Corporate hedging and capital structure decisions: towards an integrated framework for value creation[1]

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Abstract

We suggest a joint optimization model for a firm's hedging and leverage decisions that helps to establish an integrated framework for value creation. Rather than artificially separating the two interrelated parts of the firm's financial policy, we treat both corporate decision variables as endogenous. We argue that exogenous differences between financial distress costs across firms, and particularly across industries, simultaneously influence corporate risk management and capital structure decisions. Using anecdotal evidence, our focus is not on so-called direct bankruptcy costs, but rather on the cross-sectional variation in indirect bankruptcy costs, which may result from a deterioration of relationships with customers, suppliers, or other stakeholders prior to the legal act of bankruptcy.

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From a managerial perspective, hedging market price risk entails entering into selected derivative contracts, whose state-dependent payments are intended to manipulate certain features of the probability distribution of the firm's future cash flows or accounting earnings. Among the risk factors that typically cause this type of undesirable volatility are interest rates, foreign exchange rates, and the prices of commodities like crude oil, fuel, or steel, which may constitute the firm's input factors or its products.

In general, corporate hedging can be defined as a reduction in dependence between uncertain future corporate profits and random market prices. Hence, speculative policies that increase the firm's exposure to price fluctuations, and that might result from advantages in information about future prices, are not considered here.

In the academic literature on corporate hedging, several theories offer competing answers to the questions of why and how firms should hedge [Graham and Rogers (2002), Brown and Toft (2002)]. Smith and Stulz (1985) deal with two value-increasing effects of hedging, assuming a fixed capital structure. Firstly, they model the direct impact of hedging on corporate tax liability as a result of a convex tax function. Secondly, they demonstrate its influence on the costs of financial distress and bankruptcy: 'By reducing the variability of the future value of the firm, hedging lowers the probability of incurring bankruptcy costs. This decrease in expected bankruptcy costs benefits shareholders.' Ignoring the issue of bankruptcy costs, MacMinn (1987) suggests the protection of depreciation charges and tax credits as a rationale for corporate hedging. Froot, Scharfstein, and Stein (1993) propose that hedging can help to avoid the use of expensive external financing by coordinating the firm's investment and financing policy.

More recently, another line of reasoning that explicitly takes the firm's capital structure policy into account seems to be gaining popularity. According to Ross (1996), Stulz (1996), and Leland (1998), an important benefit of corporate hedging is that it represents a means of taking advantage of increased debt capacity and the resulting additional interest tax shield. While this motive has already found its way into the finance textbooks[2], a clear-cut analytical model of the interaction between the firm's hedging and capital structure decisions has been missing.

Financial distress costs and corporate taxes constitute an optimal degree of leverage

From the famous Modigliani and Miller (1958) theorem it is well known that value creation through financial decision making at the company level requires the presence of certain market frictions. In frictionless financial markets, not only a firm's capital structure decision, but also its hedging decision can be regarded as irrelevant from the shareholders' perspective. If, for example, a company decides to buy an option for hedging purposes and pays exactly its fair market value, there is no value creation for shareholders in the first place. This is where market frictions, such as bankruptcy costs, taxes, or transaction costs come into play. These market imperfections can turn the initially zero net present value of the derivatives contract into a positive value contribution.

In the widely used trade-off model of a firm's capital structure [Kraus and Litzenberger (1973), Myers (1993)], which is still a very popular prototype for practical applications [Opler, Saron and Titman (1997)] and which seems to be about to undergo a renaissance in financial theory[3] as well, the optimum debt level is obtained by minimizing the total present value of bankruptcy costs and corporate taxes. However, of primary concern to us are not the so-called direct bankruptcy costs, such as payments to trustees, lawyers, courts, auctioneers, referees, appraisers, or accountants, which are commonly modelled as a percentage fraction of the remaining asset value. Instead, we assume that there are substantial financial distress costs at a much earlier stage, specifically whenever the corporate stakeholders notice that the firm is facing some difficulty in meeting its obligations to creditors and, correspondingly, adapt their behavior towards the company. According to Smith and Stulz (1985) and Stulz (1996), these costs, which are sometimes referred to as indirect bankruptcy costs, are assumed to increase with the degree of

2 For example, Brealey, Myers and Allen (2005) state this hypothesis on their list of the ten most important unsolved problems in finance that seem "ripe for productive research."

