Futures Exchange Innovations:
Reinforcement versus Cannibalism

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Abstract

Futures exchanges are in constant search of futures contracts that will generate a profitable level of trading volume. In this context, it would be interesting to determine what effect the introduction of new futures contracts have on the trading volume of the contracts already listed. The introduction of new futures contracts may lead to a volume increase for those contracts already listed and hence, contribute to the success of a futures exchange. On the other hand, the introduction of new futures contracts could lead to a volume decrease for the contracts already listed, thereby undermining the success of the futures exchange accordingly. Using a multi-product hedging model in which the perspective has been shifted from portfolio to exchange management, we study these effects. Using data from two exchanges that are different regarding market liquidity (Amsterdam Exchanges versus Chicago Board of Trade) we show the usefulness of the proposed tool. Our findings have several important implications for a futures exchange's innovation policy.

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I. Introduction

In financial literature it is argued that the success of a futures contract is heavily dependent on both its design and the characteristics of the underlying commodity's spot market (Black (1986)). Gray (1987) identifies the importance of contract design. He argues that a futures contract must reflect the commercial movement of the commodity both closely and broadly enough to avoid price distortions resulting from specifications in the futures contract. An empirical study by Silber (1981) concludes that futures contracts whose specifications closely reflect the needs of hedgers seem more likely to succeed. Tashjian and McConnell (1989) show that hedging effectiveness is a very important determinant in explaining the success of futures contracts. In accordance with these recent findings, particular attention has been paid to hedging effectiveness. Authors who have proposed measures of hedging effectiveness include Ederington (1979), Hsin, Kuo and Lee (1994), Chang, Chang and Fang (1996) and Pennings and Meulenberg (1997). Common to all these measures is an attempt to indicate the extent to which hedgers are able to reduce spot price risk by using futures contracts. It has also been argued that the motivation for hedging is not to reduce *spot price risk* of a single commodity but to reduce the *residual risk* of the firm (Anderson and Danthine (1980), Rolfo (1980), Anderson and Danthine (1981), Zilcha and Broll (1992)). This implies that it may be of interest to an exchange to add to the existing futures contracts new ones that provide the hedger with the opportunity to cover the firm's residual risk. This raises an important theoretical and practical question for a futures exchange: is it beneficial to add new futures contracts to those already listed? In this paper we address this question by utilizing and then departing from a multi-product hedging model. In contrast to previous research in this area (e.g Anderson and Danthine (1981), Duffie and Jackson (1989), Myers and Thompson (1989), Fackler and McNew (1993), Tashjian and Weissman (1995)) we shift the perspective from portfolios to the exchange management. Based on a multi-product model we establish a framework that derives the consequences of adding a new futures contract for the optimal hedging ratios of the existing contracts and therewith their trading volume. We show that the introduction of a new futures contract might indeed increase the trading volume of the futures contracts already listed (i.e., reinforcement). However, under certain conditions, the listing of a new futures contract could also lead to a volume decrease for the existing futures contracts (i.e., cannibalism).

This paper applies a multi-product hedging model for a competitive producer who faces both input and output price risks and whose only available hedging instruments are futures contracts on these inputs and outputs. First, we focus on the optimal hedging ratio for a firm with multiple hedging opportunities, i.e., the optimal portfolio of futures contracts to hedge the residual risk of the firm. Second, we derive the conditions for futures contract reinforcement. The managerial implications of our findings are demonstrated empirically, using data from the Chicago Board of Trade on the soybean complex and data from the Amsterdam Exchanges on financial futures taking liquidity costs into account.

The paper is organized as follows. In Section II we present a multi-product hedging model, while Section III is devoted to the analysis of reinforcement, assuming optimal multi-product risk minimizing hedging. Section IV presents findings for the soybean complex traded on the Chicago Board of Trade and for financial futures traded on the Amsterdam

Exchanges, the latter being a relatively thin market. In Section V the managerial implications of reinforcement for the futures exchange are discussed. Results and main conclusions are summarized in Section VI.

