Risk Management - Variance Minimization or Lower Tail Outcome Elimination

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ABSTRACT

This paper illustrates the profound difference between a risk management strategy of variance minimization and a risk management strategy of lower tail outcome elimination. Risk managers concerned about the variability of cash flows will tend to center their hedge decisions on their best guess on future cash flows (the budget), while risk managers concerned about costly lower tail outcomes will hedge (considerably) less depending on the level of uncertainty. A risk management strategy of lower tail outcome elimination is in line with theoretical recommendations in a corporate value-adding perspective. A cross-case study of blue-chip industrial companies partly supports the empirical use of a risk management strategy of lower tail outcome elimination but does not exclude other factors from (co-)driving the observations.

INTRODUCTION

The ultimate goal of an active risk management policy is to add value. Or as Froot (1994) puts it, if hedging cannot raise the value of a company, then hedging should not be pursued. Fundamentally an increase in the value of the company can come from either a decrease in the discount rate or from an increase in the future cash flows. This stems from the simple notion that the value of a company is the discounted value of the future cash flows.

This paper focuses on exchange rate exposure management. However, the arguments of the paper are applicable to interest rate exposure management and management of commodity price risk.

Dufey and Srinivasulu (1983) state that even if an exchange rate risk does exist, it need not be hedged, and even if it is to be hedged, corporations need not hedge it.

The argument that there is no need to hedge an exchange rate risk rests on the Capital Asset Pricing Model (CAPM) introduced by Sharpe (1964). In the CAPM only systematic risk matters. Provided that exchange rate risk is a diversifiable risk, diversified stockholders should not price exchange rate risk and there is no need to hedge such a risk.

And the argument, that even if there is a need to hedge the exchange rate risk there may be no need for doing it at the corporate level, rests on Modigliani and Miller (1958). M&M showed the irrelevance of a company's financing policy in a situation with a fixed investment policy and no contracting costs or taxes. In regard to hedging the logic in the M&M debt irrelevance proposition implies that if risk managers choose to change the hedging policy of a company, the stockholders of the company can change their holdings of risky assets to offset the change in the company's hedging policy - leaving the hedging policy of the company irrelevant.

The above arguments are valid in a perfect world. However, imperfections change the rules of the game. The imperfections that justify hedging are related to the discount rate

- non-diversified stockholders (and managers)

or related to the future cash flows

- financial distress
- ability to make value-adding investments (not independent of internal funds)
- taxes.

Non-diversified stockholders (and managers) may find that stabilizing the stock price of the company is by itself value-adding even if the average value of the stock is constant - a consequence of risk aversion in combination with a lack of diversification possibilities.

Levi and Sercu (1991) emphasize that because of imperfections in various markets (product market, labor market, capital market, bankruptcy costs) hedging may increase future cash flows by reducing the likelihood of encountering financial distress. Froot, Scharfstein, and Stein (1993) write in a framework of capital market imperfections where externally obtained funds are more expensive that those generated internally. They make a case for letting the cash flow stream depend on the attractiveness of investment opportunities in the company and thus create value by improving the ability to make value-adding investments. Finally, Nance, Smith and Smithson (1993) note that because of Jensen's inequality, hedging reduces expected taxes if the company's effective tax schedule is convex.

Thus, in a corporate value-adding perspective an active risk management policy should be based on the possible impact of changes in exchange rates on cash flows rather than on stock prices - the main exception being the case of non-diversified stockholders (and managers). Furthermore, managers should be especially concerned about protecting the down side (e.g. financial distress or lack of funds for investments) rather than minimizing variance as often assumed by theory.

Stulz (1996) challenges the focus on variance. He argues that "*the primary emphasis of the theory is on the role of derivatives in reducing the variability of corporate cash flows and, in so doing, reducing various costs associated with financial distress*". Rather than putting emphasis on variance minimization Stulz emphasizes downside risk reduction or "*the elimination of costly lower-tail outcomes*".