3 See, for example, the recent work of Molina (2005), who concludes that his estimation of the ex-ante costs of financial distress can offset the current estimates of debt tax shields.

corporate financial distress[4]. These costs may, for example, arise from employees' declining motivation or from sales being lost to competitors, because customers become increasingly reluctant to buy products that require repairs or other services from a company that is on the verge of bankruptcy. Anecdotal evidence of such behavior is provided, for example, by Rawls and Smithson (1990), who report that when Wang Computers got into financial trouble, sales fell and who cite a Wang customer asking: 'How do we know that in three years you won't be in Chapter 11?'

Shapiro and Titman (1985) give various other examples of such indirect bankruptcy costs. They highlight the fact that some firms are, by the very nature of their business, more vulnerable to adverse changes in their perceived distance to default than other firms. For example, they cite Lee Iacocca's response to suggestions that Chrysler should declare bankruptcy: 'Our situation was unique... It wasn't like the cereal business. If Kellogg's were known to be going out of business, nobody would say: 'Well, I won't buy their cornflakes today. What if I get stuck with a box of cereal and there's nobody around to service it?' Hence, it is absolutely clear that financial distress costs resulting from a deterioration of customer (or other stakeholder) relationships are not constant across firms, but depend strongly on the particular business and industry. Figure 1 illustrates those potential differences in financial distress cost functions that may be due to industry-specific or product-type characteristics. Differences in direct bankruptcy costs are likely to be small.

In order to empirically estimate the cross-sectional differences between firms' financial distress cost functions, time series of at least two proxy variables are needed: one to reflect the changing degree of financial distress (measured, for example, by the firm's credit rating or, far better in terms of data availability, by its credit default swap spread[5]) and one for the resulting distress costs (measured, for example, by accounting earnings or, again far better in terms of data availability, by the firm's stock price). We will ignore these regression issues for future practical application and empirical work and return to

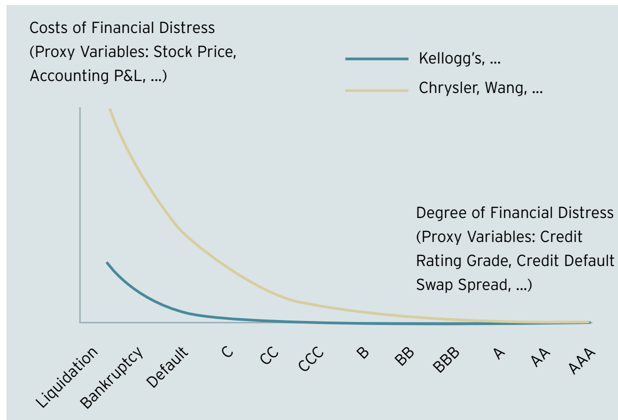

Figure 1 – Differences in financial distress cost functions across firms

the conceptual issue of capturing existing differences among the firms' distress costs.

In order to maintain the intuition of the Merton (1973, 1974) option pricing framework, it seems reasonable to simplify the firm's financial distress cost function by assuming a piecewise linear relationship between future firm value (V) and financial distress costs (DC). Then, with a constant-percentage financial distress cost rate (m) for each firm, the claim by the beneficiaries with respect to the firm's precarious situation is given simply by $DC = m \cdot \max(D - V, 0)$. Here, D denotes the face value of debt that the firm issues, so that the term $D - V$ can be interpreted as the firm's distance to default or its distance to bankruptcy that fluctuates over time. Hence, the more serious the firm's financial distress, the higher the associated costs. Furthermore, the higher the parameter m, the more sensitive is the net value of the firm to adverse changes in its perceived probability of bankruptcy. In a sense, parameter m could be described as a kind of bankruptcy beta, since its empirical content as a sensitivity measure of the firm's unsystematic bankruptcy risk resembles the beta coefficient that is commonly applied to measure a firm's systematic risk. In the Iaccoca example cited above, a car manufacturer, such as Chrysler, would probably be characterized by a much higher bankruptcy beta m than a cereal producer like Kellogg's.

4 See also Hall's (2002) analysis of a banking firm: "...one would intuitively expect the cost of financial distress to curve upwards as the bank is forced into ever more draconian action to survive."