II. Multi-Product Hedging Model

The vast majority of investigations into the optimal hedging strategy for a risk-averse competitive producer have focused on managing the risk of a single input or output in a setting of price risk and in some cases also uncertain production (see, for example, Ederington (1979), Rolfo (1980), Berck and Cecchetti (1985), Lapan and Moschini (1994)). Many firms have multiple inputs and outputs, and it is therefore reasonable to assume the firm to be interested in the protection of its over-all financial performance. Duffie and Jackson (1989), Fackler and McNew (1993), Tashjian and Weissman (1995) among others have extended earlier hedging models, using a multi-product hedging approach. They consider the natural price variation of firms' total inputs and outputs. We use such an approach to derive the conditions under which the introduction of a new futures contract leads to either a volume increase or decrease for those futures already listed.

Following the standard hedging literature (Anderson and Danthine (1981), Duffie and Jackson (1989), Myers and Thompson (1989), Fackler and McNew (1993), Tashjian and Weissman (1995)) suppose a firm has an endowment of n spot commodity positions. Let β be a n vector of these quantities where positive elements represent long (buy) spot positions and negative numbers are short (sell) spot positions. Let $\mathbf{T}$ be a m vector of futures positions, again with positive (negative) numbers representing long (short) positions. In this two-period model, the next period's spot prices **S** and the next period's futures prices **F** are random vectors. Denoting the *m* vector of today's prices for future delivery as *f*. Assume unbiased futures markets, or E(**F**) = f.[1] The mean and variance of next period's prices may be written:

$$\begin{bmatrix} S \\ F \end{bmatrix} \sim \left(\begin{bmatrix} E(S) \\ f \end{bmatrix}, \begin{bmatrix} \Sigma_{ss} \, \Sigma_{sf} \\ \Sigma_{fs} \, \Sigma_{ff} \end{bmatrix} \right) \tag{1}$$

where Σ_{ff} is the matrix of covariances between the futures prices at maturity, Σ_{ss} the matrix of covariances between the spot prices and Σ_{sf} the covariance matrix between spot and futures prices. The firm's random profit Π can be written as:

$$\Pi = S' b - C(b) + (F - f)' T \tag{2}$$

where C(β) is the firm's cost function.

[1] There is considerable empirical evidence support for this assumption (Kamara (1982))

The first-order condition for the variance-minimizing futures position **T** in terms of the spot position β in a mean-variance framework, in which firms are assumed to maximize a linear function that is increasing in expected returns and decreasing in return variance, is[2]:

$$T = -\Sigma_{ff}^{-1}\Sigma_{fs}\, b\,. \tag{3}$$

The optimal hedge position can be described in terms of the fraction of the spot commodity offset in the futures market. In such a case, the vector of hedge ratios can be written as:

$$HR = [diag(b)]^{-1}\,\Sigma_{ff}^{-1}\Sigma_{fs}\, b \tag{4}$$

where diag (β) is a diagonal matrix with vector β on its main diagonal. Hedge ratios can be defined independent of spot commodities quantities, provided that the latter are always held in fixed proportions, as is the case when they represent inputs and/or outputs for some fixed proportions technology.

[2] For the conditions which justify the use of the mean-variance framework and a discussion of the use of the mean-variance framework and the general expected utility model, see Pulley (1981), Tew, et al. (1991), Coyle (1992), Meyer and Rasche (1992), Bigelow (1993) and Pope and Chavas (1994).

