

Commodity Futures Contract Viability: A Multidisciplinary Approach

Joost M.E. Pennings and Raymond M. Leuthold*

We propose a development process of commodity futures contracts in which the decisions and wishes of potential customers are investigated simultaneously with the necessary technical properties that need to be met for trading to take place. Within this framework the relationship between trading volume and hedging effectiveness is examined taking both basis risk and market depth risk into account, and the relationship between owner-manager's characteristics and the probability of using futures is examined, taking latent variables and the heterogeneity of owner-managers into account. The relationships are tested on a set of data gathered in a stratified sample of 440 owner-managers by means of computer-assisted personal interviews and on transaction-specific futures data. Structural equation models and multiple regression models are used to validate the relationships. The hedging effectiveness and the variables that play a role in the owner-manager's use of futures are related to the tools of the exchange.

(Futures Contracts Design; Multidisciplinarity; Hedging Effectiveness; Choice Behavior; Measurement Error; Segments; Futures Exchange Toolbox)

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1. Introduction

With an almost exponential growth in the last decade and 2.2 billion futures and options contracts traded throughout the world in 1998, competition is stiff in the financial services industry (Futures Industry Association 1999). The derivatives industry is composed of competing firms: exchanges, banks and brokerage houses offering and facilitating over-the-counter trading. With commodity derivatives, the risk of failure is considerable (Carlton 1984). In the period 1994-1998 a total of 140 new commodity

derivatives were introduced around the world. Twelve of these derivatives were de-listed within this period. The London International Financial Futures & Options Exchange and the Chicago Mercantile Exchange are the leaders in introductions with fifteen and fourteen, respectively, in the period 1994-1998. If we follow the criteria formulated by Silber (1981), fifty-eight percent of the introductions have failed. The development and introduction of commodity derivatives is an expensive and time-consuming process, especially when it concerns new derivatives. Insight in the aspects that influence the success and failure of derivatives seems therefore valuable. In this paper we will focus on commodity futures contracts as an example of an exchange-listed derivative. Two streams of literature have contributed to our understanding about the factors influencing the viability of futures contracts.

The first stream of literature is on a “marco-level” or non-subject level. It defines feasible commodities for futures trade based on an extensive list of required commodity attributes. The following attributes are considered crucial for qualifying for futures trade: 1) a commodity should be durable and it should be possible to store it; 2) units must be homogeneous; 3) the commodity must be subject to frequent price fluctuations with wide amplitude; 4) supply and demand must be large; 5) supply must flow naturally to market and there must be breakdowns in an existing pattern of forward contracting (Gray 1978, Black 1986). These attributes focus on the technical aspects of the underlying commodity.

The second stream of literature is on the “micro-level” or subject level. It provides insight into the characteristics of corporations that are associated with the decision to use futures. Both finance research as well as economics contributed to this strain of literature.

In the finance studies several factors, such as the firm's risk exposure, its growth opportunity, the level of wealth, managerial risk aversion, financial distress costs, and the accessibility to financing appear to influence the decision of a corporation to adapt derivatives to their risk management toolbox (Smith and Stulz 1985, Nance, Smith, and Smithson 1993, Mian, 1996, Tufano 1996, Lee and Hoyt 1997, Géczy, Minton and Schrand 1997, Carter and Sinkey 1998, Howton and Perfect 1998, Schrand and Unal 1998, Visvanathan 1998, Koski and Pontiff 1999). In the economics literature attention has been paid to the factors influencing owner-managers use of futures. Several authors identified such factors as, experience, education, enterprise size, expected income change from hedging, age, leverage, risk management and marketing seminar participation, influencing the owner-manager's use of futures contracts (Holthausen 1979, Shapiro and Brorsen 1988, Hirshleifer 1988, Asplund, Foster and Stout 1989, Makus et al. 1990, Paroush and Wolf 1992, Goodwin and Schroeder 1994, Musser, Patrick and Eckman 1996, Patrick, Musser and Eckman 1998).

The "macro-level" literature has received a lot of attention and has increased our insight into the technical commodity factors influencing viable commodity futures trade (Black 1986, Tashjian 1995). However, the above listed attributes considered necessary have proven themselves too strict to be useful as criteria for futures market success. Different types of (exotic) commodity derivatives contracts have been developed that do not have (all of) the attributes mentioned above, but are successful anyway.

The "micro-level" literature has increased our understanding how firm characteristics and manager's characteristics influence the use of futures and hence, the viability of futures trade. In some of these studies it is assumed that managers are risk

averse. However, risk attitudes may differ across managers. Brockhaus (1980), March and Shapira (1987), and Smidts (1997) found large differences in risk attitudes among managers of corporations and owner-managers. Puzzling results were found regarding the influence of risk attitude on hedging behavior. Goodwin and Schroeder (1994) found that owner-managers with a stated preference for risk are *more* likely to adopt forward pricing than are risk-averse producers. One of the reasons for these contra-intuitive findings is the difficulty in measuring risk attitudes, and in more general, latent constructs in a realistic and accurate manner (Eliashberg and Hauser 1985, Weber and Milliman 1997). These studies address relationships between and among variables that are not always directly observable (e.g., owner-manager's risk attitude), without taking measurement error into account. When such measures are used in models, the coefficients obtained will be biased. Another point of concern in the "micro-level" literature is that these studies assume enterprises to be homogenous regarding their choice process for futures. When estimating these models, data are treated as if they were collected from a single population. This assumption of homogeneity is often unrealistic. For example, owner-managers of different size or regions may have different decision structures. Hence, pooling the data across respondents is likely to produce misleading results.

The "micro-level" literature and "macro-level" approach answer two complementary questions: will the owner-manager adopt futures? and, is the commodity suitable for futures trading? It seems interesting to investigate both questions simultaneously when trying to gain insight into the viability of commodity futures contracts.

In this paper we will first address concerns of past research within the two approaches. Then we propose a framework that will integrate the technical aspects of the underlying commodity and the decision-making needs of (potential) hedgers. The present study focuses on owner-managers of small and medium-sized enterprises (SMEs). An important difference between owner-managers and managers of a large enterprise lies in the fact that owner-managers do not have different functional departments such as research and development, manufacturing-quality control, sales and accounting. All these departments are combined within the owner-manager. The decision process is in such a case not that rationalized as in the case of large enterprises that have different functional departments. Some of the concepts used by owner-managers might be psychological constructs (such as ‘level of understanding’) that are not directly measurable and therefore remain absent in accounting data used in recent studies about managers in large companies (Géczy, Minton and Schrand 1997). These psychological constructs may very well play a part in the owner-manager’s use of futures.

This research makes a theoretical, a methodological, and a managerial contribution. *Theoretically*, we provide insight into the factors that play a role in the success of a futures contract, divided into two aspects, namely factors with a technical (market) character and factors dealing with the decision-making process of owner-managers with respect to hedging. We show that hedging effectiveness measures which take market depth risk into account reveal more coherence with trading volume than hedging effectiveness measures that do not take market depth into account. Moreover, we show that perceptions and psychological constructs influence owner-managers’ use of futures and that the heterogeneity of owner-managers leads to different segments such

that within a segment the owner-managers' behavior regarding futures is similar and between segments dissimilar. *Methodologically*, we take measurement error into account. We recognize that the theoretical constructs of interest are not always directly measurable, but must instead be estimated from multiple indicator measures. To obtain this objective, we use structural equation modeling in order to test our model and hypotheses. Structural equation modeling provides us with a method for estimating structural relationships among unobservable constructs and for assessing the adequacy with which those constructs have been measured. Moreover, we take into account that owner-managers may exhibit heterogeneity. *Managerially*, we propose a framework useful to exchanges that contains all relevant aspects, and hence is a powerful tool for designing commodity futures contract.

