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Exposures and Exposure Hedging in
Exchange Rate Risk Management

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Zusammenfassung

„Exposures und Absicherung im Währungsrisikomanagement“

Steigende Volatilitäten an den Devisenmärkten haben beträchtliche Auswirkungen auf Unternehmen. Zum Teil auch als Reaktion auf diese Entwicklung hat sich das Angebot an derivativen Finanzinstrumenten, mit denen sich Unternehmen gegen die Auswirkungen schwankender Wechselkurse absichern können, deutlich erhöht. Ein vollständiges Verständnis der mit schwankenden Wechselkursen einhergehenden Risiken und ein korrekter Einsatz derivativer Instrumente erfordern eine fundamentale Betrachtung der Parameter eines Währungsrisikomanagements. Im ersten Teil des vorliegenden Papiers werden deshalb die Begriffe des Wechselkursrisikos, des Währungsrisikos und der verschiedenen Währungs-Exposures systematisiert. Im zweiten Teil wird ein entscheidungstheoretisches Kalkül zur Bestimmung der optimalen Absicherungsposition mit Währungs-Forwards bei Vorliegen eines Transaktionsrisikos vorgestellt.

JEL-Klassifikation: F31, G15, G39

Stichworte: Währungsrisiko, Transaktionsrisiko, Währungs-Forwards, optimales Hedging.

Abstract

Corporations are affected by increasing volatilities on foreign exchange markets. A response to this development was the creation of financial instruments, so called derivatives, in order to protect corporations from the effects of flexible exchange rates. To understand the included risks and to take correct decisions it is necessary to get a fundamental insight into exchange rate risk management. First it is the aim of this paper to systemize the possibilities of determining exchange rate risk as well as objectives of exchange rate risk management. In the second part of the paper a model to determine the optimal hedge ratio in the case of hedging transaction risks with forwards is described.

JEL-classification: F31, G15, G39

Keywords: Currency Risk, Transaction Risk, Currency Forwards, Optimal Hedging.

1 Currency and exchange rate risk

Currency risks for corporations arise from all those activities of a corporation that are carried out outside the firm's currency area. Currency risks are a result of exchange rate fluctuations as well as the unforeseeable extent of exchange rate changes. The inability to predict exchange rate changes as well as the extent of these changes creates uncertainties for corporations in regard to potential losses. In line with these findings currency risk can be defined as the uncertainty regarding future movements of exchange rates. Additionally, currency risks arise from unexpected interventions of currency regulators. Depending on what causes them, the generic term currency risk can be subdivided into exchange rate risk, the risk of parity changes, and convertibility/transfer risk.

The exchange rate is the price of one currency measured in terms of another currency. Direct quotation displays the number of domestic currency per unit of foreign currency. Indirect quotation displays the number of foreign currency units per unit of domestic currency. Exchange rate risk seems to be an important source of potential losses for corporations in regard to currency risks (fig. 1). The effect of the presence of exchange rate risk is that financial positions denominated in foreign currency are exposed to possible changes in value. This risk becomes manifest in, e.g., an unfavourable change in value of receivables that is not offset by a change in value of payables.