Capel (1997) is in line with Stulz and states "*that an important question has escaped attention in the literature: does economic exposure management originate from a general aversion to exchange risk or from an aversion to downside exchange risk in particular?"* Capel argues that "*managers should only have an aversion to downside risk.*" The likelihood and magnitude of an unfavorable outcome rather than the variances of the company's market value or cash flows is the best yardstick for measuring risk according to Capel.

The distinction between variance minimization and lower tail outcome elimination may seem to be a purely theoretical encounter with no or little impact as to practical risk management. The purpose of this paper is to

1) illustrate the profound difference between a risk management strategy of variance minimization and a risk management strategy of lower tail outcome elimination
2) understand how actual risk management strategies in industrial companies fit into a framework of variance minimization or a framework of lower tail outcome elimination.

In *section 2* a dice analogy (the use of a dice analogy is inspired by Hertz, 1979) is presented that in an intuitive way highlights the different hedge decisions that result from an approach that aims to eliminate lower tail outcomes versus an approach that aims to minimize the variance of possible outcomes. Risk managers concerned about the variability of cash flows will tend to center their hedge

decisions on their best guess on future cash flows, while risk managers concerned about costly lower tail outcomes will hedge (considerably) less depending on the level of uncertainty.

Based on a cross-case study of eight blue-chip industrial companies *section 3* shows how a failure to acknowledge the possibility that risk managers try to eliminate lower tail outcomes (as opposed to reduce variance) may lead to flawed conclusions as to the speculative intentions of these managers. The empirically observed wide use of partial hedging (e.g. Bodnar, Marston, and Hayt, 1998) - partial meaning that risk managers only hedge part of their budgeted (expected) cash flows - may stem from a pursuit of a policy of lower tail elimination rather than from a policy of active position taking. However, other possibilities exist.

Section 4 concludes.

DICE ANALOGY

This dice analogy serves to bring to front an intuitive understanding of the problems inherent in establishing optimal hedges in relation to exchange rate exposure management. It shows the differences in an approach that aims to eliminate lower tail outcomes versus an approach that aims to minimize the variance of possible outcomes.

Exchange rate exposure is divided into three different exposures: translation exposure, transaction exposure, and operating exposure (e.g. Eiteman, Stonehill, and Moffet, 2001). The former exposure is an accounting exposure while the latter two exposures are cash flow exposures. As such we focus on transaction exposure and operating exposure. Operating exposure is sometimes termed strategic exposure or competitive exposure.

Transaction exposure is a nominal and often short-term exposure arising because of contractual obligations where the nominal amount in question is fixed. Operating exposure is a real exposure arising because of the impact from unexpected changes in exchange rates on the operations of the company and thus on the operating profits, the cash flows, and the value of the company.

In this dice analogy we focus on transaction exposure (game 1) where only the exchange rate (dice 1) is a risk factor and on operating exposure (game 2) where the exchange rate (dice 1) as well as the number of units sold at a foreign market (dice 2) are risk factors:

Dice 1: Exchange Rate
Dice 2: Units sold (= amount in foreign currency)

For simplicity we assume that the price in foreign currency is fixed (the company in question is a price taker on the foreign market) and equals one. Thus, the number of units sold at the foreign market is the same as the amount in foreign currency that is to be received by the exporter.