The remainder of the paper is structured as follows. First, we explain the differences and complementarities of the different approaches towards futures contract viability. Within these approaches the puzzling results in previous research are addressed. Thereafter, a conceptual framework is introduced that integrates both approaches. After the research method and the operationalization of the variables, different relationships between hedging effectiveness and trading volume on the one hand and owner-manager's characteristics and use of futures on the other hand are estimated. Data obtained from 440 owner-managers by means of computer-assisted personal interviews and transaction-specific futures trade data constitute the input for this part of the research. We interpret the results in the concept of managerial decision-making concerning contract design and viability. We conclude with an evaluation of the study and make some suggestions for further research.

2. Conceptual Framework: A Multidisciplinary Approach towards Commodity Futures Contracts

In the financial literature on futures contracts, the *commodity characteristics approach* and the *contract design approach* can be distinguished (Black 1986). The *commodity characteristics approach* defines feasible commodities for futures trading, based on an extensive list of required commodity attributes, and, in so doing, focuses on *the technical aspects of the underlying commodity*. The *contract design approach* views the contract specification (standardization process of the contract) as the critical factor determining the viability of a futures market, and hence focuses on *the technical aspects of the contract*. To warrant hedging, the contract must be as close a substitute for the cash commodity as possible (Thompson, Garcia and Dallafior 1996). Tashjian and McConnell (1989) have shown that the hedging effectiveness is an important determinant in explaining the success of futures contracts, and as a result, considerable attention has been paid to the hedging effectiveness of futures contracts.

Regarding commodity characteristics, those who have proposed alternative hedging effectiveness measures include Ederington (1979), Howard and D'Antonio (1984), Chang and Fang (1990) and Hsin, Kuo, and Lee (1994). All these measures try to indicate to what extent hedgers are able to reduce cash price risk by using futures contracts. Therefore, the extent to which a futures contract offers a reduction in overall risk is an important criterion for the managers of a futures exchange to evaluate the hedging performance. A key aspect of futures market performance is the degree of liquidity in the market (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, the transactions of individual hedgers may have significant price effects and result in substantial ‘transaction costs’ (Kyle 1985, Thompson, Garcia and Dallafior 1996). This phenomenon, which we will refer to as a lack of market depth, is particularly important for relatively small commodity futures markets and might be especially true for new futures markets. We therefore propose to use an extended version of the Ederington measure by including market depth risk (Pennings and Meulenberg 1997a,b). It can be shown that when we include market depth risk in the Ederington measure, hedging effectiveness can be measured as:

$$HE = - \frac{b^{*2} (\mathbf{s}_f^2 + \mathbf{s}_{md}^2 - 2\mathbf{s}_{fmd}) + b^* (-2\mathbf{s}_{sf} + 2\mathbf{s}_{smd})}{\mathbf{s}_s^2} \quad (1)$$

where σ_s^2 , σ_f^2 , σ_{sf} , \mathbf{s}_{fmd} and \mathbf{s}_{smd} represent the subjective variances and the covariances of the possible price (subscript s and f denote spot and futures prices respectively) and market depth cost changes (denoted by md) from time 1 to time 2, and

b^* is the risk minimizing hedge ratio with $b^* = \frac{\mathbf{s}_{sf} - \mathbf{s}_{smd}}{\mathbf{s}_f^2 + \mathbf{s}_{md}^2 - 2\mathbf{s}_{fmd}}$.

If there is no market depth risk, the measure in (1) reduces to the Ederington measure. The application of this measure requires transaction-specific futures data and cash market data.

Often, alternative products or services will be available to meet the needs of the owner-manager, which is why we also pay attention to the owner-managers’ decision-

making process. Insight into the choice process provides us with clues about the necessary characteristics of a futures contract in order to be preferred over the other alternatives. The owner-manager compares the alternatives on the basis of different attributes or dimensions, e.g. the alternative's risk reduction capacity. The owner-manager's choice for any particular alternative depends on the importance placed by the owner-manager on these attributes as well as on how the alternatives differ with respect to these attributes in the owner-manager's evaluation. Insight into these attributes and the variables influencing them provide the management of the futures exchange with a framework for improving *service design* and *service delivery*. Service design refers to the contract specification and is related to the *core service* of the futures exchange (i.e. risk reduction). Service delivery refers to the way the core service is brought to the customer and is the result of the interaction between the futures exchange and the customer and is related to such factors as the clearing system, accessibility of brokers and the information provided by the trading system. Moreover, insight into why the owner-manager chooses the way he or she does provides valuable information in efficiently identifying certain target groups and customizing services. We will elaborate on two topics, that is the measurement issues when using perceptions and psychological constructs and the heterogeneity of owner-managers.

In this paper we recognize that owner-managers make decisions, based on their beliefs, which are formed by perceptions. For example, the perceived risk reduction performance may differ from the performance as reflected by hedging effectiveness measures such as in (1). Moreover, owner-managers may very well evaluate the hedging service provided by futures exchanges along with criteria other than just performance.

That is, we take psychological constructs into account (Thaler 1993, 1997). Two empirical problems may arise when taking perceptions and psychological constructs into account. First, we have to make sure that we have *reliable* and *valid* constructs. We therefore propose to measure latent variables by a set of observable indicators (items) which are subjected to confirmatory factor analysis to assess their psychometric properties and unidimensionality. Confirmatory factor analysis permits a rigorous assessment of the stability of the latent variables and its psychometric properties (Reise, Widaman, and Pugh 1993, Hair et al. 1995, Yung 1997). Second, relationships between and among latent theoretical concepts (constructs) that are not directly observable may result in biased coefficients because of *measurement error*. Therefore, we use structural equation modeling as it permits the explicit modeling and estimation of errors in measurement (Bollen 1989, 1996, Steenkamp and van Trijp 1991, Bagozzi 1981, 1994, Baumgartner and Homburg 1996, Lee and Wang 1996).

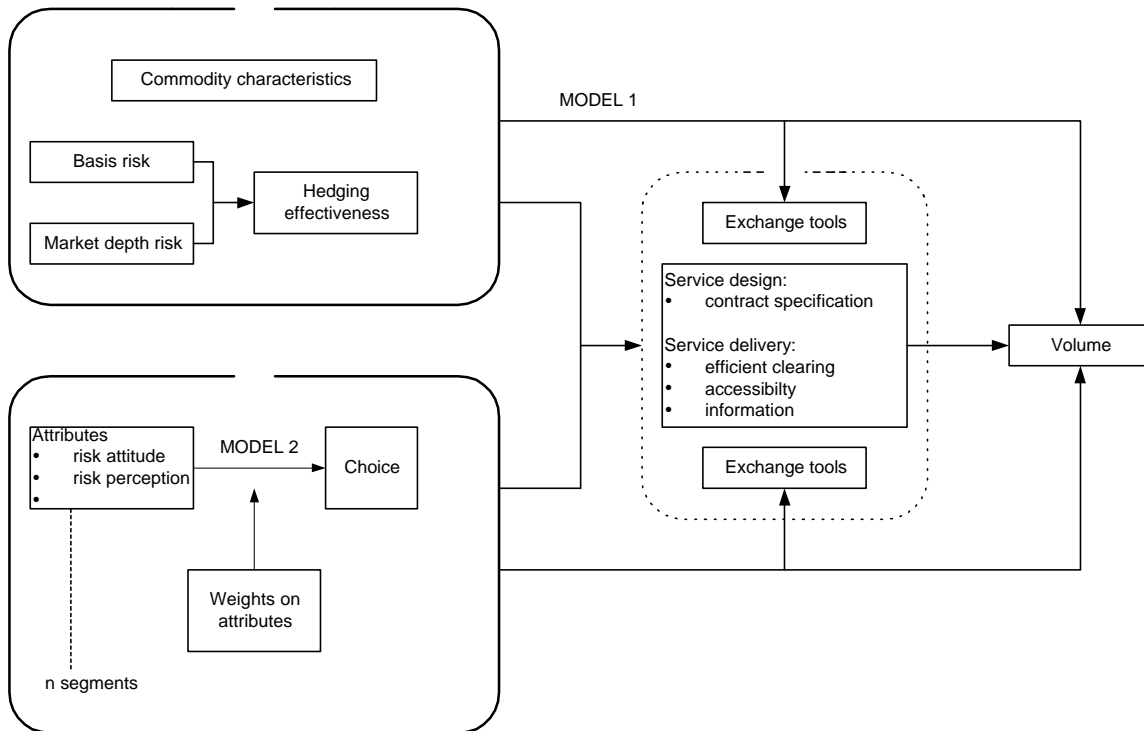
Most models assume owner-managers to be homogenous regarding their choice process for futures. These models treat data as if they were collected from a single population. In the case that this assumption of homogeneity is violated, pooling data across subjects is likely to produce misleading results. In this paper we explicitly investigate whether there are different segments in our sample population regarding choice behavior.

