The Role of Farmers' Behavioral Attitudes and Heterogeneity in Futures Contracts Usage

Joost M.E. Pennings and Raymond M. Leuthold

The relationship between farmers' behavioral attitudes and use of futures contracts is examined, taking into account non-directly observable variables and the heterogeneity of farmers. The relationships are tested on a stratified data sample of 440 farmers. Cluster analysis and covariance structure equation models are used to validate the relationships. Farmers are found not to be homogenous regarding the factors influencing their use of futures. Heterogeneity at the segment level masked important effects at the aggregate level, notably risk attitude. Furthermore, several psychological constructs for farmers related to market orientation, risk exposure, market performance and entrepreneurial behavior play important roles in their use of futures contracts.

Key words: covariance structure model, measurement error, segments, futures usage.

Developing and maintaining viable agricultural futures contracts is an expensive and time-consuming process.[1] Therefore, it seems valuable to gain insight into the characteristics of farmers who use futures markets. In the finance literature, several factors such as a firm's risk exposure, its growth opportunity, level of wealth, managerial risk aversion, financial distress costs, tax liability, and the accessibility to financing have been identified as influencing the decision of a corporation to adapt derivatives to their risk management toolbox (Géczy, Minton, and Schrand; Graham and Smith; Koski and Pontiff; Mian; Nance, Smith, and Smithson; Smith and Stulz; Tufano). In the agricultural economics literature Asplund, Foster, and Stout; Goodwin and Schroeder; Makus et al.; Musser, Patrick, and Eckman; Shapiro and Brorsen; and Turvey and Baker, among others, identified such factors as experience, education, farm size, off-farm income, expected income change from hedging, age, farm organization meetings, leverage, risk management, and marketing seminar participation, as influencing farmers' use of futures contracts.

These studies have increased our understanding of how firm characteristics influence the use of futures and hence the viability of futures trade. In this paper, we recognize that farmers make decisions based on, among others, their beliefs that are formed by perceptions.[2] For example, the perceived risk reduction performance may differ from the

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[1] 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). The derivatives industry is composed of competing firms such as exchanges, banks and brokerage houses offering and facilitating over-the-counter trading. With commodity derivatives, the risk of failure is considerable (Carlton). 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 were the leaders in introductions with fifteen and fourteen, respectively, during 1994–98. If we follow the criteria formulated by Silber, fifty-eight percent of the introductions have failed.

[2] Beliefs pertain to the degree to which an object (e.g., futures contracts) may have particular consequences, and perceptions reflect the interpretation of these consequences.

actual performance as reflected in hedging effectiveness measures. Moreover, farmers may very well evaluate the hedging service provided by futures exchanges using criteria other than just performance. Therefore, we take psychological constructs into account (Thaler).[3]

An important variable from a theoretical point of view related to hedging behavior is risk attitude. Some studies assume that managers are risk averse. However, risk attitudes may differ across managers. Brockhaus and March and Shapira found large differences in risk attitudes among managers of corporations and farmers. Elsewhere, Goodwin and Schroeder found that farmers with a stated preference for risk are more likely to adopt forward pricing (i.e., hedge) than risk-averse farmers, a puzzling result. One of the reasons for these contra-intuitive findings is the difficulty in measuring risk attitudes. Variables such as risk attitude are not always directly observable (so-called latent variables).[4] We show that farmers make decisions regarding the use of futures based on, among others, latent variables. We refer to these latent variables as attributes as well to indicate that these variables can be seen as the criteria farmers use when deciding to use futures.

Two empirical problems may arise when taking latent constructs into account. First, we have to make sure that we have reliable and valid constructs.[5] We therefore measure latent variables by a set of observable indicators that are subjected to confirmatory factor analysis to assess their properties. Confirmatory factor analysis permits a rigorous assessment of the properties of the latent variables (Hair et al.). Second, relationships between and among latent theoretical concepts (constructs) that are not directly observable may result in biased coefficients when estimated in a linear regression framework because of measurement error. To account for measurement error, a covariance structure model is used as framework (often referred to as structural equation modeling), as it permits the explicit modeling and estimation of errors in measurement (Bagozzi; Baumgartner and Homburg; Bollen; Steenkamp and van Trijp).

Often, the literature assumes enterprises to be homogenous regarding firms' use of futures. When estimating models, data are treated as if they were collected from a single population. This assumption of homogeneity might be unrealistic. For example, farmers of different size or from different regions may have different decision structures. Hence, pooling data across farmers might produce misleading results. Both issues, measurement error when using latent variables and farmers' heterogeneity, will be elaborated on.