III. Reinforcement versus Cannibalism

One advantage of the multi-product hedging approach outlined above over the single-product approach is its incorporation of correlation between spot prices. In fact, the multi-product hedging model incorporates not only the direct relationships, but also the cross relationships (the relationship between spot price A and futures price B) and the indirect relationships (the relationship between spot price A and futures price B through futures price A). This characteristic may be helpful in gaining insight into the effects of adding new types of futures contracts to those already listed. When adding a new futures contract, the following effects can be discerned: 1) Demand (reflected in the hedged portion of the firms' endowment[3]) increases for all futures contracts already listed; 2) Demand decreases for all futures contracts already listed; 3) An increase in the aggregate demand across the futures contracts already listed; 4) A decrease of the aggregate demand across the futures contracts already listed; 5) No change of the aggregate demand across the futures already listed. These five effects are referred to as *strong reinforcement*, *strong cannibalism*, *weak reinforcement*, *weak cannibalism* and *neutralism* respectively. A futures exchange planning to list a new futures contract will be interested in finding out which of the above effects will

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[3] Measuring successful commodity derivative innovations is a complicated matter. The critical success levels for trading volume is necessarily arbitrary. A difficulty with volume data is that contracts for different commodities are not worth the same amount of money so that the economic significance of total volume across different contracts is unclear. Duffie and Jackson (1989) address this ambiguity by defining the optimal futures contract as the one contributing the most to the unhedged portion of investors' endowment.

occur. Using the multi-product hedging model we are able to provide insight into the level of reinforcement or cannibalism respectively.

Myers and Thompson (1989) show that the hedge ratio in the univariate case can be estimated using a simple least squares regression of the spot prices on the futures prices. Under the assumption that the spot and futures prices are conditionally bivariate in distribution, they show that the regression coefficient associated with the futures price is a maximum likelihood estimate of $\Sigma_{ff}^{-1}\Sigma_{fs}$ and hence of the optimal hedge ratios (see equation 4).[4] This result is extended to the multi-product hedging case. We shall elaborate on the implications of these results in order to predict the effect of introducing a new futures contract on the already listed ones. Note that hedgers are not interested in discovering linear connections, but rather in finding optimal hedge ratios. When a regression coefficient is close to zero and non-significant, hedgers will not include in their portfolio that associated futures contract. The regression coefficients indicate variables of behavior, and we assume hedgers behave in accordance with them. Subsequently, we use these regression coefficients to deduce the level of reinforcement or cannibalism.

Suppose we have a matrix *F* and *S* of observations of the futures prices f' and spot prices s' respectively. Now, consider regressing the values of the fixed spot position β, Sb on the futures prices *F*:

[4] The maximum likelihood estimates of $\Sigma_{ff}^{-1}\Sigma_{fs}$ can be obtained by using the iterated Seemingly Unrelated Regression (SUR) approach. In the case where the same set of variables explains both the spot and futures prices, the Ordinary Least Squares (OLS) estimator is also the maximum

$$Sb = Ff + e \qquad (5)$$

where ϕ is the vector of regression coefficients and e is the vector of residuals. Applying OLS to (6) yields:

$$\hat{f} = (F'F)^{-1} F'Sb \qquad (6)$$

and

$$\hat{e} = \left(S - F\,(F'F)^{-1} F'S\right)b \qquad (7)$$

where (6) is an estimator of the optimal hedge amount $HP = \Sigma_{ff}^{-1}\,\Sigma_{sf}\;b$ and thus describes hedging behavior.

In order to estimate the level of reinforcement induced by a new futures contract type we define the vector $\hat{k}$ and $\hat{r}$ as the OLS estimates following from regressing the new futures contract's price z on the other futures' prices:

$$z = Fk + r. \qquad (8)$$

Applying OLS to (8) yields the estimates:

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likelihood estimator. In this paper, the results are derived from within the framework of the OLS

$$\hat{k} = (F'F)^{-1} F'z \qquad (9)$$

and

$$\hat{r} = z - F(F'F)^{-1} F'z. \qquad (10)$$

In order to analyze the influence that this new futures contract has on the original futures positions, we compare (5) with the estimates of the coefficients in its extended equivalent:

$$Sb = Fg + zd + m \qquad (11)$$

where μ is the error term. Applying OLS to (11) yields:

$$\begin{pmatrix} \hat{d} \\ \hat{g} \end{pmatrix} = \begin{pmatrix} z'z & z'F \\ F'z & F'F \end{pmatrix}^{-1} \begin{pmatrix} z'S \\ F'S \end{pmatrix} b. \qquad (12)$$

