Hedging lean hogs and the impact on profit and risk. A discussion in two markets about the utility of hedging.

Die Preisabsicherung von Schlachtschweinen und deren Auswirkung auf Profit und Risiko. Eine Diskussion in zwei Märkten über den Nutzen von Risikosteuerung.

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Abstract

Although hedging is considered a standard vehicle for managing various kinds of risk, the effectiveness of a hedging strategy can only be evaluated after the respective transaction is closed. Therefore, theoretical insights making informed *a priori* decisions possible are needed. This article shows the results of investigating the effectiveness of hedging the production of lean hogs in two markets, the CME and the RMX, Hanover, for the period between 1999 and 2008. Following WORKING'S selective hedging category, three trivial hedge-entry conditions are applied and compared to a no-hedge strategy. What emerges is that positive risk reduction can only be realized by using an arbitrage strategy. This result gives further evidence to the statement that "speculating the basis" generates a better return under uncertainty than avoiding risk. G140, Q140

KEY WORDS: hedging, lean hogs, hedge effectiveness, hedging strategies, risk management

Zusammenfassung

Obwohl die Preisabsicherung mit Warenterminkontrakten ein Standardvehikel ist, um verschiedene Arten von Risiken zu kontrollieren, kann die Effizienz dieses Vorganges nur beurteilt werden nachdem die entsprechende Transaktion geschlossen wurde. Darum sind theoretische Einsichten notwendig, um eine informierte *a priori* Entscheidung zu ermöglichen. Dieser Artikel zeigt die Ergebnisse von Untersuchungen über die Effizienz von verschiedenen Absicherungsstrategien in der Produktion von Mastschweinen für zwei verschiedene Märkte, der CME Chicago und der RMX Hannover, für die Periode von 1999 bis 2008. WORKING´S Klassifizierung der selektiven Absicherung folgend werden drei triviale Eintrittsbedingungen angewendet und mit einer no-hedge Strategie verglichen. Es tritt zu Tage dass eine positive Risikoreduktion nur mit einer Arbitragestrategie erreicht werden kann. Dieses Ergebnis gibt einen weiteren Hinweis darauf, dass die „Spekulation auf die Basis" besser geeignet ist, Erlös unter Unsicherheit zu generieren als Risiko zu vermeiden. G140, Q140

SCHLÜSSELWÖRTER: Absicherung, Mastschweine, Absicherungseffizienz, Absicherungstrategie, Risikomanagement

1. Introduction: strategies of selective hedging

In his seminal paper "New Concepts Concerning Futures Markets and Prices" HOLBROOK WORKING traced back the origins of trading in futures markets and, furthermore, categorized the different concepts developed mainly for the purpose of speculation in and risk-reduction through futures markets. It is in this paper, that the concept of "selective hedging" as a means to (not only) reduce market risk by exploiting the fact "that changes in spot prices tend to be accompanied by changes in the futures prices" (WORKING 1962: 436) makes it first appearance. For Working, selective hedging describes a hedging decision driven by future expectations of price developments grounded in past experience. This meaning of selective hedging has survived until today, e.g., if CHEW writes: "… while few companies regularly use derivatives to take a 'naked' speculative position on foreign exchange rates or commodity prices, most corporate derivatives users appear to allow their views of future interest rates, exchange rules and commodity prices to influence their hedge ratio" (CHEW 2008: 94). However, it is LESSER who as early as 1993 alerted the attention of his readers to the fact that "selective hedging is a more complex undertaking since it requires ongoing evaluations of when to place or lift a hedge" (LESSER 1993: 341), a task quite heavily eased by the fact that "the rational for the use of selective hedging is that, at last in the short term, the forward rate has been found to be a biased predictor of the future spot rate" (BUCKLEY 2004: 197). Hence, we are back to Working and his observation that changes in futures markets somehow reflect or correlate with changes in spot markets. To put it in another way: both markets are interconnected. This paves the way for technical analysis as elaborated by ENNEN (1979). Technical analysis is based on "the belief that a study of previous prices can give some insight into the future actions of prices" (ENNEN 1979: np), and that as a consequence of the close relationship between spot and futures markets, price variations in one market can be taken to forecast price development in the other.