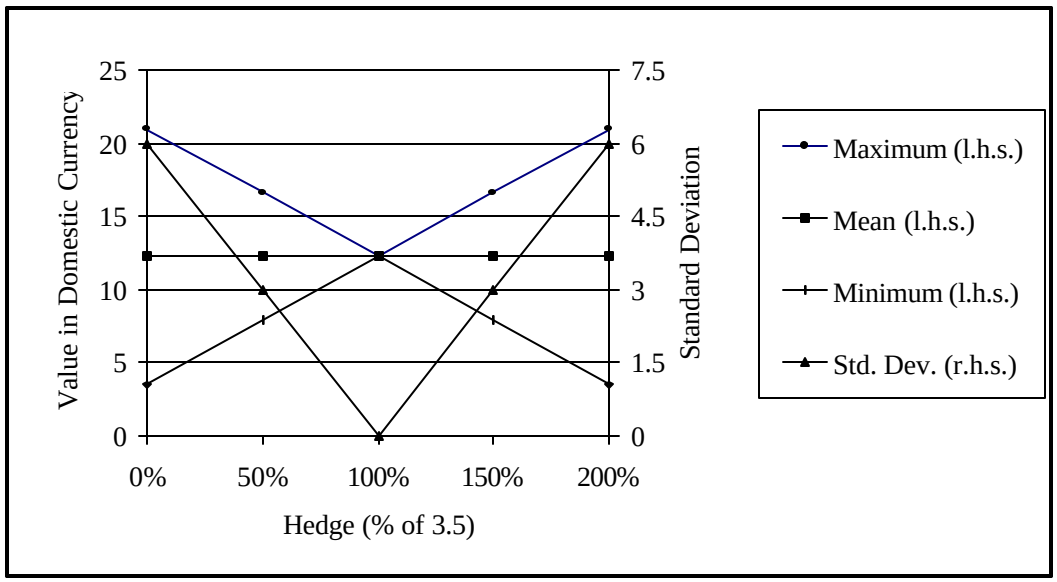
The first game (management of transaction exposure)

The first game resembles a situation in which the only uncertainty stems from transaction exposure. The player (the risk manager) knows the exact amount in foreign currency that he is to receive on a future date (he has sold the goods, sent an invoice, and is now waiting for the payment in foreign currency). What he is to receive measured in domestic currency depends on the exchange rate (the outcome of the roll of dice 1).

The player has to roll Dice 1 once. The outcome will determine the exchange rate. The average exchange rate is 3.5 units of domestic currency for 1 unit of foreign currency, the maximum exchange rate is 6, and the minimum exchange rate is 1. Because a lot of players are playing the same or opposite games, a market is created at which the player can sell forward foreign currency for the average value of 3.5. As such the player can hedge the result and eliminate any uncertainty. Figure 1

shows the player's gains dependent on his hedge decision. In this transaction exposure case the number of units sold at the foreign market (dice 2) and thus the amount in foreign currency is fixed to 3.5.

Figure 1 Transaction Exposure (Dice 1 times 3.5)



Independent of the hedge undertaken, the average gain (value in domestic currency) is 12.25 (3.5 *3.5) as hedging in itself is a zero-sum game. However, the maximum gain, the minimum gain and the standard deviation are highly dependent on the extent of hedging. If the player sells forward exactly 3.5 units of foreign currency for 3.5 per unit then the mean, the maximum, and the minimum are all 12.25 and the standard deviation is 0 (no uncertainty). However, if the player does not hedge at all (or sells forward 7 units of foreign currency) then the mean is still 12.25 but the maximum is 21 (3.5 * 6), the minimum is 3.5 (3.5 * 1), and the standard deviation is 6.0.

The amount in domestic currency that the risk manager is to receive depends on the exchange rate (the outcome of the roll of Dice 1). However, he can eliminate the uncertainty by selling forward 3.5 units of foreign currency. In this game eliminating lower tail outcomes and minimizing the variance lead to the same conclusion in relation to the optimal hedge amount. Exactly 3.5 units of foreign currency should be sold forward in order to maximize the minimum *and* in order to minimize the variance (the standard deviation).

