on mean, median, standard deviation, minimum, and maximum values. Table 2 displays data from companies using derivatives, while Table 3 represents data from companies not using derivatives. Table 4 presents tests on the differences between the two groups in terms of means and medians. Observing Table 4, we can see significant differences between derivative-using companies and those not using derivatives in Tobin's Q. The mean and median values of derivative-using companies are lower than those of non-users, contradicting our hypothesis that using derivatives positively impacts

company value. However, in subsequent multivariate analyses, results may vary when controlling for other variables. Nevertheless, this univariate test conclusion aligns with prior studies by Hagelin et al. (2007) and Fauver and Naranjo (2010). Regarding Geo-Div, the mean and median values are also higher for non-derivative-using companies compared to derivative users. Additionally, the value of cash and cash equivalents held by derivative-using companies is lower than that of non-users, as evidenced by the negative mean and median values of the cash ratio in Table 4. This conclusion is generally consistent with phenomena found in earlier studies by Choi et al. (2020). Regarding firm size, larger companies tend to use hedging to reduce risks, hence the higher mean and median values of derivative-using companies. In addition, companies using derivatives tend to have higher leverage ratios compared to those that do not use derivatives. In terms of Investment Growth, the difference in means and medians between companies using derivatives and those not using derivatives exhibits opposite signs. This might be due to a significant difference in the sample sizes, with 818 using hedgers and 149 not using hedgers. Regarding asset return rates, we observe that companies not using derivatives have higher mean and median values compared to those using derivatives. This result may lead to different conclusions in multivariate analysis. Finally, as Hagelin et al. found in their 2007 study, we can see from Tables 2 and 3 that 81.91% of hedgers pay dividends, while among non-hedgers, only 56.38% pay dividends.

Table 2 Statistics of Hedgers, Count = 818

Variable	Mean	Median	Std.dev	Min	Max
Tobin IQ	2.3414	2.0436	1.0631	0.3578	5.9433
Geo-Div	0.4635	0.3428	0.4176	0.0000	5.0400
Cash ratio	0.0810	0.0577	0.0781	0.0011	0.5172
Firm size	10.1275	10.0168	1.0405	7.5414	13.2207
Leverage	0.3514	0.3393	0.1574	0.0008	0.9978
Inv Growth	0.0264	0.0196	0.0251	0.0000	0.2001
ROA	5.8216	5.3697	3.3379	-4.7592	17.6669
DIV	0.8191	1.0000	0.3852	0.0000	1.0000

This table presents the mean, median, standard deviation, minimum, and maximum values of dependent variables and company characteristic variables within the subsample of hedgers. Count number is 818.

Table 3 Statistics of Non-hedgers, Count = 149

Variable	Mean	Median	Std.dev	Min	Max
Tobin IQ	3.0514	2.6571	1.4385	0.3558	6.0179
Geo-Div	0.6724	0.8463	0.3398	0.0813	1.1177
Cash ratio	0.1198	0.0918	0.1199	0.0021	0.5848
Firm size	9.5971	9.5377	1.1732	7.3411	13.1766
Leverage	0.3183	0.2795	0.2080	0.0000	0.9623
Inv Growth	0.0334	0.0160	0.0399	0.0015	0.2181
ROA	8.2730	7.5564	4.3785	-4.3154	17.9651
DIV	0.5638	1.0000	0.4976	0.0000	1.0000

This table presents the mean, median, standard deviation, minimum, and maximum values of dependent variables and company characteristic variables within the subsample of non-hedgers. Count number is 149.

Table 4 Differences between Hedgers and Non-hedgers

Variable	Mean	Median	T-test	P-value
Tobin IQ	-0.7100	-0.6135	-5.7460	0.0000
Geo-Div	-0.2088	-0.5035	-6.6430	0.0000
Cash ratio	-0.0388	-0.0341	-3.8067	0.0002
Firm size	0.5304	0.4791	5.1608	0.0000
Leverage	0.0331	0.0598	1.8479	0.0663
Inv Growth	-0.0069	0.0036	-2.0508	0.0418
ROA	-2.4514	-2.1867	-6.4987	0.0000
DIV	0.2553	0.0000	5.9470	0.0000

This table presents the differences in means and medians of dependent variables and company characteristic variables between the hedge and non-hedge subsamples.