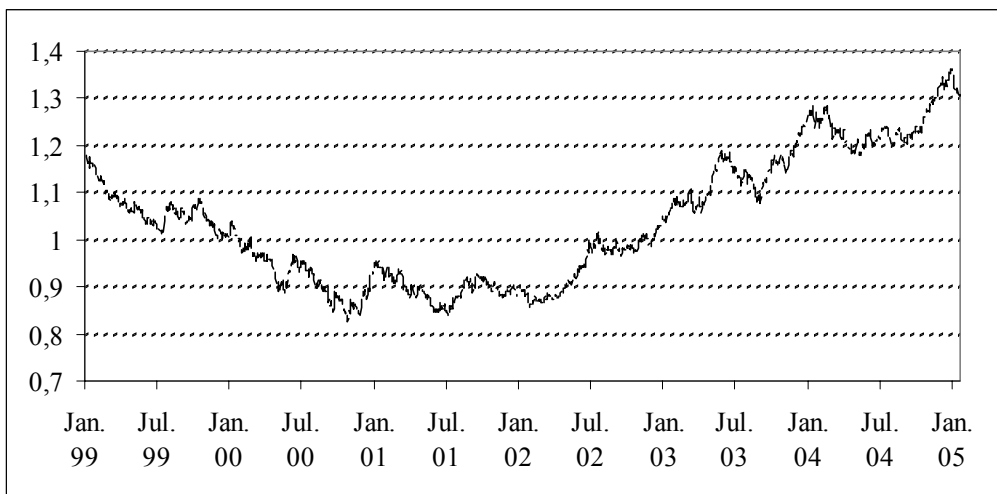


Fig. 1: EUR/US\$-Daily quotations 1999-2005, European Central Bank

The term exchange rate risk is defined in many different ways (Pfennig 1998, p. 11; Breuer 2000, p. 117). Exchange rate risk can be defined as the probability distribution of future uncertain exchange rates that affect the value calculated in home currency of certain financial positions. This definition emphasises the fact that future exchange rates typically are not known for certain in advance. In addition, it states that the knowledge of corporations as to future exchange rates is limited to a probability distribution of future exchange rate changes. A requirement for exchange rate risk and currency risk in general to arise is the existence of a financial position that is affected by possible exchange rate changes. Such a financial position is called currency exposure or, for short, exposure. An exposure represents a target for exchange rate risk. It is a result of real business and the financial activities of a corporation. Based on these statements, two parameters can be identified that affect the financial positions of a corporation:

- Price risk results from unexpected changes in future exchange rates. This risk is determined by the maturity of planned cash flows as well as the currency of denomination. The longer the maturity the longer is the duration in which possible exchange rate changes can affect cash flows. The currency of denomination influences cash flows by its specific developments and volatilities.
- Quantity risk refers to the uncertain size of cash flows. It is the risk that actual exposures are different from expected exposures (Stulz 2003, p. 224). It is determined by the volume of exposed financial positions denominated in foreign currency. These financial positions are net foreign currency positions, resulting from the balance of foreign currency cash inflows and outflows.

Hence, the effects of exchange rate risk appear in value changes of financial positions due to exchange rate changes in a certain time period.

Furthermore, it is important to differentiate between nominal and real exchange rate changes. The nominal exchange rate is defined as the price of a unit of foreign currency measured in domestic currency. The real exchange rate is defined as the nominal exchange rate corrected for relative prices (Copeland 2000, p. 70). This implies that nominal exchange rate changes result in a real exchange rate change only when the nominal change is not offset by a change in the inflation rate. If the nominal exchange rate changes and changes in the inflation rate offset each other, real exchange rates do not change and relative purchasing power parity exists. Although nominal exchange rate developments show daily changes which can be quite

strong, inflation rates change relatively slow. For this reason, purchasing power parity does not hold in the short to medium term.

The risk of parity changes is described as the uncertainty about the time and extent of changes in currency parities, initiated by currency authorities. It arises if currency authorities have established a fixed exchange rate for each foreign currency – a parity – which can only be changed by the currency authorities. Risk arises for corporations due to the possibility that these parities will be changed. This currency risk category has the same economic consequences as exchange rate risk for corporations. The difference is that these administrative interventions are rarer and can be predicted more easily.

Other types of currency risk are the convertibility risk and the transfer risk. Convertibility risk arises when currency regulators restrict the conversion of currencies. These restrictions can limit volumes and conversion dates. An additional source of risk facing an internationally operating corporation is transfer risk. Transfer risk arises from official restrictions on transferring funds from one currency area into another.

The causes of the risk of parity changes, convertibility risk and transfer risk come from various activities of currency authorities. This is what distinguishes these risks from exchange rate risk.