The remainder of the paper is structured as follows. Initially, we introduce a behavioral framework in which the characteristics that might be associated with futures usage are discussed. Then we address how unobservable constructs can be measured and tested for reliability using a confirmatory factor analysis framework, followed by the specification of a covariance structure model that simultaneously estimates the latent variables from observed variables and the structural relations between these variables and the farmers' use of futures contracts. After the research method and the operationalization of the variables, different relationships between farmers' characteristics and use of futures are estimated. Data obtained from 440 farmers by means of computer-assisted personal interviews constitute the input for this part of the research. We conclude with an

[3] The present study focuses on farmers, that is, owner-managers of small and medium-sized enterprises. An important difference between farmers and managers of a large enterprise lies in the fact that farmers do not have different functional departments, such as research and development, manufacturing-quality control, sales and accounting. All these departments are combined within the farmer. The decision process in the farmer's case is not as rationalized as that of large enterprises. Some of the concepts used by farmers 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). These psychological constructs may very well play a part in the farmer's decision to use futures.

[4] A latent variable is a hypothesized and unobserved concept that can only be approximated by observable or measured variables (indicators). An example of an unobserved concept (in this paper also referred to as a construct) is farmers' risk attitude and farmers' market orientation. In this paper, we use a set of indicators, obtained in personal computer-guided interviews, to measure latent variables. In the psychometric and statistical literature, methods are developed to test the reliability and validity of such variables (Nunnally and Bernstein).

[5] Reliability refers to the extent to which a variable or set of variables is consistent with what it is intended to measure. Validity refers to the extent to which a measure or set of measures correctly represents a concept (i.e., latent variable). Validity is concerned with how well the concept is defined by the measures (i.e., indicators), while reliability relates to the consistency of the measures. Ensuring validity starts with a thorough understanding of what is to be measured and taking the measurement as "correct" and accurate as possible. However, accuracy does not ensure validity. For example, the researcher could very precisely define total household income but still have an invalid measure of discretionary income because the "correct" question was not being asked. Reliability is the degree to which observed variables measure the "true" value. If the same measure is asked repeatedly, more reliable measures will show greater consistency than less reliable measures.

evaluation of the study and make suggestions for further research.

A Behavioral Conceptual Framework

One of the pillars in behavioral choice models is the multi-attribute attitude theory, first introduced by Fishbein and Azjen. In this theory the attitude towards an object (e.g., futures contracts) will lead to the intention to choose that object (e.g., the probability of choosing futures) and ultimately to a choice. In this paper we use this framework to study farmers' probability of using futures and farmers' choice of using futures. We discuss some constructs and identify characteristics that might influence farmers' probability of using futures.

In most hedging theories *Risk Attitude (RA)* plays an important role in the decision to engage in futures contracts (Carter). Recently, Tufano found that managerial risk aversion affects corporate risk management policy in the North American gold mining industry. Risk must first be perceived before a farmer is able to respond to it. *Perceived Risk Exposure (PRE)* may be defined as a farmer's assessment of the risk inherent in a situation. We expect these two constructs to play a role in the farmers' probability of using futures.

Tashjian and McConnell have shown that hedging effectiveness is a determinant in explaining the success of futures contracts and, as a result, considerable attention has been paid to the hedging effectiveness of futures contracts (Ederington; Howard and D'Antonio). However, for farmers the *Perceived Performance (PP)* may differ from the performance as reflected by hedging effectiveness measures. We expect the farmers' perceived performance to influence their use of futures.

In line with the broader definition of market orientation proposed by Jaworski and Kohli, we consider farmers' efforts to obtain information about prices and volume traded a central element of their *Market Orientation (MO)*. If farmers are more market oriented in terms of tracing the market, we expect them to be more inclined to use futures as a method of pricing their products.

Farmers often perceive futures as a complex financial service, which inhibits participation in futures trading (Ennew, Morgan, and Rayner). Costs associated with using futures include information gathering and the efficiency of their adoption. A high level of *Understanding (UNDER)* futures increases the ability of farmers to use futures contracts. We expect the level of understanding futures to be positively related to farmers' use of futures.