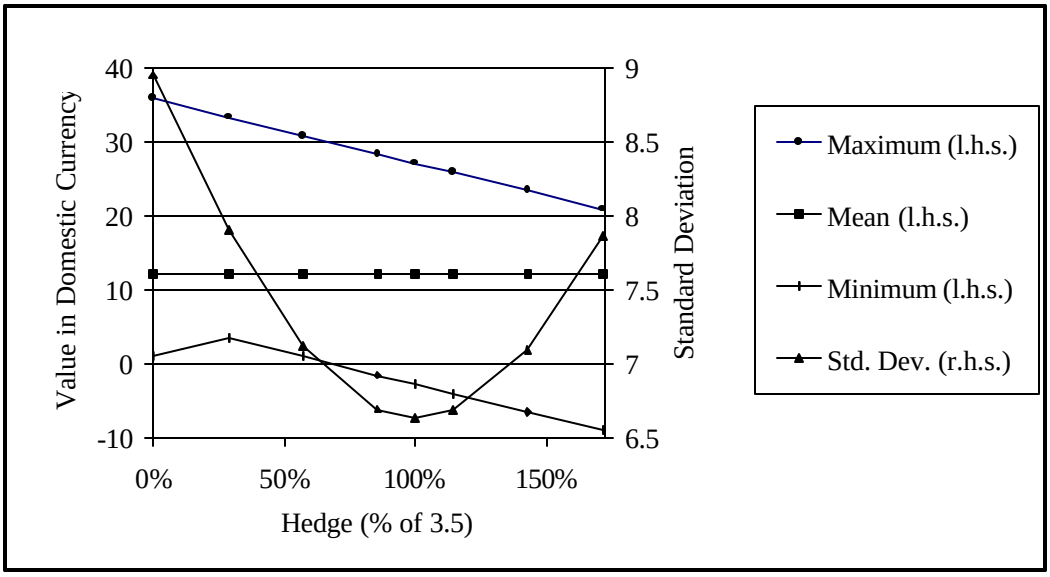
The second game (management of operating exposure)

The second game resembles a situation in which the uncertainty stems from operating exposure. The player (the risk manager) does not know the exact amount in foreign currency (the outcome of the roll of Dice 2) that he will receive on a future date because of sales. What he is to receive measured in domestic currency furthermore depends on the exchange rate (the outcome of the roll of Dice 1). However, he can try to manage the uncertainty by selling forward units of foreign currency.

The player has to roll Dice 1 and Dice 2 once. The product of the outcomes will determine what the player wins. The average value that the player will obtain is 12.25 (3.5*3.5), the maximum value is 36 (6*6), and the minimum value is 1 (1*1). Because a lot of players are playing the same or opposite games with Dice 1 type of dice, a market is created at which the player can sell forward the foreign currency for the average value of 3.5. However, a similar market is not available for Dice 2.

As such the player can hedge the outcome of Dice 1. But he does not know by which number the outcome of Dice 1 shall be multiplied - decided by the roll of Dice 2. The average number for multiplication is 3.5 (units sold according to budget) but it could also be as low as 1 (units sold in a worst case scenario) and as high as 6 (units sold in a best case scenario). Figure 2 shows the player's gains dependent on his hedge decision.

Figure 2 Operating Exposure (Dice 1 times Dice 2)



Independent of the hedge undertaken, the average gain is 12.25 as hedging in itself is a zero-sum game. However, the maximum gain, the minimum gain and the standard deviation depend on the extent of hedging. If the player sells forward exactly 3.5 units of foreign currency (100%) for 3.5 per unit then the maximum is reduced from 36 to 27.25 (6*6+3.5*(3.5-6) or alternatively 3.5*3.5+2.5*6), the minimum is *reduced* from 1 to –2.75 (1*6+3.5*(3.5-6) or alternatively 1*3.5+2.5*(3.5-6)), and the standard deviation is reduced from 9.0 to 6.6.

While selling forward exactly 3.5 units of foreign currency (100%) produces the lowest possible standard deviation, it does *not* eliminate lower tail outcomes (maximize the minimum). Eliminating lower tail outcomes (lifting the floor to the largest extent possible) is done by selling forward only one unit of foreign currency (1/3.5=29%). As such, the player must decide whether he wants to minimize the variance or eliminate lower tail outcomes (maximize the minimum). In contrast to the transaction exposure case, the two alternative decision rules produce different hedge results.