It is often difficult to derive from the owner-manager's choice behavior alone the successful functional and technical properties of futures contracts. On the other hand, it remains unclear whether the feasible properties of futures generate sufficient demand. It seems, therefore, that a multidisciplinary approach to futures contracts, whether from the

perspective of supply or demand side, complement each other in the process of developing, producing and marketing futures contracts.

Figure 1 presents a conceptual framework that contains both approaches to help acquire a better understanding of the factors that contribute to the success of futures markets. Moreover it contains our research design by indicating which relations within this framework are empirically tested (indicated by models 1 and 2).

Figure 1 A Conceptual Framework for Hedging Services



3. Empirical Models and Procedures

3.1. Research Design

The research design consists of several steps. First, the criteria as formulated in the commodity characteristics approach are evaluated for the commodity under consideration. Hedging effectiveness is evaluated by analyzing the overall risk reduction capacity of the futures contract, thereby accounting for *basis risk* and *market depth risk*. The relationship between hedging effectiveness and volume is empirically investigated: Model 1 in Figure 1. In order to gain insight in the effect of market depth costs on volume, we calculate both the Ederington measure and the extended measure as formulated in (1). We expect to find that the extended measure is a better predictor of volume than the Ederington measure that does not include market depth risk.

The choice process regarding futures contracts is investigated by identifying the attributes used by the owner-managers in reaching a choice and the importance placed on these attributes. Because we expect owner-managers not to be a homogeneous population, we segment across owner-managers such that within a segment the choice process is similar and across segments dissimilar. The relationship between attributes and the choice behavior is empirically investigated: Model 2 in Figure 1.

The variables and attributes in the two approaches influence the viability of futures contracts, and these components are linked to the service design (contract specification) and the service delivery process of the futures exchange in a conceptual way. The exchange has different tools available which determine the service design and the service delivery. We relate the components to the tools of the exchange.

3.2. Research Method

The Dutch hog industry is examined empirically. It represents a domain in which the technical conditions, as given in the commodity characteristic approach, have all been met. This implies that the underlying cash market is broad, that there are many participants, that the commodity is homogeneous, that there are breakdowns in an existing pattern of forward trading and high price fluctuations that are unpredictable according to the participants in the cash market (hog prices fluctuate widely, the coefficient of variation (CV) is 0.19, which is relatively high when compared to, for example, US soybeans (CV is 0.14), based on daily observations over the period 1990-1997). Although, from a technical perspective, the conditions would seem very favorable for a hog futures contract, only thirteen percent of the Dutch hog farmers actually use futures contracts to cover their price risk (Pennings and Smidts 1998). Therefore, this empirical domain may be considered ideal to illustrate the contribution of a multidisciplinary approach to commodity futures contract viability research.

3.3. Data Collection and Procedures

A questionnaire was developed on the basis of literature, and 40 test interviews were conducted to ensure correct interpretation of the questions. Prior to the quantitative study, we conducted four group discussions with owner-managers about price risk management. The goal of the group discussions was to gain insight into the decision-making process involved in selling hogs using price risk management instruments. More specifically, we wanted to gain insight into the criteria owner-managers use when choosing between alternative price risk management instruments and what price risk management instruments are perceived as alternatives in their industry. The groups consisted of ten

owner-managers each. The group discussions took place in an informal atmosphere and each session lasted for about two and a half-hours. From the group discussions it became clear that the owner-managers had only one price risk management instrument available, the hog futures contract traded on the Amsterdam Exchanges. It also became clear that a number of criteria are used in deciding whether or not to use futures contracts such as the (perceived) risk reduction performance and the possibility of exercising entrepreneurial freedom. The latter meant that futures are perceived as an attractive instrument whenever their use increases the degrees of freedom in the market place (that is, whenever they are perceived as a tool which can be added to their existing marketing toolbox and hence increase the strategies they can employ).

The survey consisted of personal computer-guided interviews. Care was taken to build a user-friendly interface. In line with Hershey, Kunreuther and Schoemaker (1982) and Hershey and Schoemaker (1985), we believe that the main source of bias is caused by experiments and interviews that does not match the real decision situation of the subjects under consideration. Therefore, we paid a lot of attention to the design of our interview instrument so that it resembles owner-managers' decision-making process within their own very real business context. To ensure that the computer interface was well understood and perceived as "very user-friendly" and fitting "the real business setting", fifteen test interviews were conducted. The interviews took place in the first half of 1998, on appointment, at the manager's enterprise. All the interviewers had prior interviewing experience and had followed an extensive training program for the assessment procedures. A total of 440 managers participated (the interview was stratified along firm size and region).

The interview consisted of several parts. After having been asked several background questions (pertaining to size of the enterprise, age, education level and debt-

to-asset ratio, where the latter was measured on a 10 point scale with 1 = debt-to-asset ratio 1-9%, 2=10-19% etc.) the owner-managers were confronted with statements about futures contracts. The statements about the use of futures were measured on bipolar nine-point Likert scales with the end-poles labeled as “strongly disagree” and “strongly agree”. The statements tapped the constructs exercising entrepreneurial freedom and perceived performance (see Appendix A for a detailed description of the scales and its psychometric properties).

Because owner-managers often base their decision also on the opinions of the members of their decision unit (such as husband or wife, partner and advisors) we included the owner-manager’s perception of the extent to which significant others think that he or she should engage in futures trading. We assume that if the owner-manager believes that relevant others expect him/her to make use of the hedging service of futures contracts, this will influence the owner-manager’s probability of using futures contracts. The influence of the decision unit was measured by asking the owner-manager to indicate the extent to which significant persons surrounding him/her thought that he/she should or should not use futures as a hedging tool by distributing 100 points across the two options.

Based on the depth interviews, constructs characterizing owner-managers that are expected to influence their behavior regarding futures contracts were included. We used scales as introduced by studies in marketing, psychology, and management. In developing the scales, we adhered to the iterative procedure recommended by Churchill. All scales were subjected to explorative factor analyses along with confirmatory factor analysis to test for their reliability and unidimensionality (Hair et al. 1995). Moreover, we conducted structural equation modeling to test for their validity. The following characteristics were included in this study: market orientation (Jaworski and Kohli 1993), level of understanding (Ennew, Morgan and Rayner 1992) risk attitude and perceived risk exposure (see Appendix B for a further description and the psychometric properties of the

scales). Finally, the probability of using futures contracts was measured by asking the respondent to distribute 100 points across using futures as a hedging tool or not using them as a hedging tool.