Sharpiro and Brorsen found that farmers who are in a high debt position are more likely to hedge since hedging can increase returns and/or reduce risk. Furthermore, Turvey and Baker found a clear relationship between the use of price risk management instruments and the *Debt-to-Asset Ratio (DAR)* of farmers.

Farmers often base their decisions on the opinions of the members of their *Decision Unit (DU)*, such as spouse, partner and advisors. We hypothesize that if a farmer believes that relevant others expect him/her to make use of the hedging service of futures contracts, that (s)he will be more inclined to use futures. Therefore, we included the farmer's perception of the extent to which significant others think that (s)he should engage in futures trading.

Working provided an alternative explanation for farmers' motivation to hedge that has not yet been addressed empirically: using futures gives the farmer a greater freedom for business action. Working argued that the freedom gained could be used to make a sale or purchase that would otherwise not be possible. This is in line with the recent findings in management studies showing that managers value instruments that increase their "degrees of freedom of action" in the market place (e.g., Brandstätter). In the context of our study, we may expect that farmers value using futures as a way to exploit their *Entrepreneurial Freedom (EF)*.

We hypothesize that the constructs reviewed influence farmers' probability of using futures and ultimately their choice for or against futures. We do not expect farmers to be a homogeneous population, that is, different variables influence farmers' use of futures and that common variables are weighted differently. Therefore, we segment across farmers, such that the choice process is similar within a segment and dissimilar across segments.

Research Method and Empirical Models

The Dutch hog industry is examined empirically. It represents a domain in which the underlying commodity is homogeneous, the underlying cash market is broad, there are many participants, and large, unpredictable, price fluctuations exist.[6]

A personal computer-guided interview was developed on the basis of the literature. Prior to the quantitative study, we conducted four group discussions with farmers about price risk management. The goal of the group discussions was to gain insight into the process involved in selling hogs using futures. More specifically, we wanted to gain insight into the criteria (the so-called attributes) farmers use when choosing futures. The groups consisted of ten farmers 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 relevant price risk management instrument is the hog futures contract traded on the Amsterdam Exchange. 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 the existing marketing toolbox and hence increase the strategies farmers can employ), confirming the suggestion made by Working more than forty years ago.

The survey was computerized. Care was taken to build a user-friendly interface. We carefully designed the interview instrument such that it resembled the farmers' decision-making process within their own 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 large-scale interview took place in the first half of 1998, on appointment, at the farmer's enterprise. All the interviewers had prior interviewing experience and had followed an extensive training program for the assessment procedures. A total of 440 farmers participated.

The interview consisted of several parts. After being 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 farmers were confronted with statements about futures contracts.

In selecting the measurement procedure, we evaluated the different scaling procedures as first proposed by Guttman, Likert, and Thurstone and Chave. Because previous scales based on the Likert scale procedure demonstrated good performance, the Likert scaling procedure was used to measure farmers' characteristics. Likert scales are easy to construct and can easily be tested on their reliability and unidimensionality. Furthermore, they do not suffer from some drawbacks of the Guttman, and Thurstone and Chave scaling procedures, as identified by Nunnally and Bernstein (see the Appendix for a description of the scales and the statistical properties of the scales).

The influence of the decision unit was measured by asking the farmer to indicate the extent to which persons surrounding him/her thought that (s)he should or should not use futures as a hedging tool by distributing 100 points across using futures as a hedging tool or not using them as a hedging tool.

The probability of using futures contracts was measured by asking the farmer to distribute 100 points across using futures as a hedging tool or not using them as a hedging tool.[7] Finally, the use of futures was based on past market activity, registering whether farmers had used futures in the last three years.[8]

Measuring Unobservable Constructs: A Confirmatory Factor Analytical Model

Because the unobserved variables are measured with a set of observable variables (so-called indicators), we adhered to the iterative procedure recommended by Churchill to obtain reliable and valid constructs. First, a large pool of questions

[6] Dutch 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 1990–97.

[7] Putte van den, Hoogstraten and Meertens showed that distributing 100 points across alternatives provides a more accurate measure: it forces respondents to make a trade-off between alternatives, thereby not assuming a particular comparison mechanism.

[8] Because we have accounting and survey data, we were able to distinguish between futures use for speculative and for risk management reasons. Our measure exclusively reflects futures usage in a hedging context.

