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We explain the diversity of corporate hedging behavior in a single model. The hedging ratio is obtained by maximizing expected utility that is a combination of the corporate level utility and a component that models the incentives of the financial manager. We derive a theoretical model that gives back the classic result of the literature if the financial manager has no other incentive than to maximize corporate utility. In the case the financial manager expects that his evaluation will be based exclusively on the financial profit (the profit of the hedging transactions), being risk averse, he decides not to hedge at all. The hedging ratio depends on the weight of these contradictory effects. We test our theoretical results on Hungarian corporate survey data.

JEL codes: G13, G32, G34

Keywords: corporate hedging, corporate utility, manager incentives

INTRODUCTION

The results of the empirical studies show that corporations are very diverse in their hedging solutions. They use selective hedging, the hedging instruments and hedging ratio varies not only across industries and firms, but they are not stable in time within a given firm either (Brown and Khokher, 2007).

The classical models of optimal hedging ratio (Holthausen, 1979, Rolfo, 1980) assume a one-period expected utility maximization framework, where the utility function is supposed to be concave. In the mean-variance model of Rolfo (1980), the optimal hedging ratio (w) – shown in Equation (1) - is determined by the expected value of the hedge ($E(y)$) (speculative part) and the covariance of the underlying asset (x) and the hedging instrument, that is the pure hedge. Here the hedging instrument is supposed to be costless.

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$$w = \frac{E(y)}{2a \text{var}(y)} - \frac{\text{cov}(x, y)}{\text{var}(y)} \quad (1)$$

where a stands for the corporate specific risk aversion, while the variance is denoted by var .

For the uninformed hedgers, the hedging ratio should be equal to the second part of the equation (Duffie, 1989), which suggests perfect hedge or full hedge if there exist a perfectly correlating forward product. In practice, however non-financial firms use derivatives not only for variance reducing purposes and the hedging ratio varies from zero-hedge to full hedge and even overhedge that is not justified by different expectations.

Several studies explain the question of corporate hedging from the perspective of the management. Financial manager optimizes his lifetime expected utility (Jensen and Meckling, 1976), or aims to reduce the volatility of his own revenues (Stulz, 1984; Smith and Stulz, 1985). Another managerial factor influencing the hedging behavior of the firm can be the aim of good managers to reduce information asymmetry (DeMarzo and Duffie, 1995, Breeden and Viswanathan, 1998) or the manager acts to minimize the regret on the hedge (Michenaud and Solnik, 2008).

Although the hedging of market risk aims to reduce the volatility of the total profit and loss of the corporation, hedging derivative transactions cause a fluctuation in the financial profit unless the firm applies hedge accounting. DeMarzo and Duffie (1995) shows that managerial and shareholder incentives can differ based on the available accounting information. In the case the firm reports only aggregate earnings, managers hedge more as they do not face the trade-off between the volatility of the total profit and the financial profit.

Several empirical studies examine the impact of the accounting standards on the corporate risk management practice.

Table 1: Impact of the accounting rules on risk management.

| Research | Sample | Period | Findings |
|-------------------------|--------------------------------------|-----------|--|
| Panaretou et al., 2013 | UK non-financial firms (FTSE 350) | 2003-2008 | Hedge accounting reduces dispersion of analysts' forecasts. |
| Glaum and Klöcker, 2011 | German and Swiss non-financial corp. | | Accounting rules influence hedging behavior. |
| Hughen, 2010 | 105 US non-financial firms | 2007 | Change in management behavior following a change in accounting method. |
| Joseph, 2000 | UK multinational firms (75) | | Use of certain hedging techniques is associated with increases in the variability of some accounting measures. |

The aim of this paper is to model the optimal hedging ratio chosen by the manager considering the trade-off between the volatility of the financial and the overall profit of the firm. We build a model that captures the different motives of the hedge in a mean-variance framework. As a special case we receive back the results of the classical models, however the experienced variety of the hedging ratio can be better explained in our model.

The structure of the paper is the following: the next section describes the model and its extensions, then we analyze the results of a survey to find evidence on the theoretical model.

THE MODEL

We analyze an exporting firm who invests capital in the domestic currency, and sells its product in the foreign currency. The firm is therefore exposed to currency exchange risk. The quantity of the product is deterministic, however both the foreign currency price and the exchange rate are stochastic. We assume that the current foreign denominated price and spot exchange rate ensure the expected level of the profit, therefore the firm is exposed to two stochastic variables: r that is the percentage change (effective return) of the price and s denoting the percentage change of the exchange rate.