In this game eliminating lower tail outcomes and minimizing the variance lead to different conclusions in relation to the optimal hedge amount. From the above follows that risk managers concerned about the variability of cash flows will tend to center their hedge decisions on their best guess on future cash flows, while risk managers concerned about costly lower tail outcomes will hedge (considerably) less.

The games

The two games highlight the difference in optimal hedges that arise from a corporate risk management policy based on variance minimization versus a policy based on improving the worst possible outcome (eliminating lower tail outcomes). The games show that in order to minimize the variance the hedge should cover exactly the average or the best estimate. However, in order to eliminate lower tail outcomes the hedge should cover only the lowest possible sale.

Translated to actual exchange rate exposure management a risk manager concerned about cash flow fluctuations in general must hedge the budgeted cash flows while a risk manager concerned about eliminating lower-tail outcomes should hedge only the cash flows that are expected in a worst case scenario. As such, basing the hedging decisions on the expected cash flows instead of looking at ranges of possible cash flows is adequate only if the aim of the hedging strategy is to reduce the variance of cash flows. If the aim of the hedging strategy is to improve the worst possible outcome, such a procedure is inadequate if not harmful - harmful because you may loose on two fronts (the underlying business *and* the hedge).

CROSS-CASE STUDY

Empirical studies (e.g. Bodnar, Marston, and Hayt 1998) have shown that exchange rate exposure management focus on transaction exposure and only that part of operating exposure, which is made up of (short-term) anticipated transactions. Some authors find that finance managers have a less clear understanding of operating exposure than of the more straightforward transaction and translation exposure (Malindretos and Tsanacas, 1995).

However, as the dice analogy showed, the fact that an exposure is not fully hedged does not imply that this exposure has been given insufficient attention. A partial hedge may be a result of a risk management policy that aims to eliminate lower tail outcomes. In fact, research shows that managers tend to perceive the risk of a project not to be related to the dispersion of the outcomes but rather to be related to the outcomes entailing a loss (Ruefli, Collins and Lacugna, 1999).

This section draws upon a cross-case study of the eight blue-chip industrial companies listed on the Copenhagen Stock Exchange as of the end of 1997 (Bang & Olufsen Holding a/s, Carlsberg A/S, Coloplast A/S, Danisco A/S, FLS Industries A/S, GN Store Nord as, Novo Nordisk A/S, and Superfos a/s). The study is based on interviews conducted in 1999 with finance managers (or treasurers) of the companies. For results not covered in this section please see Aabo (2001a) and Aabo (2001b).

The companies in the study cover a broad specter of branches producing a variety of products (beer, cement, enzymes, food ingredients, pharmaceuticals, roads, soft drinks, sugar, telecommunication equipment, televisions, etc.). The companies have an average turnover of USD 2.1 billion and they are all heavily internationally oriented as two thirds or more of the turnover of each company originates from foreign markets (published accounts 1997/1998 or 1998).

The aim of the section is to understand how actual risk management strategies in industrial companies may fit into either a framework of variance minimization or a framework of lower tail outcome elimination.

Table 1 shows the familiar picture of companies focusing on transaction exposure and short term anticipated transactions. Four companies state that they *always* hedge transaction exposure while on the other end of the scale six companies state that they *never* hedge the more long term and diffuse competitive exposure (operating exposure).

Table 1 Extent of Hedging (number of companies)

To which extent does your firm hedge the following categories of exposures?	Never	Some-times	Fre-quently	Always
Transaction exposure		1	3	4
Anticipated transactions 1 year or less		4	3	1
Anticipated transactions over 1 year	4	4		
Competitive exposure	6		2	

Table 2 shows a picture of companies hedging partially. The more uncertain the exposure, the less fully the exposure is hedged. Partial hedging in itself could lead to a conclusion of speculative action. This is, however, premature. As noted before, partial hedging might just as well be part of a strategy of lower tail outcome elimination.