It can be shown that the coefficient estimator $\hat{\delta}$ equals:

$$\frac{1}{\hat{r}'\hat{r}} \hat{r}' Sb. \qquad (13)$$

Note that $\hat{r}'\hat{r} \geq 0$ and that $\hat{r}'Sb = (z' - z'F(F'F)^{-1} F')Sb = z'(Sb + FHP)$ is a consistent estimator of $cov(z, sb + FHP)$. Actually, it is a consistent estimator of the covariance

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estimator. Using the SUR framework would not affect our conclusions.

between z and Π, the profit (as defined in equation 2). Since $\hat{k}$ is an OLS estimator, it holds that $F'\hat{r} = 0$. Therefore we can rewrite (11) as:

$$Sb = F(\hat{g} + \hat{k}\hat{d}) + \hat{m} + \hat{r}\hat{d}. \quad (14)$$

The incremental change in the optimal hedging position of the futures contracts already in the portfolio is thus given as:

$$\Delta HP = -\hat{g} - (-\hat{f}) = \hat{f} - \hat{g} = \hat{k}\hat{d}. \quad (15)$$

If the difference in (15) is all positive for outputs and negative for inputs, *strong reinforcement* occurs. If this difference is all negative for outputs and positive for inputs, we are confronted with *strong cannibalism.* We can now derive the conditions necessary for strong reinforcement to occur.

Proposition. *Adding a new futures contract z to the portfolio leads to strong reinforcement if and only if one of the two following situations applies:*

1) The relation between the new futures price z and the original futures prices, as expressed by the multiple regression coefficients $\hat{k}$ is negative for all inputs and positive for all outputs and $\mathrm{cov}(z,\Pi) < 0$.

2) The relation between z and the original futures prices, as expressed by the multiple regression coefficients $\hat{k}$ is positive for all inputs and negative for all outputs and $\mathrm{cov}(z,\Pi) > 0$.

The proposition could be defined for separate futures contracts already listed as well. Table 1 summarizes our finding.

TABLE 1. Strong Reinforcement and Strong Cannibalism by Additional Futures Contract z.

	$\hat{k}$ negative for inputs $\hat{k}$ positive for outputs	$\hat{k}$ positive for inputs $\hat{k}$ negative for outputs
$\operatorname{cov}(z,\Pi) < 0$	Strong reinforcement	Strong cannibalism
$\operatorname{cov}(z,\Pi) > 0$	Strong cannibalism	Strong reinforcement

From Table 1 it becomes clear that strong reinforcement/strong cannibalism is dependent on the regression coefficients of the price of the new futures type on the prices of the futures already in the portfolio, $\hat{k}$ and on the covariance between the futures price of the new futures contract and the profit, i.e. the return on the portfolio.[5]

By looking at the absolute value of the elements in the vector (15), we are able to pronounce weak reinforcement and weak cannibalism. When the sum of the elements in this transformed vector is positive (without all the individual elements being positive, which would imply strong reinforcement), we speak of weak reinforcement. When the sum of the elements in the vector is negative (again, without all the individual elements being negative, which would imply strong cannibalism), we speak of weak cannibalism.