In order to measure the hedging effectiveness which takes both basis risk and market depth risk into account, we gathered transaction-specific data from the nearby hog futures contract traded at the Amsterdam Exchanges over the period 1990-1998 (the only relevant futures contract for Dutch hog owner-managers). The transaction-specific data consist of the price quoted of every futures contract traded in a chronological order. With these data the market depth costs can be calculated. The market depth costs in the case of an order-selling imbalance were calculated as the area between the downward-sloping price path and the price for which the hedger enters the futures market. The market depth costs in the case of an 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. Having determined the market depth costs, spot prices (obtained from the central Dutch cash hog price market) and the closing prices of the futures contract, both the Ederington measure and the extended measure in (1) can be calculated.

3.4. Results

Presentation of Empirical Results of Model 1 in Figure 1

Table 1 tabulates the hedging performance measured by the Ederington measure and the value of the proposed measure as presented in (1). Note that both measures range from 0 to 1, indicating the reduction in the variance of the return. From Table 1 it appears that the hedging effectiveness of the hog futures contract is higher according to the Ederington measure than according to the proposed measure, which corresponds with our

expectations. This result is due to the fact that the proposed measure takes basis risk and market depth risk into account, whereas the Ederington measure only takes basis risk into account. This is in line with recent findings of Pennings et al. (1998), who found that the hog futures contract traded at the Amsterdam Exchanges faces market depth problems.

Table 1 Regression of Hedging Performance, and Hedging Effectiveness Measure on Volume, 1989-1998

	Hedging performance	β	<i>t</i> -value	<i>p</i> -value
Ederington Measure	0.92	0.904	7.7	0.00
		$R^2 = 0.817$	<i>Adjusted R</i> ² =0.805	
Extended Hedging Effectiveness Measure	0.87	0.995	9.09	0.00
		$R^2=0.912$	<i>Adjusted R</i> ² = 0.901	

The relationship between the two hedging effectiveness measures and the trading volume was estimated in a simple regression model in which the annual volume in the period 1989-1998 is the dependent variable and the hedging effectiveness (based on the nearby futures contract) the independent variable. From Table 1 it can be concluded that the hedging effectiveness is an important determinant in explaining the futures contract volume, which is in line with the findings of Tashjian and McConnell (1989). Moreover, Table 1 shows the extended measure having a better fit than the Ederington measure. That is, hedging effectiveness measures which take market depth risk into account reveal more coherence with trading volume than hedging effectiveness measures that do not take

market depth into account. Hence, the market place takes market depth risk into account when using futures, thereby influencing its viability.

Presentation of Empirical Results of Model 2 in Figure 1

We estimated the influence from the several variables measured in the personal computer guided interview on the owner-manager's probability of using futures. Several owner-managers' characteristics were measured with self-report measures (i.e. scales). Each of these variables is treated as a latent variable that is measured by a set of observable indicators (items). Observable variables may be assumed to be measured with error. When such measures are used in linear models, the coefficients obtained will be biased. In this paper we recognized that the theoretical constructs of interest are not directly measurable, but must instead be estimated from multiple indicator measures. To obtain this objective, we used structural equation modeling in order to test the model (see Appendix C for a short overview of structural equation modeling). Structural equation modeling permits the explicit modeling and estimation of errors in measurement (Bollen 1989, 1996, Steenkamp and van Trijp 1991, Bagozzi 1981, 1994, Baumgartner and Homburg 1996, Lee and Wang 1996). The coefficients in the structural equation model represent theoretical cause-and-effect relationships among latent variables, which underlie the observed variables, and as such, they are the parameters of our interest. Prior to using structural equation modeling, we tested whether the underlying assumptions had been satisfied. We screened the data for coding errors and the presence of outliers and tested for univariate and multivariate normality of the observed variables. The coefficient of relative multivariate kurtosis was 1.09, indicating that the assumption of multivariate

normality is tenable (Steenkamp and van Trijp 1991). As a measure of association we used the covariances. As pointed out by Cudeck (1989) and Baumgartner and Homburg (1996) the use of covariances or correlations has no effect on overall goodness of fit indices. However, standard errors may be inaccurate when using correlations. Therefore, we used covariances. The model is estimated using Maximum Likelihood in the LISREL 8 program (Jöreskog and Sörbom 1993). The estimated model parameters and related statistical information are presented in Table 2.

[INSERT TABLE 2]

First, we model the probability of using futures contracts across the whole sample. That is, we do not take heterogeneity into account, hence assuming the sample to be homogeneous. In this case the following factors were significant in the model and had the expected positive sign: the decision unit, the perceived performance, exercising entrepreneurial freedom and level of understanding. Surprisingly, risk attitude and perceived risk exposure were not significantly related to the probability of using futures, a puzzling result that was found by others as well (Shapiro and Brorsen 1988, Makus et al. 1990).

We suspect the sample not to be homogenous, that is, we expect that different groups of owner-managers may employ a different decision process. If this is the case, we might find that different factors influence their choice behavior, and that the common factors are weighted differently. Using cluster analysis, it appeared that we could distinguish between two groups based on their cash-trading behavior. Segment I (N =

120) consists of owner-managers who sell their hogs to a cooperative, segment II consists of owner-managers who sell to a trader (N=320). Interesting to note is that these two segments did not significantly differ regarding age and education. So, both segments may look alike on first sight, however different factors influence their use of futures contracts.

From Table 2 it becomes clear that risk attitude and perceived risk exposure do play a role in segment I. Moreover, the debt-to-asset ratio plays a role. As was the case for the whole sample, the decision unit and the perceived performance influence the use of futures. The value of taking heterogeneity into account is shown in this case for risk attitude and perceived risk exposure. If we treat the sample as homogenous we would have concluded that risk attitude and perceived risk exposure did not influence the use of futures contracts, something that does not comply with financial theory.

In this paper the model fit is evaluated using different types of fit indices recently developed in the literature. We use the likelihood-ratio Chi-square statistic, Goodness-of-Fit Index (GFI), Tucker Lewis Index (TLI), and the Root Mean Squared Error of Approximation (RMSEA) to evaluate the model fit.¹ The fit statistics show that the model that covers the whole sample has a modest fit, while the model that describes the use of futures contracts for segment I shows a very good fit. The same holds for Segment II. In this segment it was found that market orientation and exercising entrepreneurial freedom are factors that influence the probability of using futures, along with the decision unit and the perceived performance.

It seems that owner-managers in segment I use “financial structure” characteristics (as imbedded in the debt-to-asset ratio, risk attitude and the perceived risk reduction exposure) in their decision to engage in futures, whereas the owner-managers

in segment II use “marketing” characteristics (imbedded in market orientation and exercising entrepreneurial freedom) in their decision to engage in futures. Owner-managers in segment I (cooperative owner-managers) can be described as more conservative, in the sense that they attach a lot of value to “continuing the firm operation for successors” whereas owner-managers who sell to traders (segment II) attach value to “keeping up with markets and trying to get the high prices”.

In this study we find three factors influencing owner-manager’s use of futures contracts that were not found in previous studies. Two factors, exercising entrepreneurial freedom and market orientation, are psychometric constructs. A reason for not finding them in previous studies might be the fact that both are latent variables that can not be detected in accounting data. Moreover, measurement error in previous studies might mask these variables. Both variables are important cues for the exchange to improve their attractiveness. For example, the management of a futures exchange may use this information for its promotion of futures and in developing and redesigning futures contracts. It would seem valuable to position futures as an extra tool to increase the owner-manager’s degrees of freedom in the market place. When designing futures contracts, the futures exchange may increase the compatibility of futures with other instruments available to the owner-manager, thereby increasing its attractiveness “as an extra tool”. Although the owner-manager ultimately makes the choice on his/her own, other important individuals are involved in the decision process, that is, the members of the owner-managers decision unit. These individuals consisted in our study of the successor, wife/husband and bank advisor. We found that the opinion of these individuals, who are important to the owner-manager when futures are concerned,

influenced the owner-manager's behavior towards trading of futures. In Table 3 we summarize results regarding the non-subject and subject approach towards futures contract viability.