5.3 Multivariate Regression Analysis

In univariate analysis, the study found that using derivative instruments for hedging had a negative impact on company value, which was contrary to the initial hypothesis. To investigate the marginal effect of hedging on company value, a method of controlling variables was employed. This involved conducting a multivariate regression analysis to control for other factors that may influence company value.

Table 5 Multivariate Regression Models on Firm Value

Variables	M1	M2	M3	M4	M5	M6
FXH	0.1027	0.0524	0.0259	0.1035	0.0521	0.0084
	(0.003)	(0.126)	(0.617)	(0.003)	(0.125)	(0.911)
Geo-Div	-0.0620	-0.0110	-0.0181	-0.0634	-0.0127	-0.0740
	(0.143)	(0.757)	(0.806)	(0.131)	(0.703)	(0.400)
Cash ratio	0.6369	0.9147	0.4419	0.6060	0.8437	0.8418
	(0.000)	(0.000)	(0.065)	(0.001)	(0.000)	(0.000)
Firm size	-0.0918	-0.0732	-0.2462	-0.0930	-0.0756	-0.0765
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	0.2580	0.1925	0.8505	0.2527	0.1851	0.1809
	(0.001)	(0.064)	(0.004)	(0.001)	(0.073)	(0.083)
InvGrowth	-0.2002	0.5458	-0.3805	-0.1009	0.7754	0.8058
	(0.675)	(0.452)	(0.685)	(0.831)	(0.285)	(0.268)
ROA	0.0574	0.0528	0.0308	0.0578	0.0592	0.0593
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
DIV	0.0090	0.1571	0.1881	0.0079	0.1603	0.1619
	(0.805)	(0.002)	(0.115)	(0.830)	(0.002)	(0.001)
IRH	-0.1461	-0.1724	-0.0689	-0.1468	-0.1748	-0.1739
	(0.000)	(0.000)	(0.196)	(0.000)	(0.000)	(0.000)
CMH	-0.1368	-0.1123	0.0313	-0.1400	-0.1143	-0.1128
	(0.000)	(0.001)	(0.572)	(0.000)	(0.001)	(0.001)
FXH x Geo-Div						0.0687
						(0.456)
Constant	1.3139					
	(0.000)					
Industry effect	No	Yes	No	No	Yes	Yes
Firm effect	No	No	Yes	No	No	No
Time effect	No	No	No	Yes	Yes	Yes
Number of obs.	967	967	967	967	967	967

Variables	M1	M2	M3	M4	M5	M6
Adjusted R^2	0.429	0.676	0.849	0.435	0.689	0.688

This table presents the results of the regression model implemented in this study, corrected using the Huber-White estimator (p-values in parentheses).

In Table 5, the results of six multiple regression models from M1 to M6 are presented. The first model (M1) considers four variables: FXH, IRH, CMH, and Geo-Div. The impact of foreign exchange hedging on the outcome is positive, with a significant correlation coefficient of 0.1027. Conversely, both IRH and CMH exhibit a negative relationship that is statistically significant. Similarly, the variable Geo-Div also shows a significant negative impact, with a coefficient of -0.0620. In the second model (M2), industry fixed effects were incorporated for regression analysis. It was observed that the coefficient of Geo-Div decreased significantly compared to the regression in M1, indicating the influence of industry on geographic diversification. With the introduction of industry fixed effects, the Adjusted R^2 also showed a slight improvement, increasing from 0.429 to 0.676. This suggests that differences in firm value may potentially stem from variations across industries to which companies belong. In the third model (M3), we chose not to continue using industry fixed effects but instead opted for firm fixed effects to analyze consistent company-specific differences over time. Through this choice, we found that the correlation coefficient for Geo-Div is –0.0181. This indicates a significant negative correlation between Geo-Div and company value. Moreover, under the condition of company fixed effects, the values obtained are similar to those under the industry fixed effects in M2, suggesting that the impact is also similar. Additionally, the adjusted R^2 reached a new high of 0.849, indicating that internal changes within companies play a crucial role in explaining variations in company value. In Model 4 (M4), regression analysis was conducted using time fixed effects. In comparison with M3, the correlation coefficient for Geo-Div remains negative. Similarly, the correlation coefficient for FXH remains significantly positive, while IRH and CMH are significantly negatively correlated. In Model 5 (M5), we primarily tested the first hypothesis, incorporating time and industry effects. Regarding the coefficients of the relevant variables, we obtained results and coefficients similar to those in M2, which aligns with the first hypothesis. Specifically, hedging has a positively significant effect on firm value, showing a positive correlation. This finding is consistent with the research of Allayannis and Weston (2001) as well as Carter et al. (2006), who found a positive correlation between hedging and firm value in the United States. The last model, M6, primarily tested