A key aspect of futures market performance is the degree of liquidity in the market. The relationship between market depth and futures contract success has been thoroughly investigated in the literature (Black (1986), Cuny (1993)). A futures market is considered liquid if traders and participants can buy or sell futures contracts quickly with little price effect resulting from their transactions. However, in thin markets transactions of individual hedgers may have significant price effects and result in substantial transaction costs. The introduction of a new futures contract can, for example, turn one liquid futures contract into

[5] It should be noted that futures contract price is an unknown before the introduction of the new futures contract. However, in an empirical application, the spot market price of the new futures contract's underlying commodity may be used, it being an accurate approximation of the development of the futures contract price.

two illiquid contracts. This liquidity effect, or better stated lack of liquidity, can be incorporated in our model by correcting the futures market price for liquidity costs. In this way, we calculate the net futures price, which equals the futures price minus the liquidity costs. The stochastics of the net futures price is made up of the variance of the futures price, the variance of liquidity costs and the covariance between liquidity costs and the futures price. So, whenever we suspect a thin futures market, because of small trading volume or the absence of scalpers on the floor to absorb temporary order imbalances, we use the net futures price instead of the quoted futures price. In the next section we present an example of a relatively thin futures market where we use the net futures price.

IV. Empirical Illustration

In this section, we illustrate the respective effect of reinforcement and cannibalism on the soybean complex traded at the Chicago Board of Trade and the financial futures spread traded at the Amsterdam Exchanges. Soybean processors have at their disposal three futures contracts relevant to their production process, which consists of crushing soybeans (major input) into soy oil and soy meal (major outputs). The production process has fixed input/output ratios of 47 pounds of meal and 11 pounds of oil per bushel of beans. Estimates of the optimal hedge amounts for the three futures contracts are made using futures prices for the nearby contract month. We calculate the optimal hedging amounts of soybeans, oil and meal for a soybean crusher who is planning to process one bushel of soybeans into 11.19 pounds of oil and 0.02397 tons of meal. Daily spot (Central Illinois) and futures prices for the period January 1990 through December 1997 were obtained from the Chicago Board of Trade.

First, we estimate the optimal hedge amounts for the univariate case, the model that does not take into account the cross effects and the indirect effects by regressing the spot prices on the futures prices. Next, we estimate the separate hedge amounts for the scenario in which the entrepreneur wishes to hedge/cover profit fluctuations instead of price risk, as the univariate case presupposes. For this reason, we calculate the gross profit from the production process, by determining the spot value of the processor's endowment (i.e., the soybean crush spread, or margin) based on the fixed input/output structure of the soybean processor. Regressing the gross profit on the futures prices then enables us to estimate the optimal hedge amount.[6]

[6] A common concern in the hedging literature is whether lag variables should be included in the regression. Myers and Thompson (1989) noted that a model that does not include lags might provide poor estimates because it omits important conditioning information relevant to the means of both the cash and futures prices. We estimated the regression with and without lags (following the procedure of Britten-Jones (1999). Including the lags did not make much difference for the optimal hedge ratios and hence, the results regarding reinforcement and cannibalism. This is in line with the recent findings of Ferguson and Dean (1998). In the paper we present the results without the lags.

TABLE 2. Optimal Hedge Amounts for Single Commodities and Different Hedging Motives.

	Optimal hedge amounts[a]		
Motivation for Hedging: reduce	Soybeans (SB)	Soy oil (SO)	Soy meal (SM)
spot price risk	1.019	11.861	0.028
profit risk (residual risk)	0.076	4.239	0.004

Assume the soybean crusher's endowment is 1 bushel of soybeans, 11.19 pounds of soy oil and 0.02397 tons of soy meal. All the standard errors from the estimated coefficients were smaller than 0.01.

[a]Hedging amounts are in bushels for soybeans, pounds of oil and tons for meal.

Table 2 shows that less hedging occurs when the hedging motivation is reduction of the firm’s residual risk than when the objective is reduction of a single commodity’s spot price risk (here and elsewhere the absolute value of the hedge amounts are displayed). Our findings, which suggest lower hedging levels necessitated in profit risk management, can be explained through the presence of natural hedges in the soybean crush, that is to say, a positive correlation between the spot prices of inputs and outputs, which reduces the need for hedging. These results support somewhat that of Tzang and Leuthold (1990).