Table 3 **Summary of Empirical Findings**

- Hedging effectiveness is related to trading volume. This relationship is more prominent when the hedging effectiveness measure takes both basis risk and market depth risk into account.
- Above finding is in line with the results of the research that identifies those characteristics of owner-managers that influence the probability of using futures: the perceived risk reduction performance and the decision unit are variables that are present across the whole sample.
- Owner-managers appear to be heterogeneous regarding the use of futures contracts. Two segments were identified based on their cash-trading behavior: Segment I consist of owner-managers selling to a cooperative and Segment II of owner-managers selling to traders.
- In Segment I, perceived performance, risk attitude, perceived risk exposure, debt-to-asset ratio and the decision unit influence the probability of using futures.
- In Segment II, perceived performance, exercising entrepreneurial freedom, market orientation and the decision unit influence the probability of using futures.
- If the heterogeneity is not taken into account, we would have concluded that risk attitude and perceived risk exposure does not influence the owner-manager's use of futures.
- If psychological constructs and measurement error is not taken into account, we would have not found that the owner-manager's market orientation and the owner-manager's value of entrepreneurial freedom were variables influencing the owner-manager's use of futures.

Discussion of Empirical Findings vis-à-vis Tools of the Exchange

We now discuss the relation between the factors we found to influence the viability of futures (see Table 3) in the context of the tools the futures exchange has available. The tools of the futures exchange can be linked to the exchange service design (related to the core service) and service delivery (related to the peripheral services).

Table 4 indicates which factors relate to the viability of futures trade based on the previous results and the exchange's tools.

[INSERT TABLE 4]

Hedging effectiveness is related to the service design, and hence, the core businesses of the futures exchange. The two main components: basis risk and market depth risk can be related to the contract specification (standardization process) and the trading system, respectively. In our empirical study we showed that the hog futures contract is facing market depth risks. An open outcry system is employed by the Amsterdam Exchanges for trading. There are no scalpers on the trading floor and all orders enter the trading floor via brokers. Brokers are only allowed to trade by order of a customer. There is no central order book for the hog futures contract. The broker only has insight into his/her own order book. The owner-manager has no information on outstanding orders. Information provided by the exchange seems of vital importance. Moreover, market depth risk might be reduced by implementing a mechanism for slowing down the trade process if order imbalances do occur and to improve market depth by reporting these. Lehmann and Modest (1994) report such a mechanism on the Tokyo Stock Exchange, where warning quotas are issued when a portion of the trade is executed at different prices. Also the order book information can be improved. An order book mechanism that allows potential participants to view real-time limit orders, displaying the desired prices and quantities at which participants would like to trade, might improve the market depth risk.

From Model 2 it appeared that the owner-manager's perceived performance played an important role when deciding to use futures contracts. This result is in coherence with our finding that the hedging effectiveness is positive and significantly related to the trading volume. Performance is directly related to contract specification and the trading system, both influencing the risk reduction capacity of the exchange's service. The members of the decision unit play an important role in the owner-manager's use of futures. This implies that promotion and education efforts should not only be tailored to the owner-manager, but also on advisors surrounding the owner-manager. The owner-manager's level of understanding of futures is positively related to the probability of using futures, thereby supporting the view that education programs for owner-managers are valuable.

Owner-managers are heterogeneous regarding their decision-making behavior. We could distinguish between two types of latent segments based on their cash-trading pattern. In segment I the risk attitude and perceived risk exposure were determinants of futures use. Both elements can be related to the service design, in particular the contract specification, which influences the risk reduction capacity of the futures contract, and the clearing with respect to credit and default risk. Perceived risk exposure dictates the importance and need of education. In this segment also the debt-to-asset ratio was an important determinant. High leveraged owner-managers may find futures attractive as risk reduction tool, which makes it interesting to specify futures and come up with a palette of futures that is able to reduce fluctuations in owner-managers' profit. Clearing aspects, especially default risks, are important to high leveraged owner-managers.

Owner-managers who focus on the marketing aspects of their firm operation characterize segment II. Market orientation was a determinant when choosing futures. Providing accurate real time information by the trading system is attractive for this group of owner-managers. In this segment owner-managers value using futures as a way to exploit their entrepreneurial freedom, that is, the fact that futures provide them the opportunity to increase their degrees of acting in the market place. The value the owner-manager attaches to entrepreneurial freedom presents a challenge for the futures exchange both for the service design as service delivery. It appeared that if the owner-manager perceives the use of futures contracts as an instrument with which one fixes all prices in advance, the futures contract was not attractive because, in the perception of the owner-manager, the futures contract was a constraint on his/her entrepreneurial freedom. However, if the owner-manager perceived the futures contract as an extra tool in his/her marketing plan, futures were valued as a tool that increases the entrepreneurial freedom. For the exchange, it is important to promote futures contracts as one way of marketing the commodity, thereby increasing the different pay-off structures. Promotion and education on this aspect seems valuable. Moreover, it seems interesting to make the futures contract compatible with other risk management practices of the owner-manager. This may have an implication for the contract design.

The most interesting result is, however, that owner-manager's are heterogeneous and that the exchange needs to use different tools for different segments. Identifying the different segments is a challenge. With this information the futures exchange is able to target their marketing efforts (the so-called direct marketing). Based on the characteristics of the different segments, they are able to select a group of potential customers, to which

they offer risk reduction service, which was designed to match the customers' choice profile. This implies differentiation of the services offered by exchanges. In our empirical study the segments could easily be observed by the exchange, because they relate to the owner-manager's cash trading pattern. A challenge for further research in this regard is to create a method that simultaneously estimates all parameters such that a set of parameters identifies the segments to which owner-managers belong, and represents the structural equation model within segments. Recent findings of Jedidi, Jagpal and DeSarbo (1997) on general finite mixture structural equation model seem interesting in this respect.

4. Discussion and Conclusions

4.1. Theoretical contribution

In this paper we integrated two streams of research in order to improve the insight into the viability of commodity futures contracts. First, we elaborated on the non-subject level that is concerned with the technical aspects of the commodity and the contract. It appears that hedging effectiveness has an important influence on volume. The market is taking not only basis risk into account, but also market depth risk, the latter seems particular important in small commodity markets as well as new futures markets. As a result, measuring the hedging effectiveness with an extended version of the Ederington measure, taking market depth risk into account, yielded in a stronger relationship between hedging performance and volume than when market depth risk was not taken into account.

Second, we elaborated on the subject-hedger level that is concerned with owner-managers' characteristics that influence their use of futures contracts. In contrast to previous research regarding the use of futures contracts by managers of large

cooperation, we acknowledge the fact that our owner-managers operate firms where all functional departments are combined. Perceptions and psychometric constructs influence the owner-manager's decision process. In our empirical study it was found that the owner-manager's decision unit, owner-manager's level of market orientation and entrepreneurial freedom were influencing (at least for a particular segment of owner-managers) the use of futures contracts, something not found in previous research. Owner-managers are not homogenous regarding the factors influencing their use of futures. For different segments, different factors were found such as the debt-to-asset ratio, risk attitude and perceived risk exposure.