This paper describes an attempt to gain such insight into the future development of prices, and it does so for lean hogs and two markets. Hence, this paper is located in the realm of agricultural economics. Research in "agricultural hedging" flourished since the late 1970s and there is hardly any study to be found for which the introductory section does not stress the volatility of prices in agricultural markets and the price risk associated with such volatility. In this introductory section, JON BRANDT'S example may be sufficient for historical evidence: "Large swings in livestock product and feed prices in the 1970s have increased risks inherent in livestock production" (BRANDT 1985: 24). As today, the risk of price volatility has not decreased: "[p]rice and production uncertainty contribute the two main sources of risk to a crop producer's farming income" (ZHANG, HOUSTON, VEDENOV & BARNETT 2007: 1). As a consequence hedging of (agricultural) commodities is as important an issue as ever. However, this paper derives its relevance not only from the evergreen theme of hedging in agriculture.

Furthermore this paper attempts to compare the performance of different hedging-strategies, i.e. the profit strategy, the trend strategy and the arbitrage strategy. With the first strategy, a hedger tries to safeguard above-average profits; the aim of the second strategy pegs the hedging decision to a moving average, hence, this strategy represents the standard approach to technical analysis as ENNEN (1979) would call it. The last strategy refers to the typical arbitrageur as, e.g., described by WORKING. An arbitrageur tries to exploit profit opportunities provided by the ratio of two identical or comparable assets in two separate markets, hence strategy three is close to strategy one, however, the main difference between the two strategies is that in the case of an arbitrageur the hedging contract is not necessarily "matched by either an equivalent stock of goods or a formal merchandising commitment" (WORKING 1962: 441). Which of the above mentioned strategies is best suited to minimize market risk, is investigated by calculating a number of different performance measures for contracts for live pigs on the RMX (Risk Management Exchange) and for lean hogs on the CME (Chicago Mercantile Exchange). The calculation of performance measures for two Exchanges allows for the identification of spatial differences in the performance of the three strategies, with spatial differences proven to be a factor not to be neglected in hedging decisions (COFFEY, ANDERSON & PARCELL 2002). The

remainder of this paper is organized as follows: the next section (section 2) will provide a brief overview of research conducted with respect to selective hedging for (agricultural) commodities. Section 3 will discuss the data, method and the different performance measures used and deployed in this paper. In section 4 results are described and discussed. Section 5 provides some further conclusions.

2. Selective Hedging for agricultural commodities: a literature review

Evidence for a widespread application of selective hedging, i.e. hedging based on some sort of belief about market development is anecdotic at best, however, there is evidences that many companies base their hedging decision on their market views (BODNAR et al. 1998, DOLDE 1993). This may partly explain why researchers struggle to find evidence for a positive effect generated by selective hedging either on a firm's cash flow or a firm's overall financial performance (ADAM & FERNANDO 2005, FAULKENDER 2005). BROWN, CRABB AND HAUSHALTER (2006) confirmed the absence of any positive effect for selective hedging with respect to shareholder value. While the cited studies mainly address the issue of MNEs hedging against exchange rate risk, MEREDITH shows for oil and gas producers that they can profit from a selective hedging of oil prices, however, "oil and gas producers are unsuccessful at selective hedging of gas prices" (MEREDITH 2006: 14-15). Hence, what seems to be absent in the case of exchange rate risks, can be found in traces with respect to the price risk of commodities. Accordingly, there is a flurry of research in the field of commodity hedging in general and the hedging of agricultural commodities in particular. However, it has to be stressed that the subsequently reported results in their majority assess the performance of hedging strategy; they do not assess the effect of hedging strategies deployed by different firms on profit or cash flow of the respective firms.