Our model describes a one-period decision: in time zero the firm decides to hedge a given part of its exposure, by selling it on forward. The forward price is supposed to equal the current spot price. The hedging ratio h is expressed as a percentage of the invested capital. The hedging ratio (h) is determined to maximize the expected utility ($E(U)$).

$$E(U) \rightarrow \max_h$$

The corporate utility is based on the classical mean-variance model:

$$U(x) = E(x) - \frac{1}{2} \cdot \alpha \cdot \text{var}(x) \quad (1)$$

where the utility is the function of the profit expressed as a return of the invested capital. As described in the introduction there are several levels of the profit and loss report:

Corporate profit/loss on one unit of invested capital

- operating profit: $r+s^3$
- financial profit: $-h*s$
- corporate net profit: $r+(1-h)*s$

Rational corporate risk management of course should be based on the corporate net profit. However, the financial manager faces the problem that his performance may be evaluated based solely on the financial profit, rather than on the corporate net profit. We represent this

³ for the sake of simplicity we disregard the cross-product deriving from $(1+r)*(1+s)$

uncertainty in our model with the parameter λ which is the probability of the net profit-based evaluation. Thus, $1 - \lambda$ is the probability that only the financial profit will be taken into account. Mathematically this means that the profit relevant for the hedging decision becomes a random variable:

$$x = \begin{cases} r + (1 - h) * s & \text{with probability } \lambda \\ -h * s & \text{with probability } 1 - \lambda \end{cases} \quad (2)$$

We apply the mean-variance utility on this variable. The expected value is:

$$E(x) = \lambda * (E(r) + E(s)) - h * E(s) \quad (3)$$

After some tedious but straightforward calculation, we obtain the variance as:

$$\begin{aligned} Var(x) = \lambda\{Var(r) + (1 - h)^2Var(s) + 2(1 - h)Cov(r, s)\} + (1 - \lambda)h^2Var(s) + \\ \lambda(1 - \lambda)(E(r) + E(s))^2 \end{aligned} \quad (4)$$

The utility thus becomes:

$$\begin{aligned} U = \lambda * (E(r) + E(s)) - h * E(s) - \frac{\alpha}{2} \left[\lambda\{Var(r) + (1 - h)^2Var(s) + 2(1 - h)Cov(r, s)\} + (1 - \lambda)h^2Var(s) + \lambda(1 - \lambda)(E(r) + E(s))^2 \right] \end{aligned} \quad (5)$$

We find the optimal hedging ratio by differentiating with respect to h and setting to zero. We obtain:

$$h_{opt} = \lambda \left(1 + \frac{Cov(r,s)}{Var(s)} \right) - \frac{E(s)}{\alpha Var(s)} \quad (6)$$

Recognizing $\frac{Cov(r,s)}{Var(s)}$ as the regression coefficient β between r and s , we can rewrite our result as:

$$h_{opt} = \lambda(1 + \beta) - \frac{E(s)}{\alpha Var(s)} \quad (7)$$

The appearance of the $1 + \beta$ factor has a straightforward interpretation: if the price change correlates positively with the exchange rate changes, a higher hedging ratio is optimal, as the two stochastic factors compensate each other. We note that in most cases, a product's price and

a currency does not show much correlation, therefore this adjustment is usually small in practice. In the subsequent analysis, we assume $\beta = 0$, and consider the simplified formula:

$$h_{opt} = \lambda - \frac{E(s)}{\alpha Var(s)} \quad (8)$$

If λ equals to 1, meaning the financial manager has no other incentive than maximizing the corporate net utility, the first term is 1, suggesting a full hedge of the production. This result is the same as the classic model of Rolfo (1980) suggests, if the hedging instrument correlates perfectly with the risk factor. If λ equals to zero, that means the decision making is based exclusively on the financial risk of the hedging position, in this case the term is zero. This result corresponds to the intuition that for a risk averse actor in the absence of any expected value of the hedge, the only goal is the volatility reduction that can be achieved by full hedge if the overall profit is considered, but by zero hedge if only the financial profit is considered.

The second term is proportional to the expected exchange rate movement and can be interpreted as a speculation term. Note the negative sign. If the manager expects the rate to go up, the firm wants to profit from it, therefore he tends to hedge only partially. If rates are expected to go down, the manager may even over-hedge to reap financial profit from the hedging position.

If in addition to our original assumption, we take into account a proportional financial hedging cost (bid-ask spread or transaction cost) c , our result for the optimal hedging ratio generalizes to

$$h_{opt} = \lambda(1 + \beta) - \frac{E(s)}{\alpha Var(s)} - \frac{c}{\alpha Var(s)} \quad (9)$$

Comparison with the previous result (see Equation (7)) shows that the hedging cost has a similar effect as the expected exchange rate movement, but it always decreases the optimal hedging ratio.