4.2. Methodological contribution

Psychological constructs may very well influence the owner-manager's use of futures and hence, should not be omitted from the analysis. One major shortcoming of past empirical research is that it addresses relationships between and among latent theoretical concepts (constructs) that are not directly observable (e.g., owner-manager's perceived performance and risk attitude), without taking measurement error into account. When such measures are used in linear models, the coefficients obtained will be biased. In this paper we recognized that the theoretical constructs of interest are not directly measurable, but must instead be estimated from multiple indicator measures. To obtain this objective, we used structural equation modeling in order to test the relationships in the conceptual framework. Structural equation modeling provided us with a method for estimating structural relationships among unobservable constructs and for assessing the adequacy with which those constructs have been measured. It is valuable to take measurement error

into account when gaining insight into the factors that influence the owner-manager's use of futures. Doing so will result in accurate estimations and hence, a better understanding of the decision-making process. In recent research regarding the use of futures, typically a single set of regression coefficients is estimated for the entire sample. A problem of this latter approach is that multiple regression neglects the integer properties of the dependent variable. Further, this approach may be potentially misleading if the sample consists of a number of unknown segments in which the association of owner-manager's characteristics with the use of futures differs. In this paper we show that owner-manager's are heterogeneous regarding their factors influencing their use of futures. Taking heterogeneity into account can solve some puzzling results in previous research, in particular with respect to the concepts of risk attitude and risk perceptions.

4.3. Managerial contribution

We propose a multidisciplinary framework towards commodity futures contract management. In this framework factors that play a role in the viability of a commodity futures contracts, divided into two aspects, namely factors with a technical character (non-subject level) and factors dealing influencing the decision-making process of owner-managers with respect to hedging, are integrated. This framework can help to organize the product development process of commodity futures contracts. It yields insight into the policy measures that a futures exchange might take to create and secure viable commodity derivatives trading.

4.4. Further research

Some caveats of our analysis should be mentioned. First, this paper focussed exclusively on the individual owner-manager level, thereby not taking into account the owner-manager's commercial environment, that is, the marketing channel (s)he is in (Krasker 1985, Bowden 1995). We might expect that the owner-manager's choice for futures contracts will interact with the risk management decisions made by the wholesaler or processor whom (s)he supplies. Second, the reason owner-managers use futures contracts is often not to reduce the price risk of a single commodity, but rather to reduce the risk which remains after all price risks have been offset against one another, the so-called residual risk (Anderson and Danthine 1980, Rolfo 1980, Fackler and McNew 1993). For a financial institution, it may therefore be interesting to add price risk reduction services to the services it already provides. This raises an important question that needs to be solved: is it beneficial to add new price risk management services to the existing ones? Third, in this paper we implicitly assumed that the behavior of speculators is dependent on hedgers' actions (Working 1953). Relaxing this assumption by explicitly modeling speculation demand seems interesting. Further research that includes these elements are potential avenues to explore.

Note

1. The likelihood-ratio Chi-square statistic (χ^2) tests whether the observed and estimated matrices differ. Statistical significance levels indicate the probability that these differences are due solely to sampling variations. Low χ^2 per degree of freedom (value lower than 2.5) indicates that the actual and predicted input matrixes are not statistically different. The likelihood-ratio Chi-square statistic is heavily (negatively) influenced by sample size ($N > 200$) (Bentler 1990). Because of this problem, other fit indices have been developed, such as the Goodness-of-Fit Index (GFI) which represents the overall degree of fit, that is the squared residuals from prediction compared with the actual data. The measure ranges from 0 (poor fit) to 1.0 (perfect fit). The Tucker Lewis Index (TLI) is an incremental fit measure that combines a measure of parsimony into a comparative index between the proposed and null model. A recommended value is 0.9 or greater. The Root Mean Squared Error of Approximation (RMSEA) estimates how well the fitted model approximates the population covariance matrix per degree of freedom (Steiger 1990). Browne and Cudeck (1989) suggested that a value below 0.08 indicates a close fit (see Baumgartner and Homburg (1996), Bentler (1990), and Hair et al. (1995) for a detailed explanation of the fit indices).

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Appendix A. Description of the Perceived Performance Scale and the Entrepreneurial Scales and Their Psychometric Properties Using Confirmatory Factor Analysis

An exploratory factor analysis was conducted in order to find the underlying factor structure of the statements. A three-factor model provided the best solution. Items loading relatively high on one of these factors (factor loading > 0.4) are included with the corresponding factors in a confirmatory factor analysis to test for the psychometric properties. In what follows, RMSEA is the root mean square error of approximation, GFI the goodness-of-fit index, AGFI the adjusted goodness-of-fit index and the CFI the comparative fit index (Jöreskog and Sörbom 1993). See the text for a description of how to interpret these measures.

Entrepreneurial freedom

- 1) I think that by using futures contracts I can fully exploit my spirit of free enterprise.
- 2) I think that the use of futures contracts gives me the opportunity to receive an extra high price.
- 3) I think that using futures contracts gives me a large freedom regarding actions in the market place.

$\chi^2 / df = 1.72$ ($p = 0.08$); RMSEA = 0.03; AGFI = 0.97; GFI = 0.99; CFI = 0.98

Perceived performance

- 1) I think that selling my hogs by means of futures contracts will enable me to reduce the fluctuations in my revenues.
- 2) I think that a futures contract can help me manage risk.
- 3) I think that using futures contracts will reduce price risk.

$\chi^2 / df = 2.16$ ($p = 0.03$); RMSEA = 0.04; AGFI = 0.97; GFI = 0.99; CFI = 0.96

Appendix B. Description of the Scales Describing Owner-manager's Characteristics Using Confirmatory Factor Analysis

Risk attitude

Owner-managers were asked to indicate their agreement with each item through a nine-point scale ranging from “strongly disagree” to “strongly agree”.

Construct reliability = 0.73

- 1) I like to “play it safe”.
- 2) With respect to the conduct of business I am risk averse.
- 3) With respect to the conduct of business I like to take the sure thing instead of the uncertain thing.
- 4) When I am selling hogs I like to take risks.

$\chi^2 / df = 1.0$ ($p = 0.37$); RMSEA = 0.0; GFI = 0.99; AGFI = 0.99; CFI = 1

Market orientation

Owner-managers were asked to indicate their agreement with each item through a nine-point scale ranging from “strongly disagree” to “strongly agree”.

Construct reliability = 0.70

- 1) I think it is important to understand the wishes of my customers.
 - 2) I think it is important to know how my customers evaluate my product.
 - 3) I adapt to changes into the market place.
 - 4) I track the market prices of the products I produce.
- $\chi^2 / 1.1$ ($p = 0.31$); RMSEA = 0.01; GFI = 0.99; AGFI = 0.99; CFI = 0.99

Level of understanding

Owner-managers were asked to indicate their agreement with each item through a nine-point scale ranging from “strongly disagree” to “strongly agree”.

Construct reliability = 0.70

- 1) I know how the futures market is functioning.
 - 2) There is sufficient information on the functioning of futures markets.
 - 3) I understand the way I can hedge my risk on the futures market.
 - 4) I keep informed about futures prices.
- $\chi^2 / df = 3.1$ ($p = 0.04$); RMSEA = 0.06; GFI = 0.99; AGFI = 0.97; CFI = 0.98

Appendix C. Short Review of Structural Equation Modeling

Structural Equation Models (SEMs) consist of two parts: the measurement model and the structural model. The measurement model specifies how the psychological constructs are measured in terms of the observable variables, and it describes the psychometric properties (reliabilities and validities) of the construct as measured. The structural model specifies the relationship among the latent variables and describes the effects and the amount of unexplained variance in latent variables. A full structural equation model can be written as follows (cf. Bollen 1989, Baumgartner and Homburg 1996, Lee and Wang 1996):

$$\mathbf{h} = \mathbf{B}\mathbf{h} + \mathbf{\Gamma}\mathbf{x} + \mathbf{V} \quad (1)$$

$$\mathbf{y} = \mathbf{\Lambda}^y\mathbf{h} + \mathbf{e} \quad (2)$$

$$\mathbf{x} = \mathbf{\Lambda}^x\mathbf{x} + \mathbf{d} \quad (3)$$

Equation (1) is called the latent variable or structural model and expresses the hypothetical relationships among the constructs. The $m \times 1$ vector η contains the latent endogenous constructs and the $n \times 1$ vector ξ consists of the latent exogenous constructs. The coefficient matrix B shows the effects of endogenous constructs on each other, and the coefficient matrix G denotes the effects of exogenous on endogenous constructs. These coefficient matrixes are the beta coefficients as displayed in Table 2, and represent the relationship between the probability of

using futures and owner-manager's characteristics. The vector of disturbances V represents errors in equations. Equations (2) and (3) are factor-analytic measurement models which tie the constructs to observable indicators (i.e., items). The results of equation (2) and (3) can be found in Appendix B. The $p \times 1$ vector y contains the measures of the endogenous constructs, and the $q \times 1$ vector x consists of the measures of the exogenous indicators. The coefficient matrices Λ^y and Λ^x show how y relates to η and x relates to ξ , respectively. The vectors of disturbances ϵ and δ represent measurement errors. (For a more detailed description of SEM see Anderson and Gerbing 1988, Gerbing and Anderson 1988, Bollen 1989, Cudeck 1989, Bagozzi 1994).