Table 2 Percentage of Exposures Hedged (number of companies)

What percentage of the following categories of exposures does your firm typically hedge?	Percentage of exposure typically hedged:			
	0%	1%-25%	25%-75%	75%-100%
Transaction exposure		1	2	5
Anticipated transactions 1 year or less		3	3	2
Anticipated transactions over 1 year	4	3	1	
Competitive exposure	6		2	

Table 3 indicates that the partial hedging shown in Table 2 may in fact be part of a strategy of lower tail outcome elimination for some of the companies.

Table 3 Importance of Exposures (number of companies)

How important does your firm consider the following categories of exposures?	Not important	Of some importance	Very important
Transaction exposure		1	7
Anticipated transactions 1 year or less		1	7
Anticipated transactions over 1 year	2	5	1
Competitive exposure	1	7	

As such, two examples stand out. Seven companies find that anticipated transactions 1 year or less are very important (Table 3). However, only two companies hedge anticipated transactions 1 year or less by 75%-100% (Table 2). Likewise, seven companies find that competitive exposure is of some importance (Table 3) but only two companies hedge competitive exposure (Table 1 and 2).

The fact that some companies hedge less than implied by the attributed importance indicates that a policy of lower tail outcome elimination is pursued rather than a policy of variance minimization - because a policy of lower tail outcome elimination means partial hedging as shown in the dice analogy.

This is not necessarily the (whole) truth. Other possible reasons for partial hedging of especially long time horizons exist:

1) The more long-term a given exposure, the more likely it is that this exposure is handled by actual means such as production reallocation.
2) There is a less clear understanding of long-term exposures than of more short-term exposures (Malindretos and Tsanacas, 1995) leading to less focus on the latter.
3) The companies in this cross-case study speculate. Six of the eight companies state that they do incorporate the company's view on the exchange rates when hedging.

Asked specifically if the hedging policy of their companies is best characterized by being "Variability reducing" or by being "Down side risk reducing", six finance mangers choose the former while two choose the latter. However, only one company has a benchmark model (approved by the upper management) for their hedging policy. As such, it is not clear whether the question of variance minimization versus lower tail outcome elimination has been given explicit attention in the companies to such a degree that the answers can be taken at face value - especially so because also the academic focus on the difference between the two strategies is new.

The observations in the cross-case study do not prove that a policy of lower tail outcome elimination is followed. Although a policy of lower tail outcome elimination seems intuitively reasonable, and although the observations for at least some of the companies are in line with a policy of lower tail outcome elimination, the observations could also be a result of other factors (solely or in conjunction).

However, the possibility that some companies follow a strategy of lower tail outcome elimination rather than a strategy of variance minimization when managing risks should be given sufficient emphasis when trying to understand actual risk management strategies - especially when keeping in mind the dramatic difference in actual hedging decisions that a strategy of variance minimization and a strategy of lower tail outcome elimination may lead to (as illustrated by the dice analogy).

CONCLUSION

Using a dice analogy the profound difference between a risk management strategy of variance minimization and a risk management strategy of lower tail outcome elimination was illustrated. Risk managers concerned about the variability of cash flows will tend to center their hedge decisions on their best guess on future cash flows (the budget), while risk managers concerned about costly lower tail outcomes will hedge (considerably) less depending on the level of uncertainty.

The empirical observations in a cross-case study of eight blue-chip industrial companies did lend support to the existence of a strategy of lower tail outcome elimination but not exclusively so as other reasons could be behind the observations.