ENNEN showed in his study of the cattle market that "selective hedging strategies [mainly based on moving-average techniques, M.Z.] were able to reduce the variability in income when compared with the non-hedged strategy and some were able to increase the mean income over the non-hedged strategy" (ENNEN 1979: np). Likewise GORMAN et al. in their study of cattle feeders came to the conclusion, that while "[o]n average, feeding cattle in the study feedlot was not profitable … [a] carefully chosen hedging strategy, …, could have reduced the average loss" (GORMAN et al. 1982: 208). The efficiency of selective hedging strategies based on technical trading systems in dampening fluctuations in the cash flow of cattle feeders was furthermore shown in a study conducted by PURCELL and RIFFE (1980). BRANDT demonstrated for the hog industry that a combination of more or less elaborated forecasting techniques with hedging strategies can reduce "the risk of unfavorable price fluctuations" (BRANDT 1985: 24). More recent evidence for the efficiency of hedging strategies with respect to decreasing losses or increasing cash flow can be found in MANFREDO and LEUTHOLD for the Value at Risk (VaR) measure, in COFFEY, ANDERSON & PARCELL (2000) for grain by-products and different performance measures, for a Bayesian framework that abstains from historical data in SHI and IRWIN (2004); and for Soybeans in the South and – again – different performance measures in SAYLE et al. (2006). However, as discussed above, amongst others COFFEY, ANDERSON and PARCELL (2002) show that the efficiency of hedging strategies depends on the locality, i.e. the efficiency of a hedging strategy at the CME may vary with the locality of the spot market. Selective hedging, as it appears, promises to reduce market risk for commodity producers, however, concrete performance of selective hedging depends on space and strategy. Against the background of these results, this paper will investigate the performance of different hedging strategies on two distinct Exchanges (RMX and CME) and hence widen the scope of not only the research undertaken by COFFEY, ANDERSON and PARCELL.

3. Data, Method and Performance measures

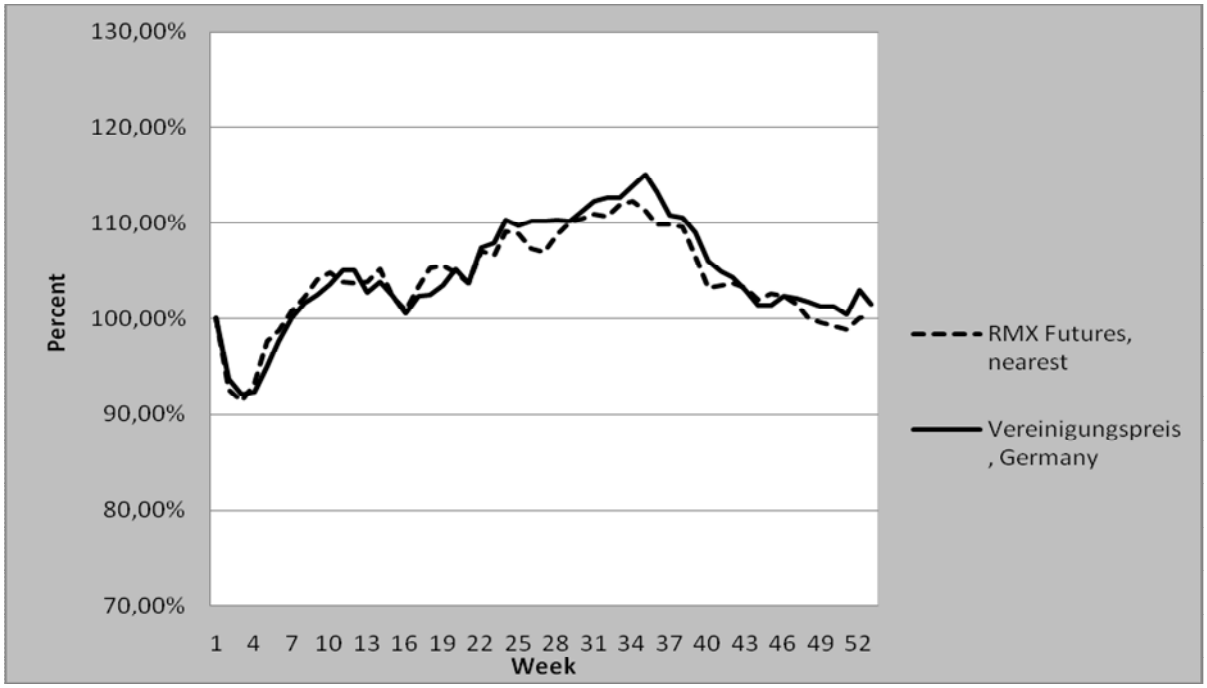
To hedge market risks or to make a profit, actors can deploy either of three strategies (at least in this paper), i.e. they can seek to cash-in above average profits, i.e. the actor will hedge whenever futures prices promise above average profit, he can play safe and peg his decision to hedge to a moving average in order to avoid loss or he can act as an arbitrageur, i.e. place a hedge whenever the ratio between spot and futures prices is favorable.