5 With the development of liquid credit default swap markets the availability of high-frequency time-series data has greatly improved. Bloomberg quotes for credit default swap spreads are now available for more than 1,500 companies. The relationship between credit default swap spreads, bond yields, and Moody's credit rating announcements is analyzed, for example, by Hull, Predescu and White (2004).

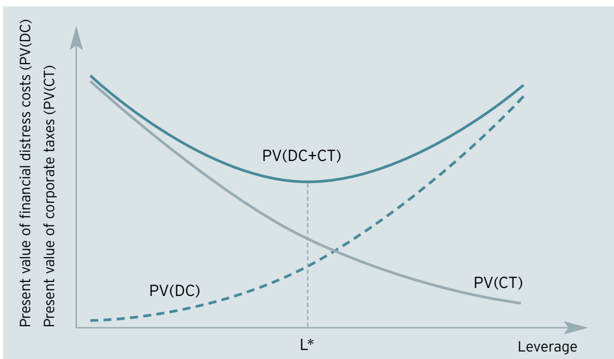

Figure 2 – Financial distress costs (DC) and corporate taxes (CT) constitute an optimal degree of leverage (L*)

Borrowing at the company level is motivated by income tax considerations. Corporate debt is assumed to create a tax shield that serves as a counterweight to financial distress costs [Brealey, Myers and Allen (2005)]. A marginal increase in the debt issue reduces the present value of the government's tax claim. In bankruptcy, taxable income would be negative and, if there was no associated tax credit, the tax shield of debt would be lost (at least partly). The interpretation of the distress costs (DC) and corporate tax (CT) functions illustrated in Figure 2, which constitute a unique optimal debt level, is straightforward. A one dollar increase in the firm's debt level leads, on the one hand, to an increase in expected financial distress costs, but on the other hand, to a reduction in expected corporate taxes. The optimal degree of leverage is reached when the present value of expected tax relief of the last dollar promised to the creditors just offsets the present value of the additional distress costs caused.

Corporate hedging benefits shareholders by reducing financial distress costs and taxes

Let us now consider the case in which the firm's risk management is confronted with a capital structure that is determined exogenously, so that only the hedge ratio is subject to optimization. As explained by Brown and Toft (2002), such a situation can be justified by thinking of the firm's capital structure choice as a more strategic long-run decision, while its hedging decision is more flexible and focuses on the short-run.

In this case, both the present values of financial distress costs and of corporate taxes are reduced by a marginal increase in the hedge ratio, as long as the probability of bankruptcy can be reduced further by corporate hedging. If, conversely, the riskless payments from certain derivatives contracts already fully cover the firm's credit obligation (D), then a marginal increase in the hedge ratio has no further impact on shareholder value.

To see how this works, it is helpful to think of the government's tax claim (CT) as a call option with a strike price that is identical to the face value of debt (D) and with the value of the firm (V) as its underlying [Majd and Myers (1987)]. In the same way, the financial distress costs (DC) can be seen as a put option which is a contingent claim owned by the firm's competitors or other potential beneficiaries of its distressed situation.

A familiar finding of option pricing theory is that the market value of any option is, in principle, an increasing function of the risk inherent in its underlying [Merton (1973)]. As long as the variance of the firm's asset value can be reduced by an increasing hedge ratio, one would expect the present value of both external drains to shrink and, as a result, shareholder value to increase. However, as pointed out by Jagannathan (1984) in an article that clarifies the role of Jensen's Inequality in option pricing theory, this result would require strictly convex payoff functions. Because the government's and the bankruptcy beneficiaries' contingent claims lose this feature when the firm's hedging activity exceeds a certain threshold level, the present values of taxes and bankruptcy costs may remain unchanged, although the variance of the firm's asset value simultaneously decreases further.

Therefore, it cannot be concluded from an option-like convexity of the deadweight costs (reflected either by costs of financial distress or corporate taxes) alone, that only the full hedge is optimal. With a fixed capital structure, the hedging policies that derive from the competing goals of shareholder value maximization and minimization of total risk (measured, for example, by the variance) will generally differ[6]. Hence, taking into account that an increased volume of derivatives contracts typically leads to additional transaction costs, in the form of bid-ask-spreads, for example, the recommendation for management is to reduce risk to the degree which will enable default to be ruled out with sufficient certainty.[7]

Corporate hedging benefits shareholders by raising optimal leverage

Let us consider the situation in which the firm's financial management is confronted with a hedge ratio that is determined exogenously, so that only the face value of the debt issuance is subject to optimization. Consider, for example, that it is the company's policy, for whatever reason, that exposures must always be fully hedged (H = 100%), hedged partly (H = 50%), or that the company has even decided not to use any derivatives at all (H = 0%). We wish to investigate briefly how a change in the hedge ratio can create additional value for shareholders by influencing the firm's capital structure choice.