Using the multi-product hedging model, the optimal hedge amounts are estimated for a scenario in which the exchange would list either soybeans, soy oil or soy meal only (see Table 3). These hedge amounts are equal to the optimal hedge amounts in Table 2 for the case where profit risk management constitutes the motivation for hedging. Subsequently, we are able to investigate the hedge amounts and reinforcement-cannibalism levels of a total of seven different combinations of futures contract listings by regressing the gross profit from the crush on the futures prices (see Table 3).

TABLE 3. Optimal Hedge Amounts for Different Combinations of Futures Contracts.

	Optimal hedge amounts[a]			
Listing	Soybeans (SB)	Soy oil (SO)	Soy meal (SM)	HE[b]
SB	0.076	*	*	4.0%
SO	*	4.239	*	14.4%
SM	*	*	0.004	13.6%
SB and SO	0.000	4.035	*	14.6%
SB and SM	0.359	*	0.013	26.7%
SO and SM	*	3.489	0.003	22.9%
SB, SO and SM	0.885	9.907	0.003	72.6%

Assume the soybean crusher's endowment is 1 bushel of soybeans, 11.19 pounds of soy oil and 0.02397 tons of soy meal. All the standard errors from the estimated coefficients were smaller than 0.01.

[a]Hedging amounts are in bushels for soybeans, pounds of oil and tons for meal.

[b]The hedging effectiveness (HE) is measured as the percentage reductions in variances relative to the unhedged position (Ederington (1979)).

Table 3 shows that listing all three contracts realize an optimum. That is, the aggregate demand for the hedging services provided by the futures exchange is maximized. In that case for each bushel of soybeans the processors plan to purchase and crush, their endowment is 1 bushel short for soybeans, 11.19 pounds long soy oil and 0.02397 tons long soy meal, the risk minimizing multivariate hedge is to go long 0.885 bushels of soybeans, short 9.907 pounds of soy oil and short 0.003 tons of soy meal. In this situation the hedging effectiveness will reaches an optimum as well.

When adding soy oil to soybeans, strong cannibalism occurs. That is, the optimal hedge amount for soybeans decreases. However, when adding soy meal to soybeans and soy oil, strong reinforcement occurs. That is, the hedge amounts of the futures already listed (soybeans and soy oil) increase by adding soy meal. This is evident from proposition 1 as well. The regression of soy meal on the prices of the futures already in the portfolio, $\hat{k}$ in Equation (15), is negative and the covariance between the futures price of the new futures contract, in our case soy meal, and the profit, i.e., the return on the portfolio, is positive. This puts us in the lower-right quadrant of Table 1, strong reinforcement. This example illustrates why an exchange would have interest in studying the whole production structure of the potential hedger. Listing only part of a production structure may imply a sub-optimal situation for the exchange.

Now we turn to an example of a relatively thin futures market. A pension fund has several possibilities to cover its risks resulting from fluctuations in interest rates. One way to hedge against adverse interest rate changes is to hedge with the help of a bond futures contract. In the Netherlands, however, this contract was not successful and was de-listed. At the Amsterdam Exchanges (AEX) the following relevant futures contracts are being traded: the AEX stock index (which consists of Dutch blue chip stocks), the Dutch top-5 index, the FTSE Europe top-100 stock index (which include European blue chip stocks) and the US Dollar/Dutch Guilder futures contract. The AEX stock index was introduced on 24 October 1989, the Dutch top-5 index futures on 21 March 1990, the FTSE Europe top-100 index futures on 6 June 1991 and the US Dollar futures on 27 September 1991. Pension funds that wish to hedge against adverse interest rates on the Dutch Guilder have at their disposal four futures contracts traded at Amsterdam Exchanges. Contrary to the futures from the soybean complex at the Chicago Board of Trade, the market for these futures at the Amsterdam Exchanges is rather thin. The volume of the AEX stock index in 1997 was 2,554,776 contracts, the Dutch top-5 index was 58,891, the FTSE Europe top-100 index was 249, and the US dollar futures was 19,914. Because we suspect that a trader incurs liquidity costs when trading these thin futures, we incorporated these costs. In order to calculate the liquidity costs and hence, the net futures price, we gathered daily transaction-specific data for the period 1992 through 1997. In the case of order selling imbalance, liquidity costs were calculated as the area between the downward-sloping price path and the price for which the hedger enters the futures market, hence