hypothesis two, which also included time and industry effects. Similar to M5, M6 showed close proximity in terms of Adjusted R^2. In M6, we introduced an additional test variable, namely FXH x Geo-Div, and obtained a correlation coefficient of 0.0687. This indicates a positive correlation confirming hypothesis two, but it is insignificant. Higher overseas income strengthens the relationship between foreign exchange hedging and firm value, with geographic diversification playing a positive moderating role in hedging effectiveness.

5.4 Robustness Tests

In the robustness testing, we conducted regression analyses on six models using various covariance estimators to verify the reliability of the results. These covariance estimators (HC0, HC2, HC3) were used to adjust the standard errors to address the issue of heteroscedasticity. HC0 is the classic heteroscedasticity-robust standard error estimator, which does not make any adjustments. It assumes that the error variance of each observation is different, but there is no specific structure among these variances. The HC2 estimator adjusts each standard error by considering the leverage of each observation (i.e., the influence of that observation in the regression). The HC3 estimator makes a stronger adjustment to the standard errors, further reducing the impact of high-leverage observations on the estimation results compared to HC2. By comparing the results from four estimators, we found that the differences in results for each model were minimal, indicating that the model results are robust. The table below presents the test results for the most significant model, M6.

Table 6 Robustness Tests of the Model 6

Variables	HC0	HC1	HC2	HC3
FXH	0.0084	0.0084	0.0084	0.0084
	(0.906)	(0.911)	(0.911)	(0.914)
Geo-Div	-0.0740	-0.0740	-0.0740	-0.0740
	(0.375)	(0.400)	(0.400)	(0.420)
Cash ratio	0.8418	0.8418	0.8418	0.8418
	(0.000)	(0.000)	(0.000)	(0.000)
Firm size	-0.0765	-0.0765	-0.0765	-0.0765
	(0.000)	(0.000)	(0.000)	(0.000)

Variables	HC0	HC1	HC2	HC3
Leverage	0.1809	0.1809	0.1809	0.1809
	(0.067)	(0.083)	(0.079)	(0.091)
Inv Growth	0.8058	0.8058	0.8058	0.8058
	(0.243)	(0.268)	(0.267)	(0.291)
ROA	0.0593	0.0593	0.0593	0.0593
	(0.000)	(0.000)	(0.000)	(0.000)
DIV	0.1619	0.1619	0.1619	0.1619
	(0.001)	(0.001)	(0.001)	(0.002)
IRH	-0.1739	-0.1739	-0.1739	-0.1739
	(0.000)	(0.000)	(0.000)	(0.000)
CMH	-0.1128	-0.1128	-0.1128	-0.1128
	(0.000)	(0.001)	(0.001)	(0.001)
FXH x Geo-Div	0.0687	0.0687	0.0687	0.0687
	(0.432)	(0.456)	(0.454)	(0.476)
Industry effect	Yes	Yes	Yes	Yes
Firm effect	No	No	No	No
Time effect	Yes	Yes	Yes	Yes
Number of obs.	967	967	967	967
Adjusted R^2	0.688	0.688	0.688	0.688

This table presents the test results for Model 6 (M6) using heteroscedasticity-robust standard error estimators HC0, HC1, HC2, and HC3, with p-values in parentheses. HC1 is the data we previously obtained in the regression model and is used here for comparison with HC0, HC2, and HC3. The other five models (M1, M2, M3, M4, M5) also yielded robust results. However, displaying all models would make the table excessively large, so only the robustness test results for M6 are shown.