A marginal increase in the hedge ratio affects the optimal capital structure through both the market value of the increase in distress costs resulting from an additional dollar borrowed and through the market value of the tax relief derived from an additional dollar borrowed. If the firm's bankruptcy risk can be reduced by a marginal increase in the hedge ratio, then this increase renders less valuable the additional financial distress costs that may arise in the future from an additional dollar borrowed today. Furthermore, the additional future tax savings from an additional dollar borrowed become more valuable now, because future taxes are only payable to the government if bankruptcy does not occur. Thus, on the one hand, corporate hedging can make the tax shield from additional debt safer, but on the other hand, can render less safe the claim by the beneficiaries of bankruptcy caused by further borrowing. Hence, a marginal increase in the firm's hedge ratio can lead to both a shrinking present value of the bankruptcy costs resulting from an additional dollar borrowed and at the same time to a growing present value of the tax relief result-

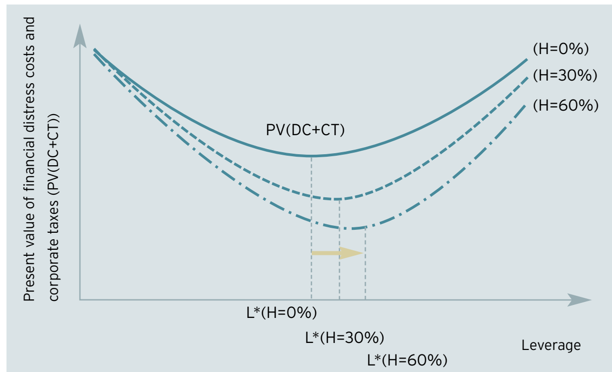

Figure 3 – Combined present value of financial distress costs and corporate taxes as a function of leverage L for alternative hedge ratios H = 0%, 30%, and 60%

ing from an additional dollar borrowed. Because the reduction in bankruptcy risk triggered by corporate hedging makes further debt financing more attractive, optimal leverage will be adjusted upwards to the benefit of shareholders.

This second-order effect of corporate hedging on shareholder value is illustrated in Figure 3. As already clear from Figure 2, the optimal size of the debt issue constitutes an optimal degree of leverage L* that minimizes the sum of the present values of distress costs (DC) and corporate taxes (CT), if the firm does not hedge at all (H = 0). The sum of deadweight costs PV(DC+CT) that must ultimately be borne by the firm's shareholders is illustrated in Figure 3 as a function of leverage (L) for three alternative hedge ratios (H) of 0%, 30%, and 60%, respectively. As the arrow indicates, optimal leverage (L*) increases with the selected hedge ratio. Hence, both types of undesired deadweight cost are not only diminished directly by corporate hedging, but they can be reduced even further, as higher hedge ratios allow the firm to raise leverage without increasing its bankruptcy risk.

Trading off the costs and benefits of corporate hedging: who hedges more?

Finally, we consider the case in which the company's management selects both its leverage and hedge ratio simultaneously. Stulz (1996) suggest that 'a company's decisions to hedge

6 The fundamental difference between hedging strategies that focus on a reduction of total risk (i.e., cash flow variance) and those that are designed to reduce bankruptcy risk is analyzed by Hahnenstein and Röder (2003).

7 The required confidence level may be derived from the firm's target rating. This idea is implemented in the economic capital approaches that have become an increasingly popular risk management concept during the past few years. See, for example, Hall (2002) or Schroeck (2002).

financial risks [...] should be made jointly with the corporate capital structure decision.'