2 Exposures to the exchange rate risk factor

2.1 Translation exposure

The two basic concepts of quantifying exposure are translation exposure and economic exposure (Fig. 2; see Adler/Dumas 1984, Froot/Scharfstein/Stein 1993). Translation exposure results from the need to convert the financial statements of foreign subsidiaries from the foreign currency to the home currency of the corporation, for the purpose of reporting and consolidation (Shapiro 2003, p. 330). If the translation of a financial position such as assets, liabilities, revenues, expenses, gains and losses in the future will be carried out with the spot rate then prevailing, which is not known for certain in advance, the value of that position in the home currency will be uncertain as well. The possible extent of the gains or losses of reported financial positions due to an exchange rate change is measured by the translation exposure.

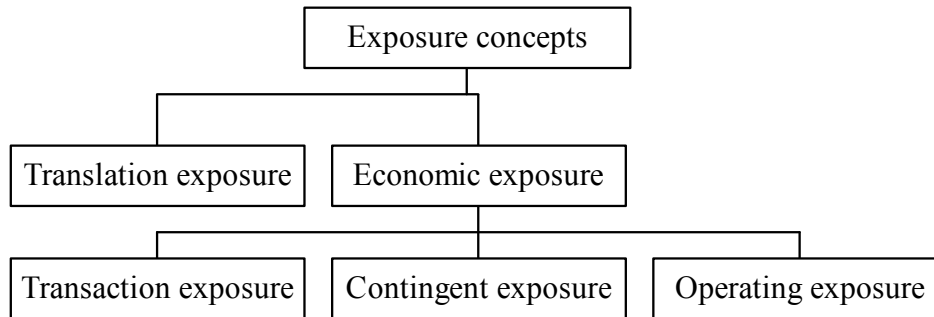


Fig. 2: Categorization of exposure concepts

Some balance-sheet positions might result in future foreign currency payments of the same amount. Therefore, these balance-sheet positions will also be of importance in the establishment of the transaction and economic concepts. However, the translation exposure concept can be delimited specifically from the other two concepts for those balance-sheet positions that will not directly result in payments. An example of this position is a multinational company owning a share of a corporation in another currency area. The process of translating balance-sheet positions from one currency into another can be carried out using several translation methods.

In order to reach a conclusion on the suitability of the translation exposure concept for exchange rate risk management, the explanatory power of balance-sheets in regard to economic performance measurement needs to be assessed. Investors are first and foremost interested in obtained net-payments of a corporation, because these payments determine the amount of the dividend and therefore represent the basis for the consumption position of investors. By contrast, balance-sheet positions do not have a direct influence on the consumption position of investors (Breuer 2000, p. 122). Additional criticism on the translation exposure concept refers to the fact that book-value oriented concepts are based on historic data.

In spite of the arguments presented so far, another argument focuses on the indirect effects of translation exposure management on the ability of corporations to raise funds. This argument becomes important when reported balance-sheet results are perceived as a measure of management performance. In such cases a loss on the balance-sheet can be associated with a decrease in the quality of a corporation's management. This in turn can reduce a corporation's abilities to raise new finance and thus have adverse effects on capabilities to invest.

2.2 Economic exposure

The concept of economic exposure focuses on cash flows. It includes already booked receivables and payables denominated in a foreign currency as well as all potential future cash flows which have, at the time of assessment, uncertain volumes that depend on the development of the exchange rate. Hence, the economic exposure represents possible fluctuations of future cash flows in home currency that are caused by changes in the exchange rate. The economic exposure concept extends the measurement of risk to the long run. Therefore it also intends to describe the consequences of exchange rate changes on the competitive position of a corporation. Thus, it includes both parameters of exchange rate risk, price risk and quantity risk.

According to Shapiro 2003, p. 337, the concept of economic exposure describes the impact of exchange rate changes on the value of a firm. He adopts the view that the economic risk can be measured by the change of the present value of future cash flows that is due to a change in the exchange rate. Thus, a comparison of present values in different exchange rate scenarios shows to what extent future exchange rates influence the value of present cash flows.

The economic exposure concept embodies all cash flows of a corporation. These cash flows can have differing characterizations that make it necessary to further subdivide economic exposure. Contingent exposure, e.g., arises when a corporation takes part in invitations to tender and makes a contractually binding bid for a contract that will create cash flows denominated in foreign currency at some later date. The outcome of the tendering procedure will only be known at a future date. Therefore a position that is exposed to exchange rate risk is created only when the corporation obtains the contract. In case of a successful bid, a company faces exchange rate risk because of possible mismatches in the cash inflows and outflows denominated in foreign currency resulting from this contract.