That some companies follow a strategy of lower tail outcome elimination rather than a strategy of variance minimization when managing risks is in line with theoretical recommendations and not empirically rejected. Trying to understand actual hedging behavior without a prudent understanding of the difference between a risk management strategy of variance minimization and a strategy of lower tail outcome elimination may prove fallacious.

The difference in the two approaches is particularly relevant in the New Global Economy if this economy is characterized by innovations, crises, new market structures etc. translating through the world economy at speeds that were unthinkable a decade ago. The increased uncertainty at the company level deems proper risk management one of the success factors. As such, understanding the basis for the optimal risk management strategy is crucial.

The empirical part of this paper is restricted by only including eight industrial companies in a cross-case study. Further research into the actual and optimal risk management strategies of companies is encouraged to elaborate on the distinction between variance minimization and lower tail outcome elimination.

REFERENCES

Aabo, Tom (2001a), "Exchange Rate Exposures and Strategies of Industrial Companies - An Empirical Study", *Thunderbird International Business Review*, Vol. 43, No 3, pp. 379-395.

Aabo, Tom (2001b), "E-commerce and Exchange Rate Exposure Management - a Tilt Towards Real Hedging", *Journal of E-Business*, Vol. 1, No. 1, pp. 1-10.

Bodnar, Gordon M., Richard C. Marston, and Greg Hayt (1998), "1998 Survey of Financial Risk Management by U.S. Non-Financial Firms", *George Weiss Center for International Financial Research*, Wharton School, University of Pennsylvania and CIBC World Markets, pp. 1-21.

Capel, Jeannette (1997), "A Real Options Approach to Economic Exposure Management", *Journal of International Financial Management & Accounting*, Vol. 8, No. 2, pp. 87-113.

Dufey, Gunter and S.L. Srinivasulu (1983), "The Case for Corporate Management of Foreign Exchange Risk", *Financial Management*, Vol. 12, Winter, pp. 54-62.

Eiteman, David K., Arthur I. Stonehill, and Michael H. Moffett (2001), *Multinational Business Finance*, Ninth Edition, Addison-Wesley Publishing Company.

Froot, Kenneth A. (1994), "Comments on Exchange Rates and Corporate Strategic Management", in *Exchange Rates & Corporate Performance*, Yakov Amihud & Richard M. Levich (eds.), Irwin Professional Publishing, pp. 253-255.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein (1993), "Risk Management: Coordinating Corporate Investment and Financing Decisions", *Journal of Finance*, Vol. 48, No. 5, pp. 1629-1658.

Hertz, David B. (1979), "Risk analysis in capital investment", *Harvard Business Review*, September-October, pp. 169-181.

Levi, Maurice D. and Piet Sercu (1991), "Erroneous and Valid Reasons for Hedging Foreign Exchange Exposure", *Journal of Multinational Financial Management*, Vol. 1, No. 2, pp. 25-37.

Malindretos, John and Demetri Tsanacas (1995), "Hedging Preferences and Foreign Exchange Exposure Management", *Multinational Business Review*, Vol. 3, No. 2, pp. 56-66.

Modigliani, Franco and Merton H. Miller (1958), "The Cost of Capital, Corporation Finance and the Theory of Investment", *The American Economic Review*, Vol. 48, No. 3, pp. 261-297.

Nance, Deana R., Clifford W. Jr. Smith, and Charles W. Smithson (1993), "On the Determinant of Corporate Hedging", *Journal of Finance*, Vol. 48, No. 1, pp. 267-284.

Ruefli, Timothy W., James M. Collins and Joseph R. Lacugna (1999), "Risk Measures in Strategic Management Research: Auld Lang Syne", *Strategic Management Journal"*, Vol. 20, No. 2, pp. 169-194.

Sharpe, W.F. (1964), "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk", *Journal of Finance*, Vol. 19, No. 3, pp. 425-442.

Stulz René M. (1996), "Rethinking Risk Management", *Journal of Applied Corporate Finance*, Vol. 9, No. 3, pp. 8-24.