Table 2 Variables Explaining Farmer’s Probability of Using Futures for the Whole Sample and Different Segments Using Structural Equation Models

	Explanatory variables								
<i>Probability of using futures</i>	DU	PERF	ENTF	MO	RA	PRE	DTA	UNDER	
Total sample (N=440)	β	0.269	0.196	0.186	*	*	*	*	0.132
	t-value	5.759	4.179	3.992	*	*	*	*	2.043
	Fit statistics	$\chi^2/df = 4.4$ p = 0.00 RMSEA = 0.09 GFI = 0.97 TLI = 0.78							
Segment I (N=120)									
Spotmarket: cooperative	β	0.202	0.204	*	*	0.308	0.233	0.090	*
	t-value	2.180	2.478	*	*	3.437	2.230	2.078	*
	Fit statistics	$\chi^2/df = 1.1$ p = 0.22 RMSEA = 0.03 GFI = 0.94 TLI = 0.95							
Segment II (N=320)									
Spotmarket: trader	β	0.274	0.198	0.265	0.111	*	*	*	*
	t-value	5.668	4.085	5.370	2.003	*	*	*	*
	Fit statistics	$\chi^2/df = 2.1$ p = 0.01 RMSEA = 0.05 GFI = 0.98 TLI = 0.92							

Note: Beta is the standardized regression coefficient which shows the relationship between the probability of using futures and the latent constructs. All variables included in the models have a *t*-value that is significant at the 5% level, variables that did not meet this criteria were not included in the model and are represented by an asterisk. DU is the decision unit, PERF, the perceived performance, ENTF the value of exercising entrepreneurial freedom, MO the market orientation, RA the risk attitude, PRE the perceived risk exposure, DTA the debt-to-asset ratio and UNDER the level of understanding. RMSEA is the root mean square error of approximation, GFI the goodness-of-fit index and TLI the Tucker Lewis Index (Jöreskog and Sörbom 1993), see footnote 1 for a detailed description of these measures.

Table 4 Overview of Factors Influencing the Viability of Futures Contracts and Their Relationship With the Exchange Toolbox

	Futures Exchange Tools			
	Service design			Service delivery
	Contract specification	Trading system	Clearing	Promotion
<i>Model 1: Market</i>				
Hedging effectiveness				
• Basis risk	X			
• Market depth risk		X		
<i>Model 2: Decision-maker</i>				
Perceived performance	X	X		
Decision unit				X
Level of understanding				X
Segment I				
Risk attitude				
• Risk aversion	X		X	X
• Risk seeking	X		X	X
Perceived risk exposure				X
Debt-to-asset ratio	X		X	
Segment II				
Market orientation		X		X
Entrepreneurial freedom	X	X		X

References

- Anderson, R.W., J.P. Danthine. 1980. Hedging and joint production, theory and illustrations. *Journal of Finance* 35, 487-489.
- Anderson, J.C., D.W. Gerbing. 1988. Structural equation modeling in practice: a review and recommended two-step approach. *Psychological Bulletin* 103, 411-423.
- Asplund, N.M., D.L. Foster, T.T. Stout. 1989. Farmers' use of forward contracting and hedging. *Review of Futures Markets* 8, 24-37.
- Bagozzi, R.P. 1981. Attitudes, intentions, and behavior: a test of some key hypothesis. *Journal of Personality and Social Psychology* 41, 607-627.
- Bagozzi, R.P. 1994. Structural Equation Models in Marketing Research: Basic Principles, in R. Bagozzi, ed.: *Principles of Marketing Research*. Cambridge: MA, Blackwell.
- Baumgartner, H., C. Homburg. 1996. Applications of structural equation modeling in marketing and consumer research: a review. *International Journal of Research in Marketing* 13, 139-161.
- Bentler, P.M. 1990. Comparative fit indexes in structural models. *Psychological Bulletin* 107, 238-246.
- Black, D.G. 1986. *Success and Failure of Futures Contracts: Theory and Empirical Evidence*. Monograph 1986-1 Salomon Brothers Center for the Study of Financial Institutions, New York.
- Bollen, K.A. 1996. An alternative two stage least squares estimator for latent variables equations. *Psychometrika* 61, 109-121.
- Bollen, K.A. 1989. *Structural Equations with Latent Variables*, New York: Wiley.
- Bowden, R.J. 1995. Production organisation and risk control when market instruments are available. *Management Science* 41, 1073-1082.
- Brockhaus, R.H. 1980. Risk taking propensity of entrepreneurs. *Academy Management Journal* 23, 509-520.
- Browne, M.W., R. Cudeck. 1986. Single sample cross-validation indices for covariance structures. *Multivariate Behavioral Research* 24, 445-455.
- Carlton, D.W. 1984. Futures markets: their purpose, their growth, their successes and failures. *Journal of Futures Markets* 4, 237-271.
- Carter, D.A., J.F. Sinkey. 1998. The use of interest rate derivatives by end-users: the case of large community banks. *Journal of Financial Services Research* 14, 17-34.
- Chang, J.S.K., H. Fang. 1990. An intertemporal measure of hedging effectiveness. *Journal of Futures Markets* 10, 307-321.
- Churchill, G.A. 1979. A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research* 16, 64-73.
- Cudeck, R. 1989. Analysis of correlation matrices using covariance structure models. *Psychological Bulletin* 105, 317-327.
- Cuny, C.J. 1993. The role of liquidity in futures market innovations. *Review of Financial Studies* 6, 57-78.
- Ederington, L.H. 1979. The hedging performance of the new futures markets. *Journal of Finance* 34, 157-170.
- Eliashberg, J., J.R. Hauser. 1985. A measurement error approach for modeling consumer risk preference. *Management Science* 31, 1-25.
- Ennew, T.C., W. Morgan, T. Rayner. 1992. Role of attitudes in the decision to use futures markets: the case of the London potato futures market. *Agribusiness: An International Journal* 8, 561-573.
- Fackler, P.L., K.P. McNew. 1993. Multi-product hedging: theory, estimation, and an application. *Review of Agricultural Economics* 15, 521-535.
- Futures Industry Association. 1999. *Volume Reports*.