We have stressed the fundamental difference between hedging strategies to reduce total risk, in terms of variance, and downside risk, in terms of the firm's probability of default, when leverage is exogenous. However, these differences may vanish in the simultaneous optimization of both corporate decision variables. To see how this works it is important to understand that shareholder value always increases with an increase in the firm's hedge ratio, when the firm is optimally levered and when transaction costs deriving from corporate hedging can be ignored. Hence, it is an immediate consequence that in the simultaneous optimum the firm fully hedges all its market price risk (H* = 100%).[8]

This intermediate finding based on neglecting the potential costs of corporate hedging is illustrated in Figure 4, which depicts the contour curves of the shareholder value surface.

In particular, it becomes apparent that total shareholder wealth always increases with the firm's hedge ratio for an optimized capital structure. Although shareholder value does not always increase with the firm's hedge ratio (the iso-shareholder-value-ellipses are vertical in the upper left corner of the base), it does so if further hedging reduces the bankruptcy risk incurred when leverage is optimal.

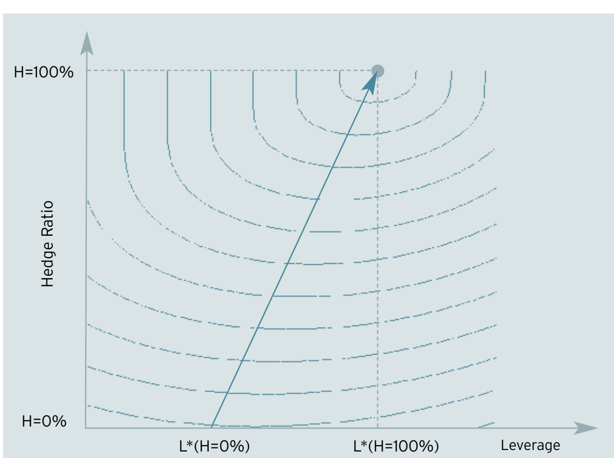

Figure 4 – Shareholder value as a function of the firm's leverage (L) and hedge ratio (H) in the absence of transaction costs of corporate hedging

Corporate hedging, which Stulz (1996) has characterized as a substitute for equity, is, in a sense, simply a means of applying regulatory arbitrage. The risk of future market price fluctuations is transferred completely to the hedge counterparty, who as the seller of protection effectively assumes the risk profile of an equity investor in the firm. Of course, this risk transfer will only take place if the counterparty's marginal costs of financial distress and taxes, which depend on the cash flows of all its other assets as well, are lower than those of the firm, possibly because it needs the firm's products as an input factor. Therefore, in equilibrium, the allocation of risk across the economy through equity, bond, and derivatives markets minimizes the total deadweight loss imposed by the legal, regulatory framework. Interestingly, this line of reasoning leads to an optimal hedging policy for the firm that coincides with the variance-minimizing solution that emerges from conventional wisdom[9].

While our analysis has so far been restricted to the benefits of corporate hedging and their interrelatedness, we now try to explain observable cross-sectional differences in corporate hedging behavior that result from trading off the benefits and costs of corporate hedging[10]. In order to establish an empirically testable theory of corporate hedging we introduce into our framework transaction costs of hedging (TC) that are assumed to directly diminish shareholder wealth. These transaction costs offset the benefits derived from reduced taxes, lower distress costs, and higher leverage and can thereby constitute a unique optimal hedge ratio. It can be shown that at the simultaneous optimum of both the firm's hedging and leverage variables, several comparative static results hold unambiguously for the chosen hedge ratio.

8 The idea of hedging away all risk in the first step and then levering up to a higher debt level in order to minimize the firm's tax liability can be attributed originally to MacMinn (1987).

9 Stulz (1996) refers to the variance-minimization-paradigm as the "prevailing academic theory of risk management" and Froot, Scharfstein and Stein (1993) summarize that "much of the previous work has the extreme implication that firms should hedge fully – completely insulating their market values from hedgeable risk."

10 As in Graham and Rogers (2002), information about differences in firms' hedge ratios may be derived from mandatory accounting disclosures. A potential empirical proxy variable for a firm's hedge ratio is the net notional amount of its total derivatives usage divided by its sales or total assets. Aggarwal and Simkins (2004) provide a summary of US-GAAP disclosure requirements for derivative financial instruments during the 1990s.