$$LC = PF^1 \cdot N - \sum_{i=1}^{N} (PF^i) \tag{16}$$

where PF^1 is the futures price for which the hedger enters the market, PF^i is the price of the *i*-th futures contract and *N* the total order flow.

The liquidity costs in the case of order buying imbalance were calculated as the area between the upward-sloping price path and the price for which the hedger enters the futures market, hence

$$LC = \sum_{i=1}^{N} (PF^i) - PF^1 \cdot N. \qquad (17)$$

The net futures price is now calculated as the quoted futures price minus the liquidity costs per futures contract. In further analyses we use these net futures prices.

We now calculate the optimal hedging amounts of a holder of one million Dutch Guilders. The dependent variable in the regression is the yield on a 10-year Dutch Treasury bond. In estimating the optimal hedge amounts and hedging effectiveness of different combinations of futures, we use the same actual sequence which was used by the Amsterdam Exchanges, that is we first estimated the optimal hedging amount when only the AEX stock index is available, followed by the Dutch top-5 index, the FTSE Europe top-100 index and finally the US Dollar contract.

Table 4 reflects the optimal hedge amounts and hedging effectiveness of the different futures.[7] It shows that the addition of the Dutch top-5 index to the AEX index leads to strong reinforcement, that is the hedging demand for the AEX index has increased from 34.45 to 80.56 due to the listing of the Dutch top-5 index. Adding the FTSE Europe top-100 index leads also to weak reinforcement. The introduction of the FTSE Europe top-100 index leads to a decrease for AEX index futures and an increase for Dutch top-5 index futures, which finds its reflection in the change of the optimal hedging amounts. Table 4 shows that listing the US Dollar futures contract leads to weak cannibalism. The introduction of the US Dollar futures leads to a decrease for both the AEX index futures and the FTSE Europe top-100 index futures. This decrease is not fully offset by the increase in the Dutch top-5 index futures.

In the above analysis, the liquidity costs have been taken into account. In order to investigate the effect of thin markets on reinforcement and cannibalism, we performed the analysis again, this time without calculating the liquidity as indicated in equations (16) and (17). These results show no major changes in the conclusions about reinforcement and cannibalism. They do show increased hedging effectiveness for the various combinations, which also overrates hedging effectiveness in each case (about three percent) because of excluding liquidity costs. These results correspond to the findings of Pennings and Meulenberg (1997). The fact that the extent of the lack of liquidity is not very severe, and the fact that it does not differ much between the contracts, might explain the lack of finding any major effects in this analysis. In another empirical setting,

[7] Each of the four futures contracts is designed such that a one-point change in the quotation

however, major differences in reinforcement and cannibalism might very well be found when the incorporation of liquidity risk in the analysis is omitted. For this reason, it is advisable to incorporate the liquidity component into the model, whenever a lack of liquidity is expected.

These two examples show to an exchange the value of studying the effects that individual contracts may have on other contracts listed. Paying attention to the structure of the residual risk of its potential customers can prove valuable to the exchange. This implies that the exchange should investigate the underlying production structure of the hedger's industry, and by doing so identify the residual risk.

V. Managerial Implications

Our findings carry important implications for a futures exchange's innovation policy. Before introducing a new futures contract, it is important for a futures exchange to study first the effects of such an introduction on those futures contracts already listed. Disregarding the possibility of cannibalism when introducing a new futures contract might lead to a volume decrease for those futures contracts currently traded. This volume decrease might, in turn, lead to a decline in liquidity, which would ultimately threaten the exchange's viability.