Operating exposure originates from the effects of currency fluctuations on a company's revenues and costs and therefore on the operating cash flows. The operating exposure is a long-term measure of the effect of exchange rate changes on a corporation's cost and price competitiveness. A corporation is exposed to operating risk when it is engaged in a market that is subject to foreign competition or when it sources inputs in a foreign market. Due to the longer time horizon of the operating exposure, real exchange rate changes give rise to this exposure. Operating exposure originates when changes in the nominal exchange rate are not offset by changes in prices. Consequently, relative prices change. This causes an alteration in the com-

petitive position of a company on its markets. The time pattern of operating exposure, which is long-term, has the effect that this exposure cannot be dealt with only through financial hedging techniques. Long-term operating adjustments need to be made to reduce negative effects of real exchange rate changes.

An advantage of the economic exposure concept is found in its specification of covering the entire planning period of a corporation. Also, it not only includes already booked future transactions into the exchange rate risk analysis, but also transactions resulting from business deals that might be made in the future. That way it takes into account the influence of possible future exchange rate changes on the strategic position of a corporation.

Criticism on the economic exposure outlines the high degree of complexity of a comprehensive economic exposure assessment. In addition, measurement of the economic exposure in certain situations requires subjective assumptions to be made which diminish the objectivity of the assessment.

2.3 Transaction exposure

Transaction exposure originates from various types of a corporation's transactions requiring settlement in foreign currency during a specified time period. Therefore, the transaction exposure concept focuses on cash flows. These are subject to the risk of unfavourable exchange rate changes because they are converted into the corporation's home currency at some later date.

Transaction exposures arise from the following business activities:

- Export and import contracts denominated in foreign currency
- Capital procurement and capital investment contracts denominated in foreign currency
- Inter-company transactions denominated in foreign currency

If transactions take place at several future dates, rather than at one date in the planning period, the transaction exposure of a corporation includes these certain, future foreign currency cash flows. Thus, the transaction exposure has a temporal structure. This characteristic of the transaction exposure can be recorded and presented by a system, that shows the balance of foreign currency cash inflows and outflows, called exposure report. This presentation of the transaction exposure is similar to a liquidity or a financial plan (Pfennig u. Rudolph 2001). In the exposure report the transaction exposure is broken down into currencies, volumes, and

dates. The time period for the transaction exposure and therefore for the exposure report, is the short-term.

Critical assessments of the transaction exposure for exchange rate risk management in finance literature state as an advantage of this concept, its focus on a corporation's future cash flows because future cash flows represent an economically correct basis to measure the value of a corporation. The transaction exposure offers the possibility to carry out sensitivity analysis regarding risk levels under different future exchange rate scenarios. This analysis can be applied for single transactions as well as the total business volume denominated in foreign currency. The simplicity of carrying out such an analysis for transaction exposures is an additional advantage of this concept. Furthermore, the simplicity of application of the transaction exposure for exchange rate risk management, resulting due to the fact that all data can be obtained from corporate financial reporting systems, is judged as a positive aspect.

Assuming the transaction exposure as a fixed amount is a problem. In reality the amount of the transaction exposure can change. This is the case in a situation where the price has to be adjusted later, due to actual costs being significantly higher than planned. Additionally, the amount of the transaction exposure can change when the maturity of a transaction is postponed because of unexpected bad payment behaviour of customers or an unexpected delay in the production resulting in a later delivery of goods. Furthermore, the amount of the transaction exposure cannot be assumed as being fixed when it is uncertain if the underlying business deal will be realised or not. This is the case when a company, e.g., takes part in a bid for a business deal with an already fixed volume and payment dates.