Someone could argue that price has nothing to do with margin, but LOY (2002: 3) calculated that the variation of the slaughter hog prices make 75% of the variation of the gross margin for markets in the European Union.

The question, which strategy performs best will be tested by analyzing contracts for live pigs on the RMX (Risk Management Exchange) Hanover, and contracts for Lean Hogs on the CME (Chicago Mercantile Exchange). The data base consists of the daily closing prices and covers the period from January 04, 1999 to December 30, 2008. Closing prices of each trading day are combined with the respective spot prices of the German "Vereinigungspreis"[1] and the CME Lean Hog index. Subsequently, contracts where arranged according to the following maturities: 1 month (front month, nearest); 2 months (2nd nearest); 3 months (3rd nearest); 4 months (4th nearest). It is worth mentioning that seasonal price variations may affect demand as well as supply quantities of a given commodity as can be seen in Figure 1 which shows a marked seasonal pattern in the price for live hogs.

[1] A Central-European Lean Hog Index is only available since 2005, therefore a leading German spot price was chosen. This price is determined and published by the „Vereinigung der Erzeugergemeinschaften für Vieh und Fleisch e.V." http://www.vezg.de

Figure 1: Seasonal Index for Live Hogs (1999-2008)



The three distinct strategies mentioned above are tested by simulating the earnings of a “fictive” live pig producer. To do so, the following scenario is used: In the fictive production facility for live pigs every month a quantity equivalent to 10 contracts is up for sale. The sale date is set to be the last trading day of the next contract month ("front month", "nearest"). The transaction costs amount to Euro 80 in the case of the RMX and USD 30 for the CME per round and will be included in the revenue calculations. For each strategy conditions are formulated to simulate entry into a hedging position. Exit will take place exclusively with the sale of physical goods that is on the last trading day. Finally, the total proceeds of the elected hedging strategy are compared to the unsecured spot position for the last trading day. While the calculation of the non-hedged position is straight forward, the three strategies are calculated as follows:

Profit strategy:

A seasonal price index is extrapolated using the average of all futures prices. If, with regard to the average of all futures prices, revenues materialize that are higher than the expectations, they are hedged. The following condition for opening a short position is formulated:

$$\text{IF } F_{\text{hedging horizon}} > M_{\text{average price}}\ 99/08 * S_{\text{seasonal index}} * 1.1 \text{ THEN SELL } Q_{\text{spot}} * h^{\min}$$ [2]

with:

F: Future price

M: 10 Year average market price

S: Seasonal index

Q: Quantity of the position to cover

h: Variance minimizing hedge ratio

Trend strategy:

Probably the most commonly used technical indicator is the moving average (ENNEN 1979), with which an average of past closing prices can be computed. The method of moving averages is used for smoothing time series. It presupposes that within the time series (short term) cyclical fluctuations occur and that the values are equidistant. A moving average (MA) is a series of arithmetic means derived from past observed values. A moving average is calculated from a stable number of observations adjacent to each other on the time line. Then it is assigned to point in time *t*, lying in the middle of each time interval. The time interval may assume either an even or an odd number of values. The smoothing effect of the MA-method can be reinforced by