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implies a change of the underlying value of the futures contract of 200 Dutch Guilders.

In view of this, it is valuable for an exchange to investigate the hedger's underlying production structure, that is, the firm's residual spot market risk before introducing new futures contracts. A futures exchange should conduct research in order to introduce only futures contracts that will actually realize (strong/weak) reinforcement, thus ensuring its own success.

These results gain special relevance when applied to new futures exchanges because of their smaller scale (Kilcollin and Frankel (1993)). For these exchanges, volume sufficiency is of vital importance. Through a thoughtful strategy of new introductions, an exchange should be able to generate a volume increase for the futures contracts already listed, thereby automatically increasing its over-all viability and, by doing so, increasing contract liquidity. Moreover, such an exchange would be better equipped to comply with the demands of companies wanting to hedge their profits. When carrying out an innovation, it would be advisable that this exchange take into account the liquidity costs of the existing futures contracts, since a lack of liquidity may have an effect on reinforcement.

Listing futures contracts that reflect the residual spot market risk of the hedger's industry would be advantageous to the clearing system of futures contracts that are subject to margining. A combination of futures contracts reflecting the production structure (and hence, the residual spot market risk) keeps margin requirements at a lower level than they would be if all futures contracts were listed separately (Goldberg and Hachey (1992), Gemmill (1994)). This creates an opportunity for the hedger to free-up more capital and hence, the possibility of enlarging futures contracts positions whenever the capital requirement is the limiting factor in taking positions. Cross margining between exchange-traded futures contracts is an option offered by some clearing houses in conjunction with futures contracts reflecting the production structure.

Gathering information on the production structures particular to different industries seems to be of great importance to futures exchanges. Computer technology and advancements in telecommunications will make this easier in the future, which will, in turn, lead to improvements in the structure of futures exchanges (Merton (1995)).

VI. Conclusion

This paper introduces a method that yields information about the effect of introducing new futures contracts. This method can be easily applied by futures exchanges. However, some caveats in our analyses should be mentioned. First, our analysis is derived from a multi-product hedging model in which the spot positions were fixed. However, as Anderson and Danthine (1981) showed decreasing the residual risk for the hedger will lead to an increase in the optimal production level, which in turns leads to an increase in the scale of hedging. Since adding a new futures contract that reflects the underlying production structure of the hedger will decrease residual risk, this effect will induce reinforcement and offset cannibalism, at least partially. Second, we did not account for the effect of redistributing liquidity, that is, the effect of redistributing liquidity from highly liquid futures contracts to relatively illiquid futures contracts due to the introduction of a new futures contract, which may increase the attractiveness of the futures exchange and hence its success.

Our findings suggest several directions for further research. First, including the demand for speculation might extend our framework. Listing futures contracts reflecting the production structure of the hedger's industry will increase spreading opportunities, which might increase the attractiveness of the futures exchange for speculators and hence, contribute to its success. Second, the competitive environment of the exchange will have an impact on reinforcement and cannibalism. Modeling these competitive forces within the framework, as proposed here, is an avenue of future exploration.

Table 4. Optimal Hedge Amounts for Different Combinations of Futures Contracts.

	Optimal hedge amounts				
Listing	AEX-index (FTI)	Dutch top-5 index (FT5)	FTSE Europe top-100 index (FET)	US dollar futures (FUS)	HE[a]
FTI	34.45	*	*	*	50.8%
FT5	*	20.07	*	*	45.1%
FET	*	*	16.96	*	54.5%
FUS	*	*	*	263.51	15.3%
FTI and FT5	80.56	28.98	*	*	53.8%
FTI, FT5 and FET	64.11	66.85	97.91	*	70.2%
FTI, FT5, FET and FUS	41.51	76.77	92.95	123.48	72.5%

All the standard errors from the estimated coefficients were smaller than 0.01.

[a] The hedging effectiveness (HE) is measured as the percentage reductions in variances relative to the unhedged position (Ederington, 1979).

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