(i.e., indicators) was generated. The indicators were based on the literature available. Care was taken to tap the domain of the construct as closely as possible. Next, the indicators were tested for clarity and appropriateness in personally administered pre-tests. The farmers were asked to complete a questionnaire and indicate any ambiguity or other difficulty they experienced in responding to the indicators, and to make any suggestions they deemed appropriate. Based on the feedback received from the farmers, some indicators were eliminated, others were modified, and additional indicators were developed. The resulting set of indicators was administered to the farmers in the large-scale personal interview.

Confirmatory factor analysis was used to assess the (psychometric) measurement quality of our constructs (Hair et al.). The factor analytical model assumes that the observed variables are generated by a smaller number of latent variables (called factors). The relationship between the observed and latent variables can be represented by the following matrix equation:

$$(1) \qquad \mathbf{x} = \boldsymbol{\Lambda}\boldsymbol{\kappa} + \boldsymbol{\delta}$$

where $\mathbf{x}$ is the $q \times 1$ vector of the n sets of observed variables (i.e., indicators), $\boldsymbol{\kappa}$ is the $n \times 1$ vector of underlying factors, $\boldsymbol{\Lambda}$ is the $q \times n$ matrix of regression coefficients relating the indicators to the underlying factors, and $\boldsymbol{\delta}$ is the $q \times 1$ vector of error terms of the indicators. Because we wish to develop unidimensional constructs, a construct is hypothesized to consist of a single factor. The overall fit of the model provides the necessary and sufficient information to determine whether a set of indicators describes a construct. Hence, equation (1) describes a measurement model.

In the Appendix the results for the confirmatory factor analysis are given. All factor loadings (i.e., the regression coefficients in $\boldsymbol{\Lambda}$ in equation (1)) were significant (minimum t-value was 4.60, $p < 0.001$) and greater than 0.4. These findings support the convergent validity of the indicators (Anderson and Gerbing). The composite reliabilities for the constructs ranged from 0.70 to 0.76, indicating good reliabilities for the construct measurements (see Appendix). The selected indicators are used in our structural model describing the relation between the farmers' characteristics and the farmers' probability of using futures, and the relation between the expressed probability of using futures and whether or not farmers had used futures.

Covariance Structure Model

The factor model in equation (1) estimates the latent variables from the observed variables but does not provide information about the structural relationship among these latent variables and the farmers' probability of using futures. Because the latent variables are measured with error, a covariance structure model is introduced that simultaneously estimates the latent variables from observed variables and estimates the structural relations between these variables and the farmers' probability of using futures and the choice for or against futures.

Let $\boldsymbol{\eta}$ be a $r \times 1$ vector of the endogenous latent variables (i.e., probability of using futures and futures usage), and let $\boldsymbol{\xi}$ be a $s \times 1$ vector of the exogenous latent variables (i.e, the farmers' characteristics).[9] The model assumes that the variables are related by the following system of linear structural equations:

$$(2) \qquad \boldsymbol{\eta} = \mathbf{B}\boldsymbol{\eta} + \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\varsigma}$$

where $\boldsymbol{B}$ is a $r \times r$ matrix of coefficients relating the latent endogenous variables to one another, and $\boldsymbol{\Gamma}$ is a $r \times s$ matrix of coefficients relating the latent exogenous variables to the endogenous variables. In the equations, $\boldsymbol{\varsigma}$ is a $r \times 1$ vector of errors indicating that the endogenous variables are not perfectly predicted by the structural equations. Equation (2) can be written alternatively as $\dot{\mathbf{B}}\boldsymbol{\eta} = \boldsymbol{\Gamma}\boldsymbol{\xi} + \boldsymbol{\varsigma}$, where $\dot{\mathbf{B}}$ is defined as $(I - B)$. It is assumed that: 1) all variables are measured as deviations from their means: $E(\boldsymbol{\eta}) = E(\boldsymbol{\varsigma}) = E(\boldsymbol{\xi}) = 0$ (this does not affect the generality of the model, since the structural parameters contained in $\boldsymbol{B}$ and $\boldsymbol{\Gamma}$ are not affected by this assumption), 2) none of the structural equations is redundant: $\dot{\mathbf{B}}$ exists, and 3) the errors in equations and the exogenous variables are uncorrelated: $E(\boldsymbol{\xi}\boldsymbol{\varsigma}') = 0$. The covariance matrix for the exogenous variables is: $\boldsymbol{\Phi} = E(\boldsymbol{\xi}\boldsymbol{\xi}')$, the covariance matrix for the errors in equations is: $\boldsymbol{\Psi} = E(\boldsymbol{\varsigma}\boldsymbol{\varsigma}')$ and the covariance matrix for the endogenous variables is

$$\begin{aligned} \mathrm{COV}(\boldsymbol{\eta}) &= E(\boldsymbol{\eta}\boldsymbol{\eta}') \\ &= \dot{\mathbf{B}}^{-1}(\boldsymbol{\Gamma}\boldsymbol{\Phi}\boldsymbol{\Gamma}' + \boldsymbol{\Psi})\dot{\mathbf{B}}^{-1}. \end{aligned}$$