The first finding that emerges from the analysis is that those firms that face lower marginal transaction costs of corporate hedging are more likely either to hedge in full or in part. A second, not surprising finding is that those firms that are exposed to more volatile operating cash flows derive greater benefits from corporate hedging. The real reason behind this result is as follows. A greater level of price volatility in the firm's operating income renders the deadweight options for the beneficiaries of bankruptcy and of government's tax claim more valuable. Because the firm chooses its capital structure such that there is always a positive probability of bankruptcy, an increase in cash flow volatility leads to an increase in the marginal benefit that shareholders derive from corporate hedging. This is the case because the reduction in market value of both the external put and call options achieved through a derivates contract is ceteris paribus higher. Our third, and most important, comparative static result is that those firms whose indirect bankruptcy cost functions react more sensitively with an increasing degree of financial distress derive greater benefits from hedging. In terms of option pricing theory, firms that have higher bankruptcy betas are characterized by more convex distress cost functions. Returning to the Chrysler vs. Kellogg's example discussed above, Figure 5 illustrates why the typical automotive manufacturing company should hedge more than the average cornflakes producer. As our hypothetical company's bankruptcy beta (m) rises from 25% to 30%, its optimal hedge ratio more than doubles from 17.2% to 35.2%, while the face value of its optimal level of outstanding debt is reduced simultaneously by only less than 1%.

Conclusion

In this article, we have demonstrated how the popular trade-off model of optimal leverage that minimizes the sum of corporate taxes and financial distress costs can be enriched with the derivatives market. In this market, the firm can eliminate the market price risk associated with its operations by means of hedging contracts. It was demonstrated that the optimal level of outstanding debt is raised by an increase in the hedge ratio, if the probability of the firm going bankrupt is reduced.

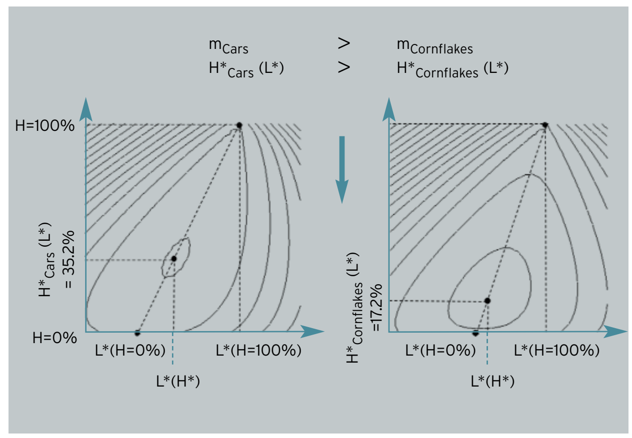

Figure 5 – Impact of increasing sensitivity m in the firm's financial distress cost function on the joint optimum of its hedge ratio H* and leverage L*.

We have illustrated that, for a given capital structure, the market value of shareholder equity is an increasing function of the firm's hedge ratio. This influence is, in terms of option pricing theory, due to the convexity of the deadweight claim payoff profiles. Interestingly, it cannot be concluded from the convexity of deadweight costs, in conjunction with a fixed capital structure, that the full hedge is the only optimal solution, because this convexity may disappear when bankruptcy risk is reduced. However, it is evident that for an optimally leveraged firm the marginal benefit shareholders derive from corporate hedging is always positive in the absence of transaction costs of hedging. Consequently, the firm insulates its future payments completely from hedgeable risk in the simultaneous optimum of its hedge ratio and capital structure. This intermediate result sheds new light on minimizing the variance of future cash flows as an appropriate goal for corporate risk management, when transaction costs of hedging are negligible.

Finally, and most importantly, however, when transaction costs of corporate hedging are taken into account that can offset the benefits, it emerges that in a group of otherwise identical optimally leveraged firms, those firms that face lower marginal transaction costs of hedging, more volatile operating cash flows and, in particular, more convex deadweight costs should choose higher hedge ratios. While the convexity of the firm's effective tax function, which is due to non-linearity of the national tax codes, has already been discussed extensively in prior empirical research [Graham and Smith (1999) and Graham and Rogers (2002)], the convexity of deadweight costs due to potential financial distress, which plays the central role in our model here, has been neglected completely. Using anecdotal evidence of greater benefits of risk management for firms selling credence goods or products involving long-term relationships, we believe that such differences in indirect bankruptcy cost functions across firms offer a promising basis for future empirical research aimed at explaining observable differences in firms' hedge ratios.

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