Criticism regarding the transaction exposure concept also points out that this exposure measurement system does not include indirect effects of exchange rate changes but only the direct effect of a possible change in value of a future transaction. Therefore it lacks the analysis on how changes in exchange rates can affect a corporation's sales volume or the competitive position of competitors. For example, an appreciation of the home currency can decrease the sales volume in a foreign market if a company wants to realize a price fixed in home currency. Pringle 1995 outlines in this context that the competitive position of a corporation that sells and sources only in the home currency market is negatively influenced by a home currency appreciation in such a way that it improves the margins of competitors that source abroad.

Tab. 1 highlights the characteristics of the three main exposure concepts covered.

Tab. 1: Comparison of exposure concepts

	Exposure concept		
	Transaction	Translation	Economic
Target	Short-term transactions	Consolidated reporting	Strategic planning
Focus	Cash-flows	Assets and liabilities	Cash-flows
Value orientation	Economic value	Book value	Economic value
Time orientation	Presence-oriented	Past-oriented	Future-oriented
Time period	Limited	Limited	Unlimited

3 Hedging transaction risk using forwards

3.1 Basic hedging positions

Hedging is characterised by all measures taken to achieve protection towards existing exchange rate risks. These actions include the creation of positions that offset the effects of exchange rate changes on already existing or anticipated exposures as well as the matching of exposures to minimize these effects. Hence, the motivation for hedging can be seen in the wish for security and risk avoidance respectively. Speculation can be defined as all measures taken that aim on the realization of profits by departing from the obtainable risk minimizing position.