Additionally, we split the dataset into two parts and conducted regression analyses on each subset separately. This approach was used to test the robustness of the model results, ensuring consistent performance across different subsets of the data. Similarly, we obtained similar results, indicating that the model is robust.

We have a concern regarding the potential reverse causality between the existence of hedging derivatives and the value of a company. It is possible that the positive correlation observed could be driven by a reverse causal relationship. If companies with higher Tobin's Q exhibit greater motivation for hedging, it could be that hedging doesn't lead to higher corporate value, but rather the other way around. To address this concern, we conduct a reverse causality test on hypothesis one, utilizing the methodology outlined by Allayannis and Weston (2001). We conducted two additional tests for reverse causality. We have made three assumptions: Hypothesis 1: The probability of not hedging in the current period (Hedging = 0) and also not hedging in the next period (Hedging = 0). In other words, assuming that hedging is not done in the current period, it will also not be done in the next period. Hypothesis 2: The probability of hedging in the current period (Hedging = 1) but not hedging in the next period (Hedging = 0). In other words, assuming hedging is done in the current period, it will not be done in the next period. Hypothesis 3: The probability of not hedging in the current period (Hedging = 0) but hedging in the next period (Hedging = 1). The first one incorporated industry fixed effects, yielding a p-value of 0.2211 for the joint hypothesis test. In the second test, we added both time and industry fixed effects, resulting in a joint hypothesis test p-value of 0.1696. In both cases, we lacked sufficient evidence to reject the null hypothesis, meaning we could not conclude the existence of a reverse causal relationship.

Table 7 Reverse Causality Test (Industry fixed effect)

Wald tests	**P-value**
Hypothesis 1:	0.0025
Hypothesis 2:	0.9854
Hypothesis 3:	0.0832
Joint test of hypothesis 2 and 3:	0.2211

The table presents separate tests for each of the three hypotheses, as well as the joint tests for hypotheses two and three under industry fixed effects, along with their corresponding p-values.

Table 8 Reverse Causality Test (Time and Industry fixed effects)

Wald tests	**P-value**
Hypothesis 1:	0.0024
Hypothesis 2:	0.8251

Wald tests	**P-value**
Hypothesis 3:	0.0597
Joint test of hypothesis 2 and 3:	0.1696

The table presents separate tests for each of the three hypotheses, as well as the joint tests for hypotheses two and three under both industry and time fixed effects, along with their corresponding p-values.

6. Conclusion

This thesis studies the impact of hedging on firm value and investigates the geographic diversification moderate the relation between foreign exchange hedging and firm value using the sample of 211 US firms listed on S&P500 from the period 2019 to 2023. Tobin's Q is used as the determination of firm value to measure how it is affected by derivatives usage in the multivariate regression analysis. We classify the derivative usage into three categories: foreign exchange, interest rate, and commodity derivatives. We mainly focus on foreign exchange hedging and the interaction between geographic diversification and foreign exchange hedging on firm value, so we control numerous variables including interest rate hedging, commodity hedging, cash ratio, firm size, leverage, growth opportunities, profitability, and dividends to prevent research biases from omitting variables which could influence the outcomes.

The empirical findings show that the use of hedging derivatives, specifically foreign exchange hedging, is associated with higher firm value as the foreign exchange hedging drives the positive relation between hedging and firm value. On the other hand, interest rate and commodity hedging are negative in most cases, indicating the negative relation between hedging and firm value. Eventually, this study finds evidence that geographic diversification moderates the effect of foreign exchange hedging on firm value.

According to the theories with presence of imperfect market, our results are consistent with the findings that foreign exchange hedging can enhance firm value, but the interest rate and commodity hedging reduce the firm value. Even the geographic diversification moderates the relation between hedging and firm value, it is insignificant and needs to further study and better understand more theoretical concept and understanding of the integrated relationships between geographic diversification and hedging. In the long run, multinational US firms which are exposed to foreign exchange risk should consider participating in hedging derivatives' activities to maximize firm value. This study is relevant to corporate risk management with practical implications. Due to the mixed results from previous empirical studies of whether hedging can impact the firm's value or not, further research on this topic is necessary and should be considered how hedging activities are measured.

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