- Géczy, C., B.A. Minton, C. Schrand. 1997. Why firms use currency derivatives. *Journal of Finance* 52, 1323-1354.
- Gerbing, D.W., J.C. Anderson. 1988. An updated paradigm for scale development incorporating unidimensionality and its assessment. *Journal of Marketing Research* 25, 186-192.
- Goodwin, B.K., T.C. Schroeder. 1994. Human capital, producer education programs, and the adoption of forward pricing methods. *American Journal of Agricultural Economics* 76, 936-947.
- Gray, R.W. 1978. Why does futures trading succeed or fail: an analysis of selected commodities. *Readings in Futures Markets: Views from the Trade*, edited by A.E. Peck, Chicago Board of Trade.
- Hair, J.F., R.E. Anderson, R.L. Tanham, W.C. Black. 1995. *Multivariate Data Analysis*, New Jersey: Prentice Hall, Inc.
- Hershey, J.C., H.C. Kunreuther, P. Schoemaker. 1982. Sources of bias in assessment procedures for utility functions. *Management Science* 8, 936-954.
- Hershey, J.C., P. Schoemaker. 1985. Probability versus certainty equivalence methods in utility measurement: are they equivalent? *Management Science* 31, 1213-1231.
- Hirshleifer, D. 1988. Risk, futures pricing, and the organization of production in commodity markets. *Journal of Political Economy* 96, 1206-1220.
- Holthausen, D.M. 1979. Hedging and the competitive firm under price uncertainty. *American Economic Review* 69, 989-995.
- Howard, C., L. D'Antonio. 1984. A risk-return measure of hedging effectiveness. *Journal of Financial and Quantitative Analysis* 19, 101-112.
- Howton, S.D., S.B. Perfect. 1998. Managerial compensation and firm derivatives usage: an empirical analysis. *Journal of Derivatives* 6, 53-64.
- Hsin, C-W., J. Kuo, C.W. Lee. 1994. A new measure to compare the hedging effectiveness of foreign currency futures versus options. *Journal of Futures Markets* 14, 685-707.
- Jaworski, B.J., A.K. Kohli. 1993. Market orientation: antecedents and consequences. *Journal of Marketing* 57, 53-70.
- Jedidi, K., H.S. Jagpal, W.S. DeSarbo. 1997. Finite-mixture structural equation models for response-based segmentation and unobserved heterogeneity. *Marketing Science* 16, 39-59.
- Jöreskog, K.G., D. Sörbom. 1993. *LISREL 8: Structural Equation Modeling with the SIMPLIS Command Language*. Chicago: Scientific Software International, Inc.
- Koski, J.L., J. Pontiff. 1999. How are derivatives used? evidence from the mutual fund industry. *Journal of Finance* 54, 791-816.
- Krasker, W.S. 1985. Sequential hedging. *Management Science* 31, 657-663.
- Kyle, A.S. 1985. Continuous auctions and insider trading. *Econometrica* 53, 1315-1335.
- Lee, C.L., R.E. Hoyt. 1997. Determinants of corporate hedging behavior: evidence from the life insurance industry. *Journal of Risk and Uncertainty* 64, 649-671.
- Lee, S-Y., S.J. Wang. 1996. Sensitivity analysis of structural equation models. *Psychometrika* 61, 93-108.
- Lehmann, B., D.M. Modest. 1994. Trading and liquidity on the Tokyo Stock Exchange: a bird's eye view. *Journal of Finance* 49, 951-982.
- Makus, L.D., B.H. Lin, J. Carlson, R. Krebill-Prather. 1990. Factors influencing farm level use of futures and options in commodity marketing. *Agribusiness: An International Journal* 6, 621-631.
- March, J.G., Z. Shapira. 1987. Managerial perspectives on risk and risk taking. *Management Science* 33, 1404-1418.
- Mian, S.L. 1996. Evidence on corporate hedging policy. *Journal of Financial and Quantitative Analysis* 31, 419-439.
- Musser, W.N., G.F. Patrick, D.T. Eckman. 1996. Risk and grain marketing behavior of large-scale farmers. *Review of Agricultural Economics* 18, 65-77.

- Nance, D.R., C.W. Smith, Jr., C.W. Smithson. 1993. On the determinants of corporate hedging. *Journal of Finance* 48, 267-284.
- Paroush, J., A. Wolf. 1992. The derived demand with hedging cost uncertainty in the futures markets. *Economic Journal* 102, 831-844.
- Patrick, G.F., W.N. Musser, D.T. Eckman. 1998. Forward marketing practices and attitudes of large-scale Midwestern grain producers. *Review of Agricultural Economics* 20, 38-53.
- Pennings, J.M.E., M.T.G. Meulenberg. 1997a. The hedging performance in new agricultural futures markets: a note. *Agribusiness: An International Journal* 13, 295-300.
- Pennings, J.M.E., M.T.G. Meulenberg. 1997b. Hedging efficiency: a futures exchange management approach. *Journal of Futures Markets* 17, 599-615.
- Pennings, J.M.E., A. Smidts. 1998. Measuring risk attitude of entrepreneurs in the domain of financial risk. Proceedings 6th *Behavioral Decision Research in Management Conference*, June 19-21, 1998, University of Miami, United States.
- Pennings, J.M.E., W.E. Kuiper, F. ter Hofstede, M.T.G. Meulenberg. 1998. The price path due to order imbalances: evidence from the Amsterdam Agricultural Futures Exchange. *European Financial Management Journal* 4, 47-64.
- Reise, S. P., K.F. Widaman, R.H. Pugh. 1993. Confirmatory factor analysis and item response theory: two approaches for exploring measurement invariance. *Psychological Bulletin* 114, 552-566.
- Rolfo, J. 1980. Optimal hedging under price and quantity uncertainty: the case of a cocoa producer. *Journal of Political Economy* 88, 100-116.
- Schrand, C. H. Unal. 1998. Hedging and coordinated risk management: evidence from thrift conversions. *Journal of Finance* 53, 979-1013.
- Shapiro, B.I., B.W. Brorsen. 1988. Factors affecting farmers' hedging decisions. *North Central Journal of Agricultural Economics* 10, 141-156.
- Silber, W.L. 1981. Innovation, competition, and new contract design in futures markets. *Journal of Futures Markets* 1, 123-155.
- Smidts, A. 1997. The relationship between risk attitude and strength of preference: a test of intrinsic risk attitude. *Management Science* 43, 357-370.
- Smith, C. W. R. Stulz. 1985. The determinants of firms' hedging policies. *Journal of Financial and Quantitative Analysis* 20, 391-405.
- Steenkamp, J-B.E.M., H.C.M. van Trijp. 1991. The use of LISREL in validating marketing Constructs. *International Journal of Research in Marketing* 8, 283-299.
- Steiger, J.H. 1990. Structural model evaluation and modification: an interval estimation approach. *Multivariate Behavioral Research* 25, 173-180.
- Tashjian, E. 1995. Optimal futures contract design. *Quarterly Review of Economics and Finance* 35, 153-162.
- Tashjian, E., J. McConnell. 1989. Requiem for a market: an analysis of the rise and fall of a financial futures contract. *Review of Financial Studies* 2, 1-23.
- Thaler, R.H. 1993. *Advances in Behavioral Finance*, New York: Russell Sage Foundation.
- Thaler, R.H. 1997. Irving Fisher: modern behavioral economist. *American Economic Review* 87, 439-441.
- Thompson, S.R., P. Garcia, L. Dallafior. 1996. The demise of the high fructose corn syrup futures contract: a case study. *Journal of Futures Markets* 16, 697-724.
- Tufano, P. 1996. Who manages risk? an empirical examination of risk management practices in the gold mining industry. *Journal of Finance* 51, 1097-1137.
- Visvanathan, G. 1998. Who uses interest rate swaps? a cross-sectional analysis. *Journal of Accounting, Auditing & Finance* 13, 173-200.
- Weber, E.U., R.A. Milliman. 1997. Perceived risk attitudes: relating risk perception to risky choice. *Management Science* 43, 123-144.
- Working, H. 1953. Futures trading and hedging. *American Economic Review* 43, 314-334.

Yung, Y. F. 1997. Finite mixtures in confirmatory factor-analysis models. *Psychometrika* 62, 297-330.