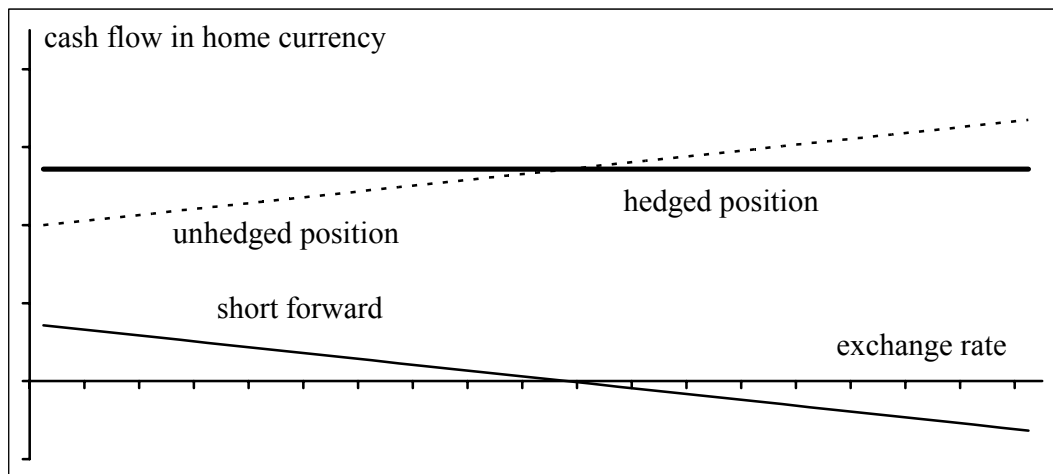


Fig. 3: Short forward hedge

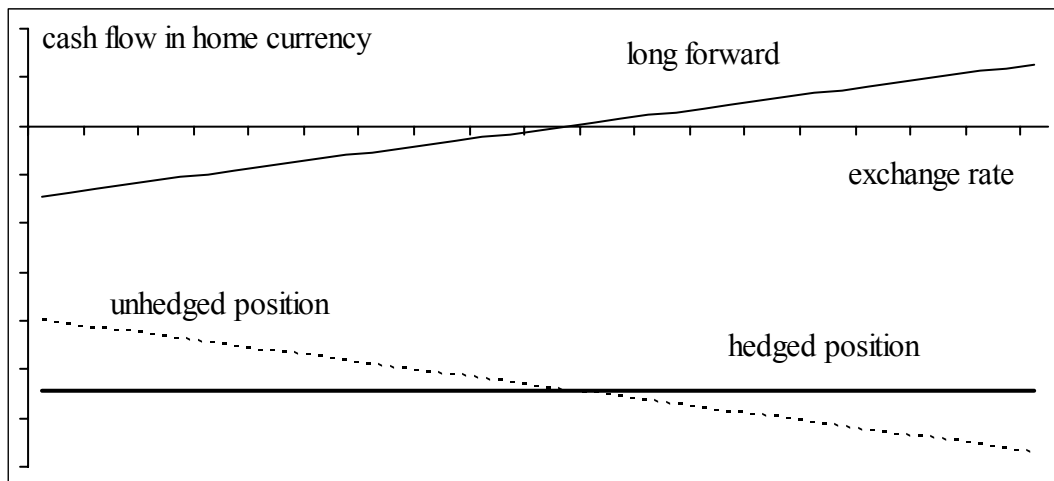


Fig. 4: Long forward hedge

Currency hedging with external instruments has become more popular in industrial companies in the last years (Gebhardt/Ruß 1999). Derivatives like forwards, futures, swaps, vanilla and exotic options offer a wide variety of possible strategies to hedge against transaction risks (Rudolph/Schäfer 2005). Two basic positions – the short and the long forward hedge – are given in fig. 3 and fig. 4.

3.2 Hedging from a utility viewpoint

If a corporation's hedging actions are assessed from a utility viewpoint, hedging specifies measures that maximize the expected utility of a decision maker in such way that the amount of expected cash inflows denominated in home currency will not be influenced. In this context, speculation is characterised by actions taken on foreign exchange markets aiming at increasing expected positive payments (Breuer 2000, p. 134).

Deriving optimal (hedging) positions of a company is a complicated task and addressed widely and controversely in literature (f.e. Breuer 2000, Kürsten 1997, Battermann et al. 2000, Broll/Wahl 1995, Pfennig 1998, Spremann 1991). In focussing on transaction risk only linear risk components are regarded. In such situations the use of options always goes in line with some speculation. Therefore only forward contracts are considered in the following.

The model description refers to some of the fundamental work mentioned above and to Battermann/Broll 2003 and Broll/Wong 2002, especially. In the model we consider a company with an output B produced under the expense of productions costs $c(B)$ and ready for export. The company can sell every unit of the output for the price P_t at a foreign market at some spe-

specified future date t . The future exchange rate at t is unknown, i.e. $S_t = \tilde{S}_t$. So the situation of an existing transaction risk with exposure B is given.

It is assumed that a derivative market exists where the company can trade in currency forwards with forward price F_t under hedging costs k . So the company might decide to hedge a part H of his transaction exposure by a forward position. The hedged volume H can be less than, equal to or more than the foreign amount $B \cdot P_t$. Therefore the unknown future cash flow resulting is

$$\begin{aligned} CF(B, H) &= \overbrace{B \cdot P_t \cdot \tilde{S}_t}^{\text{spot market}} + \overbrace{H \cdot (F_t - \tilde{S}_t)}^{\text{forward market}} - \overbrace{H \cdot F_t \cdot k}^{\text{hedging costs}} - \overbrace{c(B)}^{\text{production costs}} \\ &= (B \cdot P_t - H) \cdot \tilde{S}_t + H \cdot F_t \cdot (1 - k) - c(B) \end{aligned}$$

Taking on the utility viewpoint some assumptions and furthermore a quantification of the companies preferences is required. For that it is assumed that the company maximizes his expected utility by maximizing the future cash flow in a linear preference function of the type

$$\Phi = E(CF) - \frac{\alpha}{2} \cdot \text{var}(CF)$$

The necessary condition for the optimal volume to be exported can easily be calculated as

$$F_t \cdot (1 - k) \cdot P_t = c'(B_{\text{opt}})$$

So it can be concluded that

- the deterministic marginal receipt equals the marginal costs of production
- the optimal export volume is independent of the companies risk aversion
- the optimal export volume is independent of the unknown exchange rate
- the costs of hedging reduce the export volume

Analyzing the optimal hedging volume H , i.e. the optimal hedge ratio h

$$h = H / (B \cdot P_t),$$

we calculate the necessary conditions, too:

$$\frac{\partial \Phi}{\partial H_{\text{opt}}} = -E(\tilde{S}_t) + F_t \cdot (1-k) + \alpha \cdot (B \cdot P_t - H_{\text{opt}}) \cdot \text{var}(\tilde{S}_t) \stackrel{!}{=} 0$$