EMPIRICAL RESEARCH

A straightforward way of testing our model is to find evidence whether firms applying hedge accounting rules hedge more. Hedge accounting allows for reporting the profit and loss of hedging transaction together with the operating profit, consequently the financial profit fluctuation is not influenced by the hedging activity. In that case the manager's decision can be considered as if they were evaluated exclusively based on the net profit of the firm.

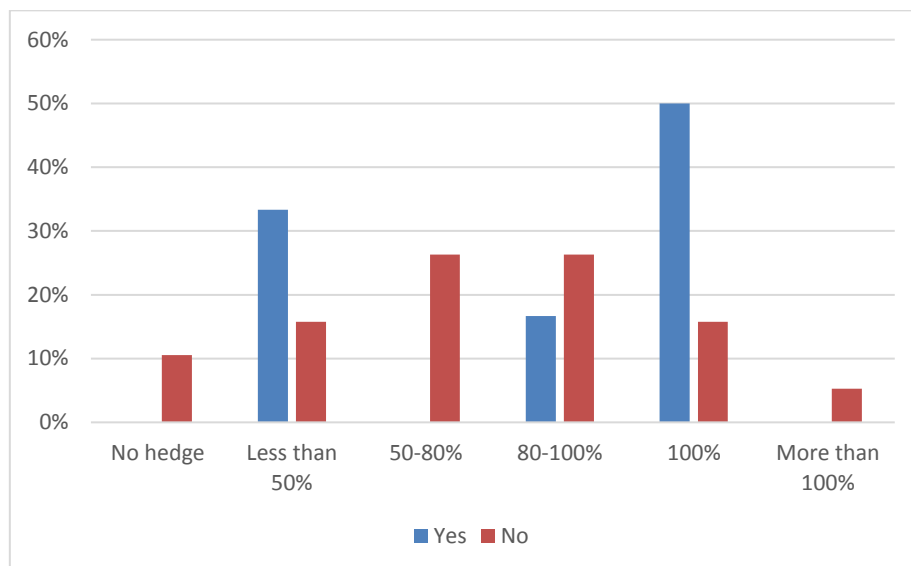
As firms has no standard reporting obligation about their hedging activity, data on corporate hedging practice can be obtained either from the appendices of the financial statements or from direct approach of the companies.

We conducted a survey on the corporate hedging practice among the active treasury clients of the Hungarian branch of a multinational commercial bank during the summer of 2013. In the

framework of the survey about 100 large corporate clients – covering almost the whole population - were contacted and we received 29 answers.

The hedging ratio that is the hedged portion of the total exposure can be seen in Figure 1. The frequencies are in blue columns if the firm applied hedge accounting, while the red histogram shows the distribution of the hedge ratio if hedge accounting was not applied.

Figure 1: Hedging ratio according to the usage of hedge accounting



In the above sample the average seems to be similar as it is also confirmed by the analysis of the variance. Although there is a difference of 7 percentage point in the expected value, but this is not significant due to the small sample size.

Table 2: ANOVA table of hedging ratio according to the accounting rules

| | <i>Hedge accounting yes</i> | <i>Hedge accounting no</i> |
|---------------------|-----------------------------|----------------------------|
| Expected value | 73.33 | 66.32 |
| Variance | 1416.67 | 1224.56 |
| Observations | 6.00 | 19.00 |
| Expected difference | 0.00 | |
| df | 8.00 | |
| t-value | 0.40 | |
| P(T<=t) one-tail | 0.35 | |
| t- threshold | 1.86 | |
| P(T<=t) two-tail | 0.70 | |
| t-threshold | 2.31 | |

The questionnaire also contained questions about the maturity of the hedging derivative deals. Based on the results the maximum maturity was significantly larger if the firm applied hedge

accounting standards, but the average maturity of the hedging transaction was the same for both groups.

CONCLUSION

The paper aimed to explain the diversity of corporate hedging practice. We investigated the optimal hedging ratio from the perspective of the financial manager, who maximizes the expected utility of a combined utility function. If the financial manager has no other incentive than maximizing the utility based on the total corporate profit, we receive the result of the classical models of the literature, according to which hedging has two components: the pure hedge and the speculation. In an unbiased forward market this suggest full hedge of the exposure. If the financial manager expects that his evaluation will be based exclusively on the financial profit (the profit of the hedging transactions), being risk averse, he decides not to hedge at all. The hedging ratio depends on the weight of these contradictory effects.

To confirm the results, we investigated the hedging ratio of the Hungarian large corporations. We found that the firms applying hedge accounting hedge more, but this difference was insignificant due to the small sample size.

Our model can be used to explain the different corporate hedging ratio according to sectors or ownership. The research is to be developed further by ex-post analyzing the hedging ratios in order to find the weight of the different manager incentives.

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