[2] Explained verbally, if the futures price is 10 per cent above the average value of the period analyzed, commodity futures contracts with the number of spot positions times the variance-minimizing hedge ratio $h^{\min}$ (set at 0.9 for the front month) will be sold.

cumulating (interleaving) several smoothing procedures. The aim of the trend strategy is to take a position in the commodity futures market if the trend indicator generates a selling signal. The seasonality can be ignored, as only the relative price change is considered. The following condition for the opening of a short position is formulated:

IF $k_{trend\ 20} < -0.005$ THEN SELL $Q_{spot} * h^{min}$

where $k_{trend\ 20}$ represents the slope of the 20-day moving average.[3]

Arbitrage strategy

In this simulation a condition is formulated which suggests a hedge only in the event of a spot price - future price - ratio that is favorable for the hedger. This rule is consistent with WORKING'S (1953) arbitrage theory. The following condition for the opening of a short position is formulated:

IF $basis_{(K-F)} <$ AVERAGE $_{basis}$ - STANDARD DEVIATION $_{basis}$ THEN SELL $Q_{spot} * h^{min}$[4]

with the basis calculated as Cash price minus future price.

[3] In words: if the slope of the 20-day moving average falls below the value of -0005, commodity futures contracts with the number of spot positions times the variance-minimizing hedge ratio h^{min} (set at 0.9 for the front month) will be sold.

[4] Explained verbally, if the basis calculated as spot price minus futures price falls below the average value minus the standard deviation, commodity futures contracts with the number of spot positions times the variance-minimizing hedge ratio h^{min} (set at 0.9 for the front month) will be sold. These positions will again be squared with the sale of the physical spot commodity.

Performance measures used in this paper are taken from COTTER and HANLY (2006). Accordingly, the following performance measures will be calculated:

- Hedging Effectiveness Metric 1 (HE_1): the Variance; "measures the percentage reduction in the variance of a hedged portfolio as compared with the variance of an unhedged portfolio" (COTTER & HANLY 2006: 679-680);
- Hedging Effectiveness Metric 2 (HE_2): semivariance; unlike the variance, the semivariance can differentiate between the tails of the distribution, i.e. it is possible to focus on downsize risk; The problem of hedging effectiveness in terms of the semi-variance can simply be written as a problem of maximization of target return (r) and expected return (R); Semivariance = $E\{(\max[0,r-R])^2\}$, HE_2 is than calculated simply by comparing the semivariance of the hedged portfolio to the semivariance of the unhedged portfolio; The metric relies on a safty-first criterion, i.e. the investor is eager to "minimize the probability of falling below some predefined level of return" (COTTER & HANLY 2006: 680).
- Hedging Effectiveness Metric 3 (HE_3): Lower Partial Moment (LPM): introduces a weight for the amount of urgency an investor places on the shortfall from the target return. Urgency levels (n) vary between values less than and greater than 1 with $n < 1$ representing an risk-seeking investor, $n = 1$ representing an risk-neutral investor and $n > 1$ representing an risk-averse investor, hence $LPM_n\ (r;R) = E\{(\max[0,r-R])^n\}$; LPM is calculated on the basis of the underlying distribution, i.e. it does not assume a normal distribution as do variance and semivariance. Again, HE_3 is calculated by comparing LPM of the hedged portfolio to LPM of the unhedged portfolio;
- Hedging Effectiveness Metric 4 (HE_4): Value at Risk (VaR); VaR has the advantage of determining the maximum size of losses associated with hedging. It does so by estimating the "probability of a loss that may occur as a result of changes in the value of a secure portfolio" (COTTER & HANLY 2006: 683). VaR is calculated with reference to a time horizon and a confidence level (usually 1%), and VaR as such describes a special case of

LPM, when n =0, i.e. high risk prevails, hence, VaR can be depicted as the inverse function of LPM_0. HE_4 is calculated by comparing VaR for the hedged to VaR for the unhedged position.

- Hedging Effectiveness Metric 5 (H_5): Conditional Value at Risk (CVaR): CVaR is the expected shortfall and can be expressed as a function of LPM (n = 1) with the minimum return set to VaR; Calculation of HE_5 follows the meanwhile well-known pattern.