Straightforward we receive the relation:

$$H_{\text{opt}} = B \cdot P_t - \frac{E(\tilde{S}_t) - F_t \cdot (1-k)}{\alpha \cdot \text{var}(\tilde{S}_t)}$$

Obviously in the case of a perfect forward market without any frictions and therefore also without hedging costs the hedge ratio is equal to one:

$$H_{\text{opt}} = B \cdot P_t$$

Furthermore we can conclude that

- hedging costs reduce the volume of hedging
- the volume of hedging increases in the case of higher exchange rate variance
- the volume of hedging increases in the case of higher risk aversion
- less than the amount $B \cdot P_t$ is „hedged“ if $E(\tilde{S}_T) > F_t \cdot (1-k)$ (normal hedge)
- more than the amount $B \cdot P_t$ is „hedged“ if $E(\tilde{S}_T) < F_t \cdot (1-k)$ (reversed hedge)

Normal and reversed hedge positions can be regarded as speculative positions (Pfennig 1998). In empirical studies a so called 50:50-hedge is often observed (Spremann 1991). Some authors speak of a suboptimal behavior in practice resp. try to get an answer for this phenomenon (Kürsten 1997, Pfennig 1998, Spremann 1991). Compared to forward-hedging options can't be used for hedging in the presented linear model. They could only be motivated in hedging a contingent or an operating exposure (Pfennig 1998).

4 Objectives of exchange rate risk management

As a consequence of the critical assessment of the exposure concepts, corporations should theoretically apply the economic exposure concept in exchange rate risk management. However, due to the high degree of effort that would be needed to achieve a comprehensive economic exposure assessment it is proposed to concentrate corporate exchange rate risk man-

agement efforts with financial derivatives only on a section of the economic exposure, such as transaction exposure.

Exchange rate risk management is a strategic process that aims at the reduction of the vulnerability of corporations with respect to unforeseeable discontinuities of exchange rates. Consequently, exchange rate risk management has to carry out the task of identifying potential risks for a corporation resulting from exchange rate risk changes as well as initiating measures of protection. The action parameters of exchange rate risk management on an operational level are the supervision of currency exposures and the limitation of effects of exchange rate fluctuations on a corporation.

The generic term exchange rate risk management subsumes all measures that aim on the alteration of exposures or exchange rate changes in order to achieve risk-prevention, risk minimization or risk compensation. The most frequently occurring objectives of exchange rate risk management include the following:

- Reduce translation exposure

The achievement of this objective requires a corporation to focus on the protection of foreign currency denominated assets and liabilities from changes in value resulting from exchange rate changes.

- Reduce quarter-to-quarter earning or year-to-year earning fluctuations resulting from exchange rate changes

This objective requires a firm to take translation exposure as well as transaction exposure into consideration.

- Reduce transaction exposure

In order to attain this objective, risk management needs to focus on a part of a corporation's cash flow exposure.

- Reduce economic exposure

Achieving this goal requires a corporation to reduce effects of currency fluctuations on its entire cash flow exposure. Consequently, protection of the corporation's assets and liabilities from changes in exchange rates will be ignored.

- Reduce foreign exchange risk management costs

In order to achieve this goal, a firm must balance off the benefits of hedging with its costs in various situations. It assumes risk neutrality.

- Avoid surprises

This goal requires a company to manage its risk in such a way that large losses due to exchange rate changes are averted.

Shapiro 2003, p. 342, states that the most appropriate way to rank these objectives is according to their ability to contribute to shareholder value maximization. The result of aligning exchange rate risk management with the objective of shareholder wealth maximization is that the concept of economic exposure is, among the objectives described above, the most adequate starting-point for corporate exchange rate risk management. In accordance with this statement the operational objective for exchange rate risk management can be described in the following way: “... *to arrange a firm’s financial affairs in such a way that however the exchange rate may move in the future, the effects on dollar returns are minimized.*” (Shapiro 2003, pp.342-343)

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