[9] Note that the variable measuring whether or not farmers used futures is not a latent variable, therefore this variable is not measured with error, and hence, the measurement error of this variable is zero.

Unlike regression models, $\boldsymbol{\eta}$ and $\boldsymbol{\xi}$ are not required to be observable variables. Rather, $\boldsymbol{\eta}$ and $\boldsymbol{\xi}$ are related to observable variables **x** and **y** by a pair of confirmatory factor models as expressed in

$$(3) \quad \mathbf{x} = \boldsymbol{\Lambda}_{\mathbf{x}}\boldsymbol{\xi} + \boldsymbol{\delta}$$
$$\mathbf{y} = \boldsymbol{\Lambda}_{\mathbf{y}}\boldsymbol{\eta} + \boldsymbol{\varepsilon}$$

where **x** is a $q \times 1$ vector of observed exogenous variables (i.e., the indicators measured during the interview) and **y** is a $p \times 1$ vector of observed endogenous variables (i.e., the farmers' probability of using futures and choice of futures). $\boldsymbol{\Lambda}_{\mathbf{x}}$ is a $q \times s$ matrix of loadings of the observed **x**-variables on the latent $\boldsymbol{\xi}$ variables, $\boldsymbol{\Lambda}_{\mathbf{y}}$ and is a $p \times r$ matrix of loadings of the observed **y** variables on the latent $\boldsymbol{\eta}$ variables. The vectors of disturbances $\boldsymbol{\delta}$ $(q \times 1)$ and $\boldsymbol{\varepsilon}$ $(p \times 1)$ represent measurement errors (the so-called unique factors). Within each factor model (e.g., equation (3)) the unique factors may be correlated. That is, $\mathrm{COV}(\boldsymbol{\delta}) = E(\boldsymbol{\delta}\boldsymbol{\delta}') = \boldsymbol{\Theta}_{\delta}$ and $\mathrm{COV}(\boldsymbol{\varepsilon}) = E(\boldsymbol{\varepsilon}\boldsymbol{\varepsilon}') = \boldsymbol{\Theta}_{\varepsilon}$.

Since the variables are measured as deviations from their means, the covariance matrix for the observed variables can be written as

$$(4) \quad \boldsymbol{\Omega} = E\begin{bmatrix} \Lambda_y\eta\eta'\Lambda_y + \varepsilon\varepsilon' & \Lambda_y\eta\xi'\Lambda_x' + \varepsilon\delta' \\ +\Lambda_y\eta\varepsilon' + \varepsilon\eta'\Lambda_y' & +\Lambda_y\eta\delta' + \varepsilon\xi'\Lambda_x' \\ \Lambda_x\xi\eta'\Lambda_y' + \delta\varepsilon' & \Lambda_x\xi\xi'\Lambda_x' + \delta\delta' \\ +\Lambda_x\xi\varepsilon' + \delta\eta'\Lambda_y' & +\Lambda_x'\xi\delta' + \delta\xi'\Lambda_x' \end{bmatrix}.$$

Using the assumptions made about the zero covariances among variables and applying the definitions of the covariances among variables, the covariance can be expressed in terms of the parameters of the structural model:

$$(5) \quad \boldsymbol{\Omega} = \begin{bmatrix} \Lambda_y B^{-1}(\Gamma\Phi\Gamma' + \Psi) & \Lambda_y \dot{B}'^{-1}\Gamma\Phi\Lambda_x' \\ \times \dot{B}'^{-1}\Lambda_y' + \Theta_\varepsilon & \\ \Lambda_x\Phi\Gamma'\dot{B}'^{-1}\Lambda_y' & \Lambda_x\Phi\Lambda_x' + \Theta_\delta \end{bmatrix}.$$

This equation relates the variances and covariances of the observed variables to the parameters of the model. Estimation of the model involves finding values for the parameter matrices that produce an estimate of $\boldsymbol{\Omega}$ according to equation (5) that is as close as possible to the sample matrix **S** (e.g., the covariance matrix of the raw data).