The following sections will investigate the performance of the hedging strategies differentiated above. The intention is not so much to design strategies that can beat the market. Rather, the goal is to present ideas which are fundamental to the comparison of financial results of the risk-minimizing hedger vis-à-vis the arbitrage hedger. These strategies, however, do not claim to represent optimal solutions but serve only to illustrate the basic idea.

4. Results

This chapter analyses the success of the three selective hedging strategies from a seller's (short-hedger's) point of view. Thus, success is measured by the overall financial revenue in the period, and assessed with the performance measures HE_1 to HE_5.

4.1 Profit strategy performance

The main feature of the profit strategy is the entry in a hedging position because of above-average profit margins. Table 1 presents the results for revenue and performance measures obtained by the simulation relying on the strategy implementation discussed in the last chapter.

Table 1: Profit Strategy - Revenue Results and Hedging Efficiency

	Revenue Results: Profit Strategy							
	RMX				**CME**			
	1 month	**2 months**	**3 months**	**4 months**	**1 month**	**2 months**	**3 months**	**4 months**
hedge-ratio	0,9	0,8	0,7	0,6	0,9	0,6	0,4	0,3
No. of trades	32	33	27	23	43	50	60	55
positiv thereof	16	20	17	13	24	37	48	49
total revenue of unhedged	100%	100%	100%	100%	100%	100%	100%	100%
total revenue of selectively	100,04%	100,31%	100,59%	99,61%	100,28%	102,17%	102,77%	102,75%
revenue from price	0,01%	0,08%	0,12%	-0,39%	-0,05%	0,7%	0,86%	0,93%
revenue from basis change	0,21%	0,39%	0,58%	0,08%	0,37%	1,50%	1,94%	1,84%
transaction cost	-0,17%	-0,16%	-0,11%	-0,08%	-0,04%	-0,03%	-0,03%	-0,02%
	Hedging Efficiency: Profit Strategy							
	RMX				**CME**			
	1 month	**2 months**	**3 months**	**4 months**	**1 month**	**2 months**	**3 months**	**4 months**
HE_1 (variance)	0,0204	0,0180	0,0454	0,1865	-0,0443	0,1489	-0,0140	-0,0429
HE_2 (semivariance)	0,0014	-0,0426	-0,0282	0,0683	-0,0237	-0,2241	-0,0695	-0,0692
HE_3 (LPM) n=3, τ=0,8*Average$_{mkt}$)	-0,0205	0,0878	0,1656	0,0325	0,1157	1,1073	0,2069	0,1412
HE_4 (VaR)	0,0103	0,0090	0,0230	0,0980	-0,0219	0,0775	-0,0070	-0,0212
HE_5 (CVaR), N=1, x=1%	-0,0431	-0,0860	-0,1510	0,0273	-	1	-	-

This *ex post* empirical study shows that when transaction cost are taken into account, the hedging of income that is above the long-term average may lead to marginally higher total revenue. By far the greater contribution to revenue is not derived from price rises, but from a change in the basis that is favorable for the hedger. Hedging on CME seems to be generally more profitable than hedging on RMX and the contribution of favorable changes in the basis is more distinct on CME as compared to RMX. This hints at the validity of results that stress the dependence of hedging performance on locality (COFFEY, ANDERSON & PARCELL 2002). With respect to hedging efficiency results are mixed. While for the variance and semivariance models a higher revenue risk can be observed (HE < 0) for the extremely risk adverse hedger the lower partial moment approach (with n = 3, and τ = 80% of average spot revenue) shows a risk reduction of up to 20% (hedging horizon: 3 months). However, reductions in value at risk fall quite short when compared to HE_4, what suggests that the considerable risk reduction for the extremely risk–averse hedger is not accompanied by an equally substantial reduction in VaR.[5] Interestingly enough; the better performance of the CME as compared to the RMX is not mirrored in considerable differences with respect to performance measures. Risk reduction on CME is not better than on RMX which is shown in mixed values for HE_1 to HE_4, but when the hedged portfolio for the CME and the RMX are compared to the unhedged portfolio, the CME generally performs better. A last result that needs mentioning refers to the considerable differences in hedging performance at different time horizons. However, there does not seem to be a pattern in these differences, so that the only statement justified by the results displayed in table 1 is, that the time horizon does influence the hedging performance.

[5] CVaR can not be interpreted unambiguously, since the data series for the calculation of this measure hold only insufficient statistical power.

4.2 Trend strategy performance

The trend strategy assumes hedging to take place when prices are falling. Accordingly, the strategy is the prototype of WORKING'S selective hedging for loss prevention. Table 2 shows the results of the simulations for this strategy.

Taking transaction costs into account, these results show an almost continuous increase in the risk of revenue or, to put it differently, a significant deterioration of the hedging efficiency. Again, changes in the basis contribute more to the overall performance than changes in price. Overall the performance of the trend strategy is not good. This is best shown in the result that a strategy that follows the moving average in order to prevent losses is inferior to a no-hedge strategy. The values for the different performance measures reflect this underperformance of the strategy. However, variance of the measured efficiency and its independence on the time horizon is quite considerable and comes close to a random result suggesting that as time seems not to matter and hedging pegged to a moving average comes close to a gamble. Furthermore, it is worth mentioning that a reduction in VaR and a risk reduction in LPM coexist with a performance that – with respect to revenue – falls short to the unhedged position. Accordingly, strategy 2 is a strategy to be avoided.

Table 2: Trend Strategy - Revenue Results and Hedging Efficiency

	Revenue Results: Trend Strategy							
	RMX				**CME**			
	1 month	**2 months**	**3 months**	**4 months**	**1 month**	**2 months**	**3 months**	**4 months**
hedge-ratio	0,9	0,8	0,7	0,6	0,9	0,6	0,4	0,3
No. of trades	34	30	20	18	83	86	90	88
positiv thereof	16	10	8	7	37	42	50	49
total revenue of unhedged	100%	100%	100%	100%	100%	100%	100%	100%
total revenue of selectively	99,65%	99,00%	99,37%	99,17%	98,75%	99,66%	100,64%	100,03%
revenue from price	0,30%	0,08%	0,03%	-0,19%	0,30%	0,23%	0,15%	0,15%
revenue from basis change	-0,47%	-0,94%	-0,58%	-0,58%	-1,47%	-0,52%	0,17%	-0,09%
transaction cost	-0,18%	-0,14%	-0,08%	-0,06%	-0,08%	-0,05%	-0,04%	-0,03
	Hedging Efficiency: Trend Strategy							
	RMX				**CME**			
	1 month	**2 months**	**3 months**	**4 months**	**1 month**	**2 months**	**3 months**	**4 months**
HE_1 (variance)	0,0186	-0,0913	0,0322	0,0118	-0,0488	-0,0350	-0,0103	0,0028
HE_2 (semivariance)	0,0777	-0,0258	0,0075	-0,0216	-0,0943	-0,0987	-0,0405	-0,0013
HE_3 (LPM) n=3, τ=0,8*Average ...)	0,6298	-0,1385	-0,109	-0,0297	-2,2436	-1,2954	-0,5483	-0,3505
HE_4 (VaR)	0,0090	-0,0446	0,0162	0,0059	-0,0241	-0,0174	0,0051	0,0014
HE_5 (CVaR), N=1, x=1%	1	0,2915	0,0067	0,0781	-	-	-	-