Estimation Procedure

The covariance structure in equation (5) can be estimated by one of the full information methods: unweighted least squares, generalized least squares, and maximum likelihood. The fitting function measures show how close a given $\widehat{\boldsymbol{\Omega}}$ is to the sample covariance matrix **S**. Because of its attractive statistical properties, we use maximum likelihood procedures (Bollen). The maximum likelihood estimators minimize the following fitting function:

$$(6) \quad F_{ML}(\mathbf{S}; \widehat{\boldsymbol{\Omega}}) = \mathrm{tr}(\widehat{\boldsymbol{\Omega}}^{-1}\mathbf{S}) + (\log|\widehat{\boldsymbol{\Omega}}| - \log|\mathbf{S}|) - (r + s),$$

where $\log|\widehat{\boldsymbol{\Omega}}|$ is the log of the determinant of $\widehat{\boldsymbol{\Omega}}$, r is the number of endogenous variables (in our case $r = 2$) and s is the number of exogenous variables (in our case $s = 8$). If $\boldsymbol{\xi}$ and $\boldsymbol{\eta}$ have a multivariate distribution, the maximum likelihood procedure has desirable asymptotic properties, is scale invariant and has desirable properties for statistical testing (e.g., Anderson and Gerbing; Bagozzi; Bollen; Gerbing and Anderson).

Prior to the estimation, we tested whether the underlying assumptions of the covariance structure model 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). As a measure of association we used the covariances. As pointed out by Baumgartner and Homburg the use of covariances or correlations has no effect on the overall goodness of fit indices. However, standard errors may be inaccurate when using correlations. Therefore, we used covariances. The model can be estimated in the maximum likelihood LISREL framework developed by Jöreskog and Sörbom.

Results

First, we model the farmers use of futures across the whole sample. That is, we do not take heterogeneity into account, assuming the sample to be homogeneous. Table 1 shows that, in this case, the decision unit, perceived performance, exercising entrepreneurial freedom, and level of understanding significantly

Table 1. Results of Covariance Structure Models for the Whole Sample and Different Segments (equation 2)

		Probability of Using Futures								Use of Futures	
		Explanatory Variables								Explanatory Variables	
		DU	PP	EF	MO	RA	PRE	DAR	UNDER	Probability of Using Futures	
Total sample (N = 440)	Γ	**0.254**	**0.195**	**0.188**	0.042	0.156	0.123	0.004	**0.130**	*B*	0.682
	t-value	5.632	4.028	3.872	1.126	1.567	0.943	0.426	2.041		15.776
	Fit statistics	$\chi^2/\text{df} = 4.3$ $p = 0.01$ RMSEA = 0.09 GFI = 0.97 TLI = 0.78									
Segment 1 (N = 120) Spot market: cooperative	Γ	**0.212**	**0.201**	0.084	0.062	**0.306**	**0.212**	**0.091**	0.092	*B*	0.566
	t-value	2.203	2.488	1.422	1.246	3.246	2.228	2.066	1.567		13.682
	Fit statistics	$\chi^2/\text{df} = 1.0$ $p = 0.23$ RMSEA = 0.03 GFI = 0.94 TLI = 0.95									
Segment 2 (N = 320) Spot market: trader	Γ	**0.264**	**0.189**	**0.258**	**0.111**	0.172	0.148	0.036	0.980	*B*	0.599
	t-value	4.996	3.966	5.348	2.003	1.636	1.171	0.412	1.678		14.238
	Fit statistics	$\chi^2/\text{df} = 2.0$ $p = 0.01$ RMSEA = 0.05 GFI = 0.98 TLI = 0.92									

Note: Beta is the standardized regression coefficient that shows the relationship between the probability of using futures and the latent constructs. DU is the decision unit (indicating the influence of the farmer's spouse, partner and advisors on the probability of using futures), PP perceived performance, EF exercising entrepreneurial freedom, MO market orientation, RA risk attitude, PRE perceived risk exposure, DAR debt-to-asset ratio and UNDER the level of understanding futures. RMSEA is the root mean square error of approximation, GFI the goodness-of-fit index, and TLI the Tucker Lewis Index (Jöreskog and Sörbom). See footnote 11 for a detailed description of these measures.

influence the probability of using futures and consequently farmers' choice. Surprisingly, risk attitude and perceived risk exposure are not significantly related to the farmer's use of futures (Makus et al.; Shapiro and Brorsen).

We suspect that the sample is not homogenous. That is, we expect different groups of farmers use different criteria (attributes) when deciding to use futures. If this is the case, we might find that different factors influence their choice behavior, and that the common factors are weighted differently (i.e., the coefficients in matrix $\mathbf{\Gamma}$ in equation (2)).

To test for heterogeneity we use cluster analysis using squared Euclidian distances and Ward's method (error sum of squares method) (Punj and Stewart).[10] We found two distinct segments. Segment 1 consists of 120 farmers who have a relatively low probability of using futures. Segment 2 consists of 320 farmers who have a relatively high probability of using futures. In order to explore the differences between these two segments, we analyzed the characteristics of the farmers regarding the probability of using futures using the Mann-Whitney U test (Hinkle, Wiersma, and Jurs). The two segments mainly differed on their cash-trading behavior ("selling to a cooperative", $z = 4.88$ [$p = 0.00$] and "selling to a trader", $z = 5.28$ [$p = 0.00$]). These two segments do not significantly differ regarding age and education. So, while both segments may appear similar, different factors influence the use of futures contracts. Hence, we divide the sample into two segments and estimate the model for each segment.

From table 1 it is clear that risk attitude and perceived risk exposure do play a role in segment 1. Also, the debt-to-asset ratio plays a role for this segment, which is in line with the recent findings of Sharpiro and Brorsen, and Turvey and Baker. The value of taking heterogeneity into account is shown in this case. Had we treated the sample as homogenous, we would have concluded that risk attitude and perceived risk exposure do not influence the use of futures contracts, which would not have complied with financial theory. In segment 2 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. The role of understanding futures does not play a significant role any more when analyzing the two segments separately.

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.[11] 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 segments 1 and 2 shows a very good fit.

It appears that farmers in segment 1 use "financial structure" characteristics (as imbedded in the debt-to-asset ratio, risk attitude and the perceived risk exposure) in their decision to engage in futures, whereas the farmers in segment 2 use "marketing" characteristics (imbedded in market orientation and exercising entrepreneurial freedom) in their decision to engage in futures. Farmers in segment 1 (cooperative farmers) attach high value to "continuing the firm's operation for successors" whereas farmers who sell to traders (segment 2) attach value to "keeping up with markets and trying to get high prices".

Also, we estimated the models with multiple regression, using the sum scores of the latent constructs in the regression. This was done to test whether taking measurement error into account using a covariance structure model does indeed contribute to our understanding of farmers' behavior. In the multiple regression, the latent variables

[10] For a detailed explanation on cluster analysis, see Hair et al.

[11] The likelihood-ratio Chi-square statistic (χ^2) tests whether the matrices observed and those estimated 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). 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). Browne and Cudeck suggested that a value below 0.08 indicates a close fit (see Baumgartner and Homburg; Bentler; Hair et al.).

risk attitude, market orientation, and exercising entrepreneurial freedom were not significant, thereby substantiating the importance of taking measurement error into account. These results show that by taking measurement error into account we are able to detect relevant factors influencing farmers' use of futures that otherwise (i.e., in a regression framework) would not have been identified. The proposed modeling procedure is a more general modeling framework than the multiple regression framework as it can include directly observable variables and non-directly observable variables (constructs). This framework allows researchers to include farmers' perceptions when trying to understand farmers' behavior. Farmers' perceptions and beliefs appear to have relationships with revealed behavior.

Our results show that farmers are a heterogeneous group, suggesting that futures exchanges might consider offering different tools to different segments. Identifying the different segments is a challenge. With this information, the futures exchange could target their marketing efforts. Based on the characteristics of the different segments, they would be able to select a group of potential customers to whom they would offer a risk reduction service designed to match the customer's 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 farmers' cash trading pattern. In this regard, a challenge for further research would be to develop a method that simultaneously estimates all parameters, such that a set of parameters identifies the segments to which farmers belong, and that also represents the structural equation model within the segments. The recent findings by Jedidi, Jagpal, and DeSarbo on general finite mixture structural equation modeling relate to this.

Discussion and Conclusions

This study expands earlier work on farmer's use of futures by including their market orientation, perceived risk reduction and market performance, farmers' entrepreneurial behavior and perceived risk exposure as factors that influence futures usage. These factors are all non-directly observable variables and hence must be measured by a set of observable indicators. By introducing a modeling technique that is able to account for the measurement error of these variables, we were able to identify their effect on farmers' decision making. Not taking account of measurement error (e.g., using a multiple regression framework) would have led us to conclude that these factors do not play a role in farmers' decision to use futures. The proposed modeling method allowed us to confirm empirically a suggestion made by Working more than forty years ago, namely that futures usage is positively related with the extent to which farmers believe that using futures gives them greater freedom for business action. These results show the importance of farmers' perceptions, and psychological constructs in general, and the importance of taking measurement error into account, when attempting to understand farmers' futures usage behavior.

In this study we also included the influence of the members of the farmer's decision unit, such as husband, wife and successor, on futures usage. It appears that the opinions of these decision-unit members about futures have an influence on the farmer's futures usage. Hence, the decision to use futures is not solely made by the farmer, but it is also influenced by the opinions of others.

Special attention is paid to the fundamental driver of risk management: farmers' risk attitude. Although theory suggests that risk attitude should be related to futures usage, empirical research in agricultural economics does not always confirm that relationship (Goodwin and Schroeder). Here, risk attitude is an important determinant of futures usage for a particular segment of farmers. In this group of farmers (segment 1 in our study), other financial factors also play an important role, such as the debt-to-asset ratio, which is in line with the findings of Shapiro and Brorsen, and Turvey and Baker.

Because some of the theoretical constructs related to futures usage can not be measured directly, but must instead be estimated from multiple indicator measures, it is recommended to use a covariance structure modeling framework. This framework provides us with a method for estimating structural relationships among unobservable constructs and for assessing the adequacy with which those constructs have been measured. Such framework allows agricultural economists to include farmers' perceptions in their analysis. The proposed modeling approach is not a substitute but rather a complement to the regression framework used in previous studies on futures usage. These studies could have benefited from this modeling framework because it allows for explicit management of measurement error of the independent variables. As shown in this study, variables that seemed to play no role in explaining futures usage in a regression framework did play a role when measurement error was accounted for. Moreover, taking farmers' heterogeneity into account showed that different groups of farmers have different decision structures. Such information can be valuable for a futures exchange, especially when the exchange wishes to customize its hedging service.

Some caveats of our analysis should be mentioned. First, this paper focused exclusively on the level of the individual farmer, thereby not taking into account the farmer's commercial environment, that is, the marketing channel (s)he is in. Although Dutch hog farmers do not have as many alternative risk management instruments (there is virtually no forward trading) as their U.S. colleagues, we might expect the farmer's choice for futures contracts to interact with the risk management decisions made by the wholesaler or processor whom (s)he supplies. Second, we do not include transaction costs in our analysis. Recently, Lence showed that hedging costs are important determinants of hedging behavior. In the context of our model it would be interesting to include the farmers' perceived transaction costs. Third, the reason farmers 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; Fackler and McNew). For a futures exchange, it may therefore be interesting to add other types of futures contracts to the contracts already listed. This raises an important question that needs to be solved: is it beneficial to add new futures contracts to the existing ones? Further research that includes these elements are interesting avenues to explore.

Appendix. Description of the Scales Describing Farmer's Characteristics Using Confirmatory Factor Analysis

Farmers were asked to indicate their agreement with each item through a nine-point scale ranging from "strongly disagree" to "strongly agree".

Perceived Performance

Construct reliability = 0.76*

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.

Model is saturated resulting in a perfect fit ($\chi^2 = 0$; df $= 0$; $p = 1$).

Entrepreneurial freedom

Construct reliability = 0.75

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.

Model is saturated resulting in a perfect fit ($\chi^2 = 0$; df $= 0$; $p = 1$).

Perceived risk exposure

Construct reliability = 0.74

1. I am able to predict hog prices.
2. The hog market is not at all risky.
3. I am exposed to a large amount of risk when I buy/sell hogs.

Model is saturated resulting in a perfect fit ($\chi^2 = 0$; df $= 0$; $p = 1$).

Risk attitude

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.

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

Market orientation

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

Construct reliability = 0.74

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.

χ^2/df = 3.1 (p = 0.04); RMSEA = 0.06; GFI = 0.99; AGFI = 0.97; CFI = 0.98.

*The value of the construct reliability ranges between 0 and 1, with higher values indicating higher reliability (see Hair et al.)

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