4.3 Arbitrage strategy performance

Table 3 shows the results for the arbitrage strategy. Although the entry condition for the hedge was not optimized and no exit condition was formulated, it immediately becomes obvious that the overall result can be improved by around 2 per cent by that strategy. This can be considered a clear arbitrage opportunity in an *ex post* analysis. Again it appears that the CME performs better than the RMX and again the increase in revenue is more a result of changes in the basis than of changes in prices. This result is – again – mirrored in the values calculated for the different efficiency measures. Variance and semivariance measures are generally positive for the SME suggesting a reduction in revenue risk when the hedged portfolio is compared to the unhedged one. This positive trend is maintained by the HE_3 and HE_4 Metrics. The LME shows quite considerable amounts of risk reduction for the CME and VaR reductions that are generally above the respective reductions that materializes at the RMX. The picture for the RMX is mixed as best as negative values in variance and semivariance measures that suggest an increase in revenue risk when the hedged portfolio is compared to the unhedged one, coexist with positive values for LME risk reduction. However, one way to interpret this result is straightforward: While the arbitrage strategy for a time horizon of one month does not reduce the overall revenue risk, it quite considerably decreases the respective risk for the extremely risk adverse investor as compared to the unhedged position. This result seems to be confirmed by the revenue of the hedged position being higher than the revenue of the unhedged position. Finally, the arbitrage strategy confirms what has been the result of preceding analysis: time horizon and locality matter. As has been mentioned, the CME generally performs better that the RMX and a time horizon of two or three months seems to guarantee a better performance with the arbitrage strategy than does a time horizon of one or four months, at the CME that is, because results for the RMX are not as straightforward as results for the CME.

Table 3: Arbitrage Strategy - Revenue Results and Hedging Efficiency

	Revenue Results: Basis Strategy							
	RMX				**CME**			
	1 month	**2 months**	**3 months**	**4 months**	**1 month**	**2 months**	**3 months**	**4 months**
hedge-ratio	0,9	0,8	0,7	0,6	0,9	0,6	0,4	0,3
No. of trades	58	47	45	45	51	39	41	38
positiv thereof	44	39	41	39	45	37	41	38
total revenue of unhedged	100%	100%	100%	100%	100%	100%	100%	100%
total revenue of selectively	102,33%	102,31%	102,18%	102,22%	103,13%	104,11%	104,01%	103,02%
revenue from price	0,48%	0,16%	0,00%	0,15%	0,48%	1,15%	1,18%	0,73%
revenue from basis change	2,16%	2,37%	2,37%	2,23%	2,78%	3,02%	2,87%	2,32%
transaction cost	-0,31%	-0,22%	-0,19%	-0,16%	-0,13%	-0,06%	-0,04%	-0,03%
	Hedging Efficiency: Basis Strategy							
	RMX				**CME**			
	1 month	**2 months**	**3 months**	**4 months**	**1 month**	**2 months**	**3 months**	**4 months**
HE_1 (variance)	0,0360	0,0428	-0,0425	-0,0556	0,0210	0,0858	0,0529	0,0204
HE_2 (semivariance)	0,0566	-0,0066	-0,0419	-0,0708	0,0313	0,0817	0,0414	0,0372
HE_3 (LPM) n=3, τ=0,8*Average$_{mon}$)	0,8041	0,0866	0,1634	0,0616	0,1874	0,4618	0,4682	0,2122
HE_4 (VaR)	0,0182	0,0216	-0,0210	-0,0274	0,0106	0,0439	0,0268	0,0102
HE_5 (CVaR), N=1, x=1%	0,8863	-0,4348	-0,1857	-0,1129	-	-	-	-

5. Conclusion

The main result of the analyses presented in this paper is the dominance of the arbitrage strategy over conventional price hedging strategies: Applying a trivial strategy focusing exclusively on price differences between spot and futures markets, lead to a significant increase in overall revenue and a significant reduction of risk. By contrast, a profit strategy designed to safeguard above-average profits failed to reach the level of performance reached by the arbitrage strategy. Furthermore, a trend strategy pegging its hedging decision to a moving average failed to produce any kind of risk reduction and trailed with respect to revenue far behind an unhedged position. Given that each strategy resembles a particular motivation, i.e. to cash-above-average profit margins, to prevent loss and to profit from favorable ratios between sport markets and futures markets, this analysis clearly hinted at the fact, that hedging fits more to the purpose of the last strategy than to the purpose of the two preceding strategies. Hence, hedging suggests itself as a strategy for the exploitation of favorable price constellation, less so as a means for reducing the risk of a loss, at least if the hedger is not inclined to alter his position on